Inflation-Linked Research

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Global Inflation-Linked Products

A User's Guide

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INTRODUCTION

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The global inflation market has continued to grow since the publication of *The Global Inflation-linked Products: A User's Guide* in May 2012. Barclays World Government Inflation-linked Bond index has increased to $2.3trn, with over $1trn of that from TIPS, and our Emerging Market Government Inflation-linked Bond index has again topped $500bn after falling in 2013. The number of countries issuing inflation-linked debt has expanded as well, with New Zealand starting its program in 2012, India in 2013 and Spain earlier this year. Additionally, Japan re-launched its JGBi issuance (with par floors this time) in 2013 after halting it in 2008.

Demand for inflation-linked debt remains robust, as it continues to hold up well in asset allocation frameworks. In the themes section, we update our asset allocation analysis and show that "After a storm, TIPS still pass the test". Holders of inflation-linked bonds are increasingly focused on adding alpha through more active trading, and we update our "Finding relative value" piece, also in the themes section, by adding UK and EUR relative value frameworks to our US TIPScores valuation. Low real yields and realized inflation have resulted in a slowing of structural allocations over the past two years from new investors, and many, particularly those in retail funds, have become increasingly aware that linkers are real yield products that have duration and are not pure inflation instruments. Existing investors, in particular official institutions, continue to increase and broaden their holdings; for example, US Treasury data show that foreign investors increased their allocation to TIPS by about $100bn from June 2012 to June 2013, a figure greater than net issuance over that period.

Inflation risk premiums across most markets appear low. While this may be justified by current low levels of realized volatility in inflation and markets, we expect it to rise along with inflation in the coming years, which makes linkers generally attractive versus their nominal counterparts from a structural insurance perspective. Another structural factor that could affect linker markets is global demographic trends. In the theme piece "Economic implications of demographic change," we highlight that potential growth may be slowing in some countries, justifying structurally lower real yields, but the effect of demographic trends on inflation depends largely on the monetary policy response.

As with each past version, our main goal of *The Global Inflation-linked Products: A User's Guide* is education. We provide the market backgrounds and analytical details to help new investors understand inflation-linked bonds and derivatives, while also providing a valuable reference guide for all market participants. The first section explains the products within the inflation-linked universe, and how they work, through a series of primers, including a detailed section on linear and non-linear inflation-linked derivatives. The second outlines the features of each country's individual market. Lastly, we address key issues for the asset class, including modeling structural breaks in real yield trends and an overview of inflation-linked resources on Barclays Live.

This is the sixth guide with which I have had the privilege of being involved, and, along with previous versions by my predecessors, I believe each one is emblematic of Barclays' long-standing commitment to this asset class. We hope that you find this guide useful for navigating global inflation markets in the coming years and that it helps to manage risk successfully and generate profitable investment decisions.

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INFLATION PRODUCTS

Linker cash flows and yields

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Inflation-linked bonds can trade in different formats, but there has been a trend for the so-called "Canadian model" to be accepted as the standard framework. The indexation of cash flows in linkers adds a level of complexity relative to the nominal market, although the pricing principles, or "bond maths", are generally similar.

Inflation-linked bonds trade in a variety of formats. One common feature across sovereign linker markets, though, is that cash flows are based on a variable principal adjusted for inflation, ie, indexed to the growth of the linking price index, over the life of the bond. In all cases, this indexation will contain a lag mechanism, given that inflation data for any period are published with a delay. The indexation methods, as one can see across this publication, are different across markets, with the lag applied also varying. However, there has been, in the developed markets at least, a tendency for harmonization, with the so-called "Canadian model" now established as the standard trading format, given its simplicity. Also, in many markets, in particular the developed ones, linkers contain an embedded floor such that the principal repayment at maturity cannot be below par.

The Canadian model

We start with a simple illustration of the concept of indexation. We ignore indexation lags and deflation floors for now. We consider a newly issued 2y inflation-linked bond. Its principal is therefore still at par (at 100), as inflation has not yet started to accrete on the bond. The principal is adjusted for inflation, ie, for the growth of the linking price index, over the life of the bond, with annual coupon payments at a rate of 3% calculated off this adjusted principal. We assume that the value of the index is currently 125 and that at the end of the first year, its value is 130; inflation over the first year is therefore 4%. The indexed principal becomes 104 (ie, 100 * 130 ÷125). The coupon paid at the end of that first year is therefore calculated as 3% * 104 = 3.12. At the end of the second year, the index is 133, so inflation over the second year is 2.31%. Inflation over the two-year period, measured by the index increase from 125 to 133, is 6.4%. At the end of that second year, the indexed principal, which is reimbursed, is therefore 106.4 (ie, 100 * 133 ÷ 125) and the coupon paid is 3% * 106.4 = 3.192.

For longer-dated bonds, the same principle would apply. For simplicity, we assume, for the time being, that we are looking at a new bond which is being issued at present; ie, there is no inflation that has accreted yet on the principal. In general, if we assume such a linker with annual coupons, we can write its future cash flows as follows:

$$\text{Cash flow at end of year t} = \text{cash flow before adjustment for inflation} * \frac{I_t}{I_0},$$

Where:

I_t is the price index value at the end of year t

I_0 is the price index value at present

So we can write, for a principal of 100:

$$\text{Coupons at end of year t} = 100 * \text{IC\%} * \frac{I_t}{I_0}$$

Principal repayment at maturity = 100 * $\frac{I_m}{I_0}$,

Where:

IC% is the linker's coupon rate

m is the year of maturity

By definition, future inflation is unknown; therefore, the future cash flows formulated above are unknown. Nevertheless, these cash flows are expressed in nominal terms. Therefore, if we take one of these coupon payments, its present value can be represented by:

Present value of coupon at end of year t = 100 * IC% * $\frac{I_t}{I_0} * \frac{1}{(1+N_t)^t}$

Where: $\frac{1}{(1+N_t)^t}$ is the nominal discount factor for a cash flow at the end of year t.

Similarly, we can write:

Present value of the principal repayment at maturity = 100 * $\frac{I_m}{I_0} * \frac{1}{(1+N_m)^m}$

These are familiar concepts which are analogous to the pricing principles of a common nominal bond where the price represents the sum of discounted future cash flows. In practice, for a nominal bond, a nominal yield to maturity can be found such that the sum of future cash flows discounted using that nominal yield equals the price of the nominal bond. This is the widely known present value formula for a nominal bond:

$$\text{Invoice price of nominal bond} = \sum_{t=1}^{m} \frac{100 * C\%}{(1+N_t)^t} + \frac{100}{(1+N_m)^m}$$

$$= \sum_{t=1}^{m} \frac{100 * C\%}{(1+NY)^t} + \frac{100}{(1+NY)^m},$$

Where:

C% is the nominal bond's coupon rate

NY is the nominal yield to maturity on the nominal bond

For a linker, the full invoice price (which we note P^F) also represents the sum of discounted cash flows, and given the above, the formula is expressed as:

$$P^F = \sum_{t=1}^{m} \left[\frac{I_t}{I_0} * \frac{100 * IC\%}{(1+N_t)^t} \right] + \frac{I_m}{I_0} * \frac{100}{(1+N_m)^m} \qquad (1)$$

Obviously, this formula, in that form, is not useful for a linker. Indeed, given that future values of I_t are unknown, an average yield to maturity cannot be calculated. To circumvent that issue, let us define the concept of a real return for an asset, which is its nominal return adjusted for inflation. For example, let us assume that average annual nominal return over three years is 5% and that the price index increases from 125 to 140 over that period. The factor representing the growth, in nominal terms, is given by $(1+5\%)^3$. To get the change in "real" terms, the growth in the price index has to be accounted for. We get $(1+5\%)^3 \div (140 \div 125) = (1+1.107\%)^3$, where 1.107% represents the average annualised real return.

In the same way, $(1+N_t)^t$ in the nominal discount factor term above implicitly represents the nominal growth of a cash flow from now to the end of year t. Divided by $\frac{I_t}{I_0}$, it therefore represents the growth in real terms, ie, adjusted for inflation. We write it as:

$$(1+N_t)^t \div \frac{I_t}{I_0} = (1+R_t)^t$$

We can therefore reformulate expression (1) as:

$$P^F = \sum_{t=1}^{m} \frac{100 * IC\%}{(1+R_t)^t} + \frac{100}{(1+R_m)^m} \qquad (2)$$

The term $\frac{1}{(1+R_t)^t}$ can be interpreted as a "real" discount factor for a cash flow occurring at the end of year t. Expressed this way, the price formula is more useful; the (unknown) values of I_t have been eliminated and an average "real yield to maturity" can then be found such that the sum of cash flows (before adjustment for inflation) discounted using that real yield is equal to the linker's price.

$$P^F = \sum_{t=1}^{m} \frac{100 * IC\%}{(1+RY)^t} + \frac{100}{(1+RY)^m} \qquad (3)$$

where RY is the real yield to maturity of the linker.

This is the general principle of the Canadian model. Its simplicity lies in the fact that there is no need to make any assumption about future inflation. To calculate yield metrics, the usual and familiar present value framework is used, but with everything expressed in "real" terms. This real yield can intuitively be interpreted as a yield that is earned above inflation if the linker is held to maturity.

Up to now, for the sake of simplicity, we have considered a bond that is being issued at present, so the principal has no inflation accretion yet and is at par. We generalise the framework to the case of a "seasoned" bond, where the principal has already started to be adjusted with the growth of the linking price index. In that case, and following on the formulation above, the cash flow at the end of year t is rewritten as:

Cash flow at end of year t = cash flow before adjustment for inflation $* \frac{I_t}{I_{base}}$, Where: I_{base} corresponds to the value of the price index at the point in time when indexation of the principal starts. We refer to that point in time as the base index date.

Therefore, we modify the price formula (1) to get:

$$P^F = \sum_{t=1}^{m}\left[\frac{I_t}{I_{base}} * \frac{100 * IC\%}{(1+N_t)^t}\right] + \frac{I_m}{I_{base}} * \frac{100}{(1+N_m)^m}$$

However, we can decompose $\frac{I_t}{I_{base}}$ as a combination of the index growth from the base index date until now and from now until the end of year t. So we write:

$$\frac{I_t}{I_{base}} = \frac{I_0}{I_{base}} * \frac{I_t}{I_0}$$

Consequently, we have:

$$P^F = \sum_{t=1}^{m}\left[\frac{I_0}{I_{base}} * \frac{I_t}{I_0} * \frac{100 * IC\%}{(1+N_t)^t}\right] + \frac{I_0}{I_{base}} * \frac{I_m}{I_0} * \frac{100}{(1+N_m)^m}$$

If we divide both sides of the expression by $\frac{I_0}{I_{base}}$, we get:

$$P^F \div \frac{I_0}{I_{base}} = \sum_{t=1}^{m}\left[\frac{I_t}{I_0} * \frac{100 * IC\%}{(1+N_t)^t}\right] + \frac{I_m}{I_0} * \frac{100}{(1+N_m)^m} \quad (4)$$

The right-hand sides of expressions (1) and (4) are the same. Therefore, in the same way that we moved from expression (1) to (2), we have:

$$P^F \div \frac{I_0}{I_{base}} = \sum_{t=1}^{m}\frac{100 * IC\%}{(1+R_t)^t} + \frac{100}{(1+R_m)^m} \quad (5)$$

We can see that the right-hand sides of expressions (2) and (5) are the same. This is very convenient, as this means that, just as in expression (3), we can reformulate the expression using a real yield to maturity:

$$P^F \div \frac{I_0}{I_{base}} = \sum_{t=1}^{m}\frac{100 * IC\%}{(1+RY)^t} + \frac{100}{(1+RY)^m} \quad (6)$$

Expression (6) represents a general case where the linker's principal has already started accreting inflation. Expression (3) refers to a special case where the base index date is the current date, such that $\frac{I_0}{I_{base}}=1$.

Intuitively, $P^F \div \frac{I_0}{I_{base}}$ represents a price from which inflation that has already accreted has been extracted. It represents a price unadjusted for past inflation accretion and in the Canadian model, prices are quoted on that unadjusted basis. In that case, as per expression

(6), the framework allows a real yield to maturity to be easily calculated. Obviously, when a linker is bought, this unadjusted quoted price will need to be adjusted for accreted inflation to determine the effective price paid, as we shall see shortly.

With the general principles of the Canadian model laid out, we look precisely at how they are applied in practice. In particular, the indexation of the principal is always done with a lag. This is because price index data are not available in real time. For example, on 20 May 2014, the latest euro HICPx index value available was for April 2014, which was printed around mid-May. Also, consumer price data typically have a monthly frequency, whereas linkers trade on a daily basis. Reference values of the linking index therefore need to be computed so that the principal can be adjusted for every trading day. In the Canadian model, a “Daily Reference index” (DRI) is calculated for each settlement date. It is usually computed as a linear interpolation between the published CPI values for two consecutive months in the past. Typically, the DRI is calculated as follows (the result is usually truncated to six decimal places and rounded to five decimal places):

$$DRI_{d,m} = CPI_{m-3} + \frac{(d-1)}{D_m} * \left(CPI_{m-2} - CPI_{m-3}\right)$$

Where:

CPI_{m-2} is the price index for month m-2

CPI_{m-3} is the price index for month m-3

D_m is the number of days in month m

m is the month in which settlement takes place

d is the day of the month on which settlement takes place

The base index value of a linker is the DRI which is calculated for the date from which inflation accretes. This “base date” does not always correspond to the initial settlement date of the bond. For example, in France, the accrual date of the first coupon is typically before the initial settlement date of the bond; ie, at issuance, the bond already has an accrued coupon element. In that case, the “base date” would be the same as the accrual date of the first coupon. In other words, even at issuance, the bond’s principal would already have accrued some inflation.

For every settlement date, an index ratio (IR) is calculated to measure the inflation adjustment for the principal. This is usually rounded to five decimal places.

$$IR_{d,m} = \frac{DRI_{d,m}}{DRI_{base}}$$

Cash flows are calculated based on the IR. We take an Italian linker, the BTP€i 15 September 2017 (noted BTP€i17), as an example. It pays coupons semi-annually, where the annual coupon rate is 2.1%, linked to the euro HICPx. We calculate the semi-annual coupon paid on 15 March 2013:

DRI_{base} = 100.88323 (which is the DRI for 15 March 2006, the base date of the bond)

Euro HICPx December 2012 = 116.39

Euro HICPx January 2013 = 115.13

$DRI_{15\,March\,2013}$ = $116.39 + \frac{(15-1)}{31} * (115.13 - 116.39) = 115.82097$ (rounded)

$$IR_{15\,March\,2013} = \frac{115.82097}{100.88323} = 1.14807 \text{ (rounded)}$$

So the semi-annual coupon paid on 15 March (for a notional of 100) was:

$$\frac{2.1\%}{2} * €100 * 1.14807 = €1.2054735$$

Similarly, the principal repayment at maturity for a linker is determined by the IR corresponding to that date. For example, the OAT€i12 matured on 25 July 2012 and the IR corresponding to that date was 1.24130. On a €100 notional, the principal repayment was therefore €124.13.

In the Canadian model, the IR is also used to calculate the full settlement price (ie, the total monetary price that is actually paid to the seller) when a linker is traded, as the price which is quoted is unadjusted for past inflation accretion. Note that, as for nominal bonds, prices are quoted in "clean terms", ie, without accrued coupon. So in general, the settlement price for settlement day *d* of month *m* is calculated as follows:

$$P^F_{d,m} = IR_{d,m} * \left(P^{cu}_{d,m} + AC_{d,m}\right), \textit{where we can note } P^{cu}_{d,m} + AC_{d,m} = P^{du}_{d,m}$$

where:

$P^{cu}_{d,m}$ is the quoted "screen" clean price, unadjusted for past inflation accretion and without accrued coupon

$AC_{d,m}$ is the accrued real coupon, before adjustment for inflation, on the settlement date

$P^{du}_{d,m}$ is the "dirty" price, unadjusted for past inflation accretion with accrued real coupon

We illustrate the calculation of the settlement price in the Canadian model for the OAT€i 25 July 2020 (linked to euro HICPx).

Bond: OAT€i 25 July 2020

Real coupon rate: 2.25%, paid annually

Trade date: 20 May 2014

Settlement date: 23 May 2014

Quoted price $(P^{cu}_{23\,May\,2014})$ = 115.91

Previous coupon date: 25 July 2013

Next coupon date: 25 July 2014

Number of days between last coupon date and settlement date: 302

Number of days between last and next coupon date: 365

Real accrued coupon (on €100 notional) = $AC_{23\,May\,2014}$

$$= \frac{302}{365} * 2.25\% * 100 = 1.86164...$$

DRI_{base} = 96.08560 (which is the DRI for 25 July 2003, the base date of the bond)

Euro HICPx February 2014 = 116.28

Euro HICPx March 2014 = 117.39

$$DRI_{23May2014} = 116.28 + \frac{(23-1)}{31} * (117.39 - 116.28) = 117.06774 \text{ (rounded)}$$

$$IR_{23May2014} = \frac{117.06774}{96.08560} = 1.21837 \text{ (rounded)}$$

Therefore, settlement price = $1.21837 * (€115.91 + €1.86164...) = €143.4894...$

The usual indexation lag for Canadian-style linkers is the same as the one illustrated above. However, some countries have slightly different inflation lags. For example, in Japan, the three-month lag is to the tenth of the month, rather than the first, and in South Africa the lag is four months. Other variations can apply. In Sweden, for instance, day count conventions for inflation accrual are based on a linear rate that assumes 30 days in each month, which means discontinuous accretion at month-end for months that are not this length. The Swedish market also trades almost entirely on a real yield basis, with quoted prices including inflation uplift, as Canadian conventions were adopted only after the market began.

Some other trading formats

The Canadian model has proven very popular, due to its simplicity, and the developed linker markets have generally adopted that framework. Other trading formats used in some markets also provide a real yield measure but the price indexation methodologies can be very different. The individual country sections later in this publication provide thorough explanations of these. Here, we outline the main characteristics for some.

Old-Style UK linkers

Issuance in UK linkers is now exclusively in Canadian-style bonds. However, the stock of “old-style bonds” is still significant. Old-style linkers trade in clean price cash (nominal) terms (ie, not unadjusted for inflation). The traded price rises and falls to reflect inflation that has occurred. Because they trade in nominal terms, it is necessary to know the inflated value of the next coupon so that the true accrued coupon can be calculated. As a result, indexation is done with an eight-month lag. The derivation of the real yield measure also entails an inflation assumption to project the future value of the bond’s cash flows.

Australia

Australian linkers are similar to old-style UK index-linked bonds in that the inflated value of the next coupon amount is always known, but indexation is done with a six-month lag. It is noteworthy also that the Australian CPI is published on a quarterly basis. The calculation of cash flows (coupons and principal repayment) is significantly different from other markets and is based on a mathematical formula.

Latin-American linkers

Given the experience of very high inflation in many Latin American countries, the indexation lags tend to be shorter than in the developed markets. Typically, this means that once an index value is published, it is “instantaneously” integrated in the indexation calculations.

In Brazil, bonds linked to the IPCA consumer price have an indexation lag which implies that their actual value in the early part of each month cannot be computed using the published index values. During this period, the bonds are priced off a consensus expectation for the next IPCA number, calculated from the official ANBIMA's (Brazilian Association of Financial and Capital Market Companies) inflation forecast. The market then switches to the actual value of the IPCA once it is released.

In Mexico, the UDI inflation index is released twice a month such that there is a very short de facto lag in the indexation mechanism. In each period, the UDI index changes by the daily geometric equivalent of the corresponding bi-weekly inflation rate. That said, the daily interpolating of the Reference Index means that the mechanics are very similar to the standard Canadian model.

In Argentina, linkers are based on the CER Index, which is calculated via a formula using the geometric mean of the changes in the Argentine CPI, with the latter tracked with a one-month lag. Prices are quoted in nominal terms, but once this is adjusted for past inflation, a real yield can then be computed in much the same way as for a Canadian-style linker.

Israel

In Israel, indexation has a one- to a one-and-a-half-month lag. There is no official daily indexed reference, so the principal and coupon can have step moves according to the release of the latest CPI report. Given that the quoting convention is to use the inflation-adjusted prices, the latest CPI report is used to compute the index ratio from the time of issue. The inflation-uplifted price can then be deflated and an implied real yield derived.

The breakeven concept

Inflation-linked bonds provide a real yield. To gauge the total yield that is earned, ie, in nominal terms, one needs to add inflation to that real yield. For instance, if a 10y linker carried a real yield of 2.5% when it was bought and annualised inflation over that 10y holding period was 2.2%, then the nominal-equivalent yield that would have been earned is roughly 4.7% (assuming reinvestment of coupons at the same initial yield and ignoring compounding effects). Put differently, if a 10y nominal bond is currently quoted with a nominal yield of 4.7% and a 10y linker (same issuer, credit quality, etc., as the nominal bond) currently trades with a real yield of 2.5%, this means that annualised inflation over the 10y holding period needs to be about 2.2% in order for the total realised nominal-equivalent yield on the two bonds to be equal at 4.7% (excluding frictions due to coupon reinvestments, different coupons dates, compounding, etc.). If the market functions on a no-arbitrage opportunity principle, this suggests that it is effectively expecting inflation to be about 2.2% annualised over the coming ten years. Indeed, if expected inflation is not 2.2%, for instance lower at 2%, this effectively means that the total return to maturity on the nominal bond is expected to be higher than for the linker. Theoretically, this would drive demand for the nominal bond and selling pressures in the linker until the nominal/real yield spread adjusts to 2%.

The Fisher equation, as we shall see in more detail later, provides the theoretical connection between real and nominal yields. In Fisher's framework, a nominal yield can be broken down into three components: inflationary expectations, a required real yield that investors demand over and above those inflationary expectations, and a risk premium element such that:

(1 + nominal yield) = (1 + real yield)*(1 + expected inflation)*(1 + liquidity-adjusted inflation risk premium)

The inflation risk premium reflects the assumption that investors require additional compensation for accepting the undesirable inflation risk inherent in holding nominal bonds, but this is usually offset by the liquidity discount of linkers versus nominals. In practice, what is most relevant for investors is the level of future inflation that would equate the returns on a linker and the nominal bond to which it is being compared. This level of inflation is commonly referred to as "breakeven inflation" or "breakeven" and is such that:

(1 + nominal yield) = (1 + real yield)*(1 + breakeven)

If the nominal and real yields are low, the previous equation above can be expressed in an additive form and we have:

Breakeven = nominal yield - real yield

Following the above, the breakeven priced by the market is a combination of expected inflation and the liquidity-adjusted risk premium. However, the latter is somewhat of an elusive concept and the breakeven is essentially interpreted as the market's pricing or expectation of future inflation. There is no exact rule for choosing the nominal comparator of a linker. Of course, it typically needs to be from the same issuer and of a maturity which is as close as possible to that of the linker. However, sometimes, a different nominal bond with a less close maturity may be preferred because it is more liquid and its valuation less subject to distortions. A liquid nominal comparator is important, because linkers also trade on a breakeven basis; ie, market participants would trade a linker against its nominal comparator to express a view on the evolution of the breakeven. Usually, there is a consensus in the market about what is the assumed nominal comparator for a linker when talking about its breakeven.

Embedded deflation floors in linkers

The inclusion of a deflation floor on the principal at maturity is a common feature for Canadian-style linkers, although Canadian linkers themselves do not have such floors embedded in them. The idea of the floor is simple: the principal reimbursed at maturity cannot be below par, even if the index ratio applicable at maturity is less than one. Effectively, this means that if there is a deflation floor, we have:

Principal repayment at maturity = $Max\left\{Par, Par * IR_{maturity\ date}\right\}$

What needs to be stressed here is that except for Australia, the floor applies only to the principal repayment at maturity, not on coupons. If during the life of the bond the index ratio is below 1 for a coupon payment date, the coupon will be paid off a sub-par principal.

It is also important to note that what is floored is the inflation accretion from the base date to maturity, not the accretion from the current settlement date to maturity. Let us consider a linker which had an initial 15y maturity when it was issued five years ago, such that it now has a remaining maturity of 10 years. We assume that the current index ratio (IR) on that bond is 1.12; ie, 12% of inflation has already accrued on its principal. We consider that over the coming ten years, there is deflation such that the index ratio at maturity would be 1.05. In that case, the principal repaid would be 1.05*100 =105. There has been deflation, but it has not been severe enough to completely reverse the initial increase in the index ratio and push it below 1. On the other hand, if the index ratio at maturity is 0.98, the floor will kick in; the principal repaid would be 100.

When many breakevens turned negative in 2008 and the developed world experienced deflation in 2009, market participants started to look more closely at the embedded deflation floors in linkers. Prior to that, deflation was seen as a very remote possibility and the value attached to these floors was negligible. When the market started to price the threat of deflation, especially for US TIPS, it became crucial to understand how floors affect the valuation of different bonds.

Let us assume an environment where the market expects deflation overall over the coming five-year period. We consider two linkers which have the same residual maturity of five years. The first has just been issued so that its index ratio is currently 1; ie, no inflation has accrued yet on its principal. The second is a seasoned bond which was issued ten years ago, and its index ratio is currently 1.20. We assume that the market believes that deflation over the coming five years will be 2% annualised. This means that the factor representing the fall in the price index over the five-year period is $(1\text{-}2\%)^5 = 0.904$. Therefore, given that its index ratio is currently 1, the market is pricing the index ratio of the first bond to be 1 * 0.904 = 0.904 at its maturity. However, the principal on that bond is floored at par such that the market cannot price/integrate that deflation fully in that bond. The deflation can, of course, be priced on the coupon payments, but this effect is marginal. On the other hand, taking again the market's deflation expectations, the index ratio at maturity on the seasoned bond would be expected to be 1.20 * 0.904 = 1.085. This is above 1, so that the market can fully price expected deflation in that bond.

What we have implicitly shown is that the amount of inflation that has already accrued on a bond determines the extent to which the deflation floor is out of or in the money. To illustrate this, we compare two bonds as of 30 April 2012, the TII January 2017 and the TII April 2017.

FIGURE 1

Seasoned bonds can integrate more deflation than recently issued ones

Trade date	20 May 2014	
Settlement date	21 May 2014	
	TII 2.125% Jan 2019	**TII 0.125% Apr 2019**
Maturity date	15 January 2019	15 April 2019
Issuance date	15 January 2009	30 April 2014
Remaining time to maturity	4.654 years	4.901 years
Base CPI value	214.69971	234.31967
DRI for 21 May 2014	235.75648	235.75648
IR for 01 May 2012	1.09808	1.00613
Annualized deflation needed for the IR to equal 1 at maturity	**2.03%**	**0.12%**

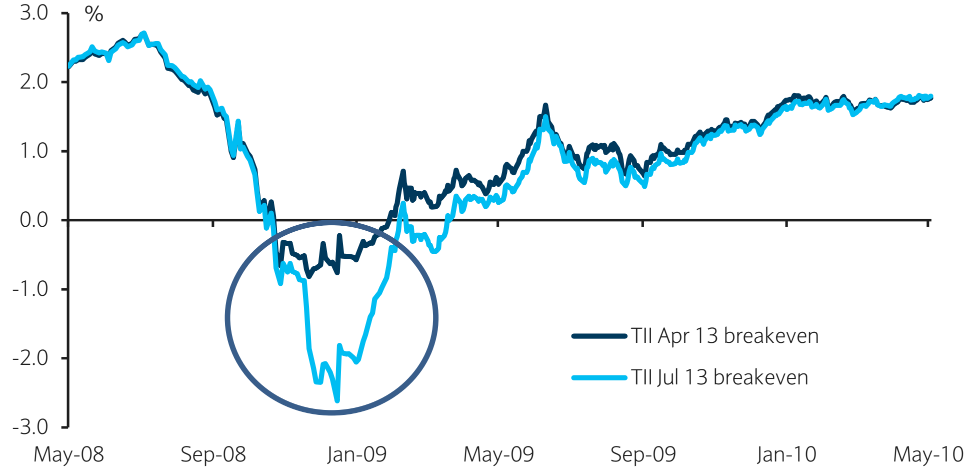
Source: Barclays Research

Figure 1 shows that given that the TII April 2019 has recently been issued, only very little inflation has accreted on it. Therefore, even if the annualized deflation to maturity is negligible, its index ratio at maturity will hit 1. Implicitly, this means that the strike of its deflation floor, expressed in annualized terms, is 0.12%. The TII Jan 2019, on the other hand, is a seasoned bond. It can withstand annualized deflation of about 2.03% for its index ratio to hit 1 at its maturity. The strike of its deflation floor is therefore about -2.03%.

Deflation floor strikes in different, albeit close maturity, TIPS had a strong influence on relative breakevens towards the end of 2008/start of 2009, when the market was at its peak in pricing deflation. This is quite explicit in Figure 2. The TII Jul 2013 was more seasoned than the TII Apr 2013 and therefore had accreted much more inflation. At that time, the deflation strike of the TII Apr 2013 was about -0.9%, so the lowest breakeven that the market priced on it was about -0.8%. The deflation strike on the TII Jul 2013 was significantly lower and the market pushed its breakeven to as low as -2.6% in December 2008. Therefore, when the market is keen to price deflation, there can be a significant disconnect between the breakevens of even close maturity bonds. Once breakevens started rising in 2009, those of the TII Apr 2013 and TII Jul 2013 converged again, reflecting the fact that at higher breakeven levels, the value of the embedded floors become negligible and therefore do not affect relative breakeven valuations significantly.

FIGURE 2

Relative floor valuations can trigger a sharp divergence in breakevens



Source: Barclays Research

INFLATION PRODUCTS

Real yield and breakeven carry

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Carry is an essential concept for analysing inflation-linked bonds. Inflation accretion can be very different from one month to another because of factors such as seasonality and energy price volatility. In periods of extreme seasonality or discrete shocks to inflation, the carry on linkers can be significant and therefore needs to be factored in when evaluating the richness/cheapness of valuations or interpreting market moves.

Carry is a much more important factor for linkers than nominal bonds, although the general concept is similar in both cases: it is the required change in yield over a specified holding period such that the total income received (intermediate coupon payments + the difference between the purchase and selling invoice price of the bond) is equal to the repo cost of financing that position. Carry is basically the required change in yield such that the non-arbitrage principle holds. For a linker, what is calculated is, of course, a real yield carry. As we shall see, this is inherently volatile from one month to another because of seasonality in price indices, and for some periods, the magnitude of that carry can be significant. We explain the mechanics of carry calculations in the Canadian model.

The income or return from buying and holding a linker over a period has three components: any coupon payments received and/or coupon accrual, the inflation accretion on the principal and the change in the quoted "real" price. As we explain in "Seasonality: Estimation and adjustment" later in this publication, consumer price indices exhibit patterns over specific periods of a year that tend to be reproduced from one year to another. For example, in the euro area, monthly euro HICPx inflation is typically very negative in January because of the sales period. Given the lag in the indexation of bonds linked to the euro HICPx, January's very negative monthly inflation would accrete on such a linker's principal from 1 March to 1 April (in terms of settlement date). Therefore, if one buys the linker at the start of and holds it over that period, the inflation accretion component will tend to be very negative. This means that for the total income from holding the bond to equal the repo cost, the quoted "real" price (ie, the price before inflation indexation is applied) must rise a lot or, put differently, the real yield on the linker will need to fall. Therefore, the real yield carry of holding a euro HICPx linker over that period would be negative. On the other hand, monthly euro HICPx inflation tends to be very positive in March and April. The combined inflation from those two months would accrete on a linker from 1 May to 1 July; therefore, the real yield carry over that period will tend to be very positive.

We illustrate the exact carry calculations via an example. Consider an OATi, linked to the French CPI ex-tobacco (FRCPIx), bought on 17 April 2012. We calculate the carry to 22 May 2012.

Bond: OATi 25 July 2017

Real coupon rate: 1%, paid annually

Trade date: 17 April 2012

Settlement date: 20 April 2012

Quoted price $\left(P^{cu}_{20\,April\,2012}\right)$ = 104.08, corresponding to a real yield of 0.219%

Previous coupon date: 25 July 2011

Next coupon date: 25 July 2012

Number of days between last coupon date and settlement date: 270

Number of days between last and next coupon date: 366

Real accrued coupon (on €100 notional) = $AC_{20\,April\,2012}$

$$= \frac{270}{366} * 1\% * €100 = €0.737705...$$

DRI_{base} = 111.17742 (which is the DRI for 25 July 2005, the base date of the bond)

FRCPIx January 2012 = 123.06

FRCPIx February 2012 = 123.58

$DRI_{20\,April\,2012}$ = $123.06 + \frac{(20-1)}{30} * (123.58 - 123.06) = 123.38933$ (rounded)

$IR_{20\,April\,2012} = \frac{123.38933}{111.17742} = 1.10984$ (rounded)

Settlement price paid = $1.10984 * (€104.08 + €0.737705) = €116.3309\ldots$

We now look at calculations for 22 May 2012, the trading date to which carry is calculated. This is commonly known as the forward trade date.

Corresponding settlement date: 25 May 2012 (called the forward settlement date)

Holding period = 35 days (calculated as difference between the settlement dates)

Assumed repo rate for financing the purchase of the bond: 0.14%

There are no intermediate coupon payments over the holding period in this case. Therefore, the income from the position will consist only of the difference between the settlement price to be received when the bond is sold and that paid at the beginning to purchase it. To calculate the carry, we need to find the settlement price received that makes the total income equal to the repo cost. This is called the forward settlement price. So we have:

Forward settlement price – Settlement price paid = Repo Cost

Forward settlement price = Settlement price paid + Repo Cost

Repo Cost = $\frac{Holding\ period\ in\ days}{360} * repo\ rate * Settlement\ price\ paid$

$$= \frac{35}{360} * 0.14\% * €116.3309$$

$$= €0.0158$$

Forward settlement price = $€116.3309 + €0.0158$

$$= €116.3467$$

This forward settlement price has been derived using a non-arbitrage principle, ie, derived in such a way that the return received is equal to the financing cost. We now need to find the real yield that corresponds to a settlement price of €116.3467 on the 25 May 2012 forward settlement date. Being a settlement price, it should be inclusive of everything, ie, the accrued coupon on the forward date, and importantly, inflation adjusted by the index ratio corresponding to the forward date. We have seen in "Linker cash flows and yields" that for a real yield to be extracted from a linker's price, that price needs to be expressed without the adjustment for past inflation accretion. We therefore need to divide €116.3467 by the index ratio that corresponds to the forward settlement date.

FRCPIx February 2012 = 123.58

FRCPIx March 2012 = 124.63

$$DRI_{25\,May\,2012} = 123.58 + \frac{(25-1)}{31} * (124.63 - 123.58) = 124.39290 \text{ (rounded)}$$

$$IR_{25\,May\,2012} = \frac{124.39290}{111.17742} = 1.11887$$

Forward settlement price unadjusted for past inflation = $\frac{€116.3467}{1.11887}$

$$= €103.9859$$

€103.9859 corresponds simply to $\left(P^F \div \frac{I_0}{I_{base}}\right)$ in the general price formula that we saw in "Linker cash flows and yields" and that enables a real yield to be calculated:

$$P^F \div \frac{I_0}{I_{base}} = \sum_{t=1}^{m} \frac{100 * IC\%}{(1+RY)^t} + \frac{100}{(1+RY)^m}$$

The above calculations can easily be laid out in a spreadsheet. In the last step, the real yield RY can be derived as a solution of the equation, via an iteration calculation. It is called a "forward real yield"; here, we find that it is equal to 0.383%.

We also note that €103.9859 is a "dirty" price, as it contains the accrued real coupon. We calculate the "clean" inflation-unadjusted price, which corresponds to a "screen" clean price.

For the 25 May 2012 settlement date, we have:

Previous coupon date: 25 July 2011

Next coupon date: 25 July 2012

Number of days between last coupon date and settlement date: 305

Number of days between last and next coupon date: 366

Accrued real coupon at forward date = $AC_{25\,May\,2012}$

$$= \frac{305}{366} * 1\% * €100$$

$$= €0.833333...$$

Therefore, forward "clean" inflation-unadjusted price = $(P^{cu}_{20\,April\,2012\;fwd})$

$$= €103.9859 - €0.833333$$

$$= €103.1526$$

€103.1526 therefore corresponds to the "screen" quoted price on the 22 May 2012 forward trade date such that the income from holding the position is equal to the repo cost. While the forward real yield can be calculated at the earlier step above, it is, however, useful to calculate $P^{cu}_{20\,April\,2012\;fwd}$ as, in practice, in some systems, it is that input which is required, rather than the "dirty" price, to get the corresponding real yield. For example, using €103.1526 as the input in the "yield" function in Excel or the "YA" (Yield Analysis) page on Bloomberg, we get 0.383% as the corresponding real yield. We can now calculate:

Carry = Forward real yield – real yield when bond was purchased

= 0.383% - 0.219%

= +0.164% or +16.4bp

The carry is positive in our example, which is not surprising, given that it corresponds to a holding period when the index ratio has increased. The fact that the repo rate is very low also contributes to a high positive carry figure.

A +16.4bp carry means that if the real yield rises by that amount, the holder will get just the right amount of total income from the bond to cover the repo cost. If the real yield rises by less or actually falls, then a profit would be made; if it rises more than 16.4bp, a loss is incurred. For example, if on the 22 May 2012 trading day, the selling price of the bond is such that the real yield is 0.319%, ie, 10bp higher than at the beginning, the real yield would appear to have sold off by 10bp. Actually, after adjusting for the carry (16.4 minus 10bp), we can see that a 6.4bp profit has been made. Therefore, the real yield will have rallied even if it appears to have sold off.

In the example above, we have considered a forward settlement date for which the index ratio is already known. However, let us assume that the forward settlement date considered was 14 June 2012. The index ratio for that is calculated as an interpolation between the FRCIPx of March and April 2012. However, the index for April 2012 would not yet have been available on the calculation date (17 April 2012). Indeed, the carry for linkers is known with certainty over a horizon that is as far as the last available data allow. For instance, on 17 April 2012, the last FRCIPx print known was for March 2012, which implies that carry was then known with certainty only up to the 1 June 2012 settlement date. When the April 2012 data were printed in mid-May 2012, the horizon of exact carry calculations was then extended, and calculations for any settlement date in June could be computed. To circumvent the constraint imposed by data release dates, it is therefore very common to estimate carry for horizons beyond the point of exact calculations using inflation forecasts, ie, projections of future values of the price index. These can be based, for instance, on one's own projections, economists' forecasts or consensus expectations. The calculation principles do not change, though.

Note also that our example does not contain any intermediate coupon payment over the holding period considered. If this is the case, one needs to calculate the forward linker settlement price to that intermediate date when the coupon is paid using the same non-arbitrage principle used above. Of course, that forward price and the value of the coupon payment may need to be estimated using projected index values if the date is too far in the future. The assumption, then, is that the intermediate coupon payment is reinvested in the bond once it is received, with the price paid being the forward price calculated. What this implies is that at the end of the holding period considered, the notional held in the bond will be higher than at the beginning. If the holding period is so long that there is more than one coupon payment, the same assumption applies; ie, each coupon flow is reinvested in the bond with the successive forward bond prices calculated such that the non-arbitrage principle is respected. Exhibit 1 formalises carry calculations in a general case when an intermediate coupon is paid out during the holding period.

Exhibit 1: Computation steps for carry calculations

We assume that the bond is purchased and financed in the repo market at a trade settlement date T_0 and held until the settlement date T_2. We assume that an intermediate coupon is paid on the settlement date T_1. We calculate the carry from date T_0 to the forward date T_2.

The following notations are used:

P_t^{cu} is the clean quoted price, unadjusted for past inflation accrual, at settlement date t

AC_t is the accrued real coupon at settlement date t

P_t^{du} is the dirty price, unadjusted for past inflation accrual, at settlement date t

C is the real coupon, i.e unadjusted for past inflation accrual, for each payment date

IR_t is the Index ratio at settlement date t, and can be a known or expected ratio

Repo is the repo rate used to finance the position and is assumed to be constant

t can be the spot or a forward date

In T_0, the cash settlement price paid $= \left(P_{T_0}^{cu} + AC_{T_0}\right) * IR_{T_0}$

$$= P_{T_0}^{du} * IR_{T_0}$$

Using the non-arbitrage principle for forward calculations, the total proceeds, ie, resale value plus any reinvested coupon, from the bond at date T_2 should be equal to the cash settlement price in T_0 uplifted with the repo cost. Given the coupon to be paid in T_1, the forward bond price in T_1 has to be computed first; it is assumed that the coupon received will be reinvested in the bond at the calculated forward bond price for T_1. $P_{T_1}^{du}$ at settlement date T_1 should satisfy the same non-arbitrage constraint and is deduced from the equation:

$$\left(C + P_{T_1}^{du}\right) * IR_{T_1} = \left(P_{T_0}^{du} * IR_{T_0}\right) * \left[1 + \left(\frac{T_1 - T_0}{360} * repo\right)\right]$$

The monetary coupon payment in T_1 is equal to $C * IR_{T_1}$. This is assumed to be reinvested in the bond. The additional inflation-unadjusted notional bought is therefore $\frac{C * IR_{T_1}}{P_{T_1}^{du} * IR_{T_1}}$, ie, $\frac{C}{P_{T_1}^{du}}$.

Total inflation-unadjusted notional held in T_2 is therefore $1 + \frac{C}{P_{T_1}^{du}}$. $P_{T_2}^{du}$ at settlement date T_2 is then deduced from the equation:

$$\left(1 + \frac{C}{P_{T_1}^{du}}\right) * P_{T_2}^{du} * IR_{T_2} = \left(P_{T_0}^{du} * IR_{T_0}\right) * \left[1 + \left(\frac{T_2 - T_0}{360} * repo\right)\right]$$

The forward real yield can then be derived from $P_{T_2}^{du}$ using the generic present value formulation for the inflation-unadjusted price of a linker in the Canadian model

We also have: $P_{T_2}^{cu} = P_{T_2}^{du} - AC_{T_2}$

In practice, the forward real yield for T_2 can then be obtained through the "Yield" function in Excel or the "YA" (Yield Analysis) page on Bloomberg, with both using $P_{T_2}^{CU}$ as an input.

The real yield carry is the difference between the forward real yield calculated and the real yield on the bond at the start of the holding period.

The magnitude of carry will naturally tend to be higher the shorter the linker. When the difference between the linker's price at the beginning and its calculated forward price is transformed into the required change in real yield, the magnitude of that change is implicitly determined by the duration of the bond. For instance, for the OATi 25 July 2013, which has a maturity of four years shorter than the bond we considered in the example above, the real yield carry calculated using the same method is +52.3bp, significantly higher than the +16.4bp of the OATi 25 July 2017.

In fact, intuitively, the basis point real yield carry on a linker over a given month can be approximated via the formula below:

[M/M inflation accretion + (real yield– repo rate)/12]/forward modified duration of bond

The inflation accretion may therefore be the same on the two bonds, but the shorter one's real yield carry has a notably higher sensitivity to that accretion because of its shorter duration.

Given that linkers also trade on a breakeven basis, ie, against nominals, it is also common to calculate the carry on the breakeven. This is defined simply as the real yield carry on the linker minus the nominal yield carry on the nominal bond. We assume that we are looking at a DV01-neutral pure breakeven position, ie, where trade notionals are set such that the real yield DV01 on the linker is equal to the nominal yield DV01 of the nominal bond. Consider again our example above. On 17 April 2012 (20 April 2012 settlement date), the nominal yield on the OAT April 2017 (which is the nominal comparator of the linker) was 1.889%. The breakeven on the linker is therefore 1.669%. Using the same repo rate as before, we calculate the carry on the OAT April 2017 at +3.8bp to the 25 May settlement date. The carry on the breakeven is therefore +16.4bp minus +3.8bp = +12.6bp. This means for a long breakeven position (where one buys the linker versus the nominal comparator) to generate a profit, the breakeven over the holding period must not fall more than 12.6bp.

The mechanics of the carry calculations for a linker depend on its trading format and can therefore be very different from the Canadian model. One notable example is for old-style UK linkers. One important consideration there is that each time an RPI inflation print is released, the actual release replaces one month of the 3% inflation assumption. Therefore, there is a mechanical adjustment to the real yield of an old-style linker on every release date. As explained in the dedicated section to the UK inflation-linked market, this implies clear differences in terms of carry calculations versus the Canadian model.

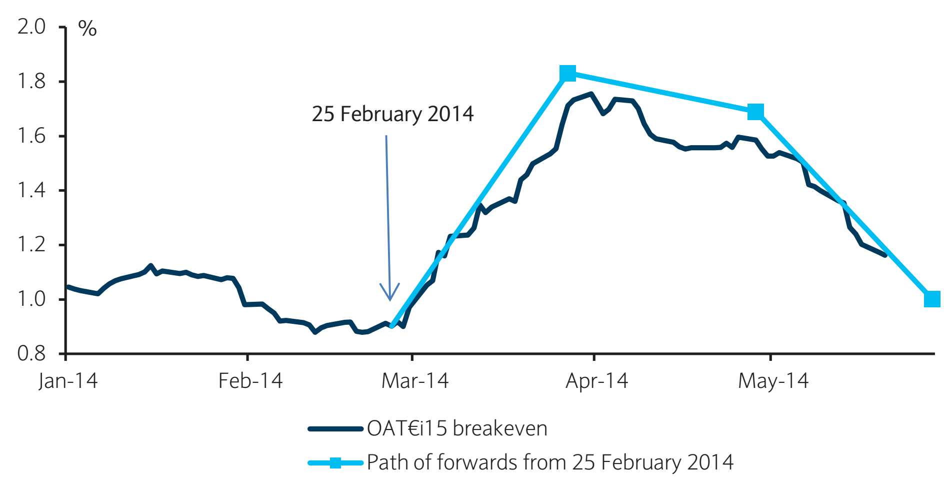
Why is carry important for linkers?

When looking at the evolution of a linker's real yield or breakeven history, it is important to bear in mind that the spot level may be distorted by seasonality and provide a biased assessment of richness/cheapness. For example, if a bond's breakeven is low by historical standards, it would appear cheap. However, if carry is so negative over the coming month that the breakeven needs to rise significantly over that period for a long position to yield a profit, that low breakeven may not appear so attractive after all. Plotting the forward real yield and breakeven points over a horizon during which carry is expected to be extreme therefore provides a more accurate picture of where valuations stand. This is particularly important for short-dated linkers, where the absolute value of carry tends to be high.

Also, when carry is extreme in linkers, there tends to be a convergence towards forwards. For example, as noted above, carry is very positive on euro HICPx linkers over the two months from the start of May to the start of July. Other things equal, as the index ratio grows day by day over that period, there is a tendency for the market to adjust the inflation-unadjusted price on a linker correspondingly lower such that the inflation-adjusted settlement price is not biased mechanically higher. Therefore, over that period, the real yield on a linker will tend to rise significantly (or the breakeven tend to fall), but what can then appear to be strong sell-off may just represent a mechanical adjustment to the positive carry.

FIGURE 1

Extreme carry tends to induce mechanical adjustments in spot levels



Note: The forward path is computed using realised monthly January to March euro HICPx values, although the February and March prints were unknown on 25 February 2014. Source: Barclays Research

This tendency for a mechanical adjustment is illustrated in Figure 1. We look at the evolution of the OAT€i15 breakeven from the start of January 2014 up to the third week of May. We compute the path of monthly forward points from 25 February, ie, the forwards to late March, late April and late May (we compute the forward path using realised monthly January to March euro HICPx values, although the February and March prints were unknown on 25 February 2014). M/m euro HICPx was very negative in January (-1.15%), moderately positive in February (0.30%) and very positive in March (0.95%), hence the path of monthly forwards in Figure 1. The spot breakeven has, to a large extent, tracked this path. In other words, what appeared to be a significant bullish momentum in March and a very bearish move in April/May merely reflected adjustments to carry swings.

Plotting the forward real yield or breakeven points helps, but does not necessarily solve, the problem of optically biased valuations. For example, an investor trading a euro HICPx linker at the start of March may look at the forward real yield/breakeven to the start of April to correct for the very negative inflation over the coming month. However, a forward date to the start of April would then correspond to the start of a three-month period when carry is typically very positive. Therefore, that forward would not itself be unbiased. For a forward real yield or breakeven to be unbiased from any element of seasonality, it needs to be calculated to a forward date when its residual maturity is a multiple of whole years (by definition, inflation over a whole year has no seasonality). For example, consider a bond with a residual maturity of two-and-a-half years. We assume that the half-year period up to the date when it will be a two-year bond is one of very negative seasonality. The bond's real yield or breakeven is expressed in annualised terms, and given the half-year of negative seasonality, the real yield or breakeven measures appear cheaper than what they really are if that negative seasonality is accounted for. Of course, if there is another date during the year (other than when its maturity is in whole years) when the residual seasonal bias on a linker is nil or negligible, it is also appropriate to calculate its forward real yield or breakeven to that date.

In practice, things are complicated by the fact that linkers mature at different periods of the year. For example, US TIPS mature in mid-January, mid-February, mid-April or mid-July. In euro HICPx linkers, French ones mature on 25 July, while the German issues have 15 April maturities. This means that to compare French to German euro HICPx bonds, choosing a 25 July forward date corrects the seasonality on the French but not the German ones. A 15 April forward date does not solve the problem, either. In short, when comparing linkers that mature at different periods, it may not be possible to find a forward date such that the adjustment for carry removes valuation biases. In that case, it may be better simply to adjust the different linkers for their own respective embedded seasonals. The methodology is explained in "Seasonality: Estimation and adjustment" later in this publication.

INFLATION PRODUCTS

Building a real yield curve

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This article describes the methodology for building a real yield B-spline fitted curve. The curve is fit in the discount function space using regression splines with a small number of fixed knot points and no roughness penalty. In the case of TIPS, our B-spline real yield curve uses the entire universe of outstanding TIPS bonds. A TIPS spline can be used to assess micro-relative value, as well as construct forward real yields and forward breakevens when combined with a nominal spline.

Introduction

A spline is a piecewise polynomial function, made up of individual polynomial segments that are joined together at points known as "knot points". It is a common practice to use cubic splines for extracting discount curves from prices of coupon bonds. A cubic spline is a spline constructed of piecewise third-degree polynomials defined by $s_i(t) = a_i(t-t_i)^3 + b_i(t-t_i)^2 + c_i(t-t_i) + d_i$ for $t_i \in \left[t_i, t_{i+1}\right]$, where t_i are knot points, n - number of knots and $i = 1, 2, \ldots, n-1$. At each knot point, the polynomials are restricted so that the level and first two derivatives of each cubic polynomial are identical; in other words, at each knot point, the slope and the curvature of the curve on either side must match. Fitting in the discount function space versus zero rate space or forward rate space ensures that we have no local/global convergence issues and that we are therefore confident of our fitted curve, and the estimation is fast with easy statistical computations.

We fit the TIPS real yield curve using a cubic B-spline, a specific type of cubic spline. A cubic B-spline uses a linear combination of cubic polynomials, such that each function for these polynomials is always between zero and one. Over any segment between adjacent knot points, there are only four non-zero functions, and they always add up to one. Neighboring segments always share three of the four functions. The estimated base coefficients in a B-spline fit, as opposed to those for a regular spline, are well behaved and numerically stable, owing to the constraints we impose on the functions comprising the B-spline. Level, slope, and curvature vary smoothly across the knots. Smoothness is achieved because each segment of the curve shares three of its cubic functions with a neighbor.

Building B-spline curve

From the theory of bond pricing, we know that that the price of a bond is equal to the present value of its future cash-flows: $p_i = \sum_{j=1}^{m_i} c_{ij}\delta(t_{ij}) + 100\delta(t_{im_i}) + \varepsilon_i$, where p_i is a dirty price for a bond with m_i remaining coupons c_{ij}, $\delta(t)$ is a discount function and ε_i are the pricing errors resulting from the fact that all coupon payments are discounted using the same function. One caveat here is that linker prices are not adjusted for the par-floor values. The curve fitting process attempts to minimize these errors subject to constraints imposed on the discount function. The B-spline curve is expressed as linear combinations of basis functions that are fitted to the discount function $\delta(t)$. The curve is parameterized as follows (see Appendix for more details):

$\delta(t) = \sum_{i=0}^{N+3} \varphi_i(t)\beta_i = \boldsymbol{\varphi}(t)^{\mathrm{T}}\boldsymbol{\beta}$, where $\boldsymbol{\varphi}(t)$ is the vector of B-spline basis functions, and $\boldsymbol{\beta}$ is the vector of basis coefficients.

We seek to find a vector of basis coefficients such that the sum of the squared pricing errors is a minimum: $\min_{\boldsymbol{\beta}}\left[\left(P-\Pi(\boldsymbol{\beta})\right)^{\mathrm{T}}\left(P-\Pi(\boldsymbol{\beta})\right)\right]$, where P is the vector of dirty bond prices and $\Pi(\boldsymbol{\beta})$ is the corresponding vector of discounted cash flows for the bond. To find the minimum, the cash flows are regressed on a set of basis functions using OLS regression.

Knot selection

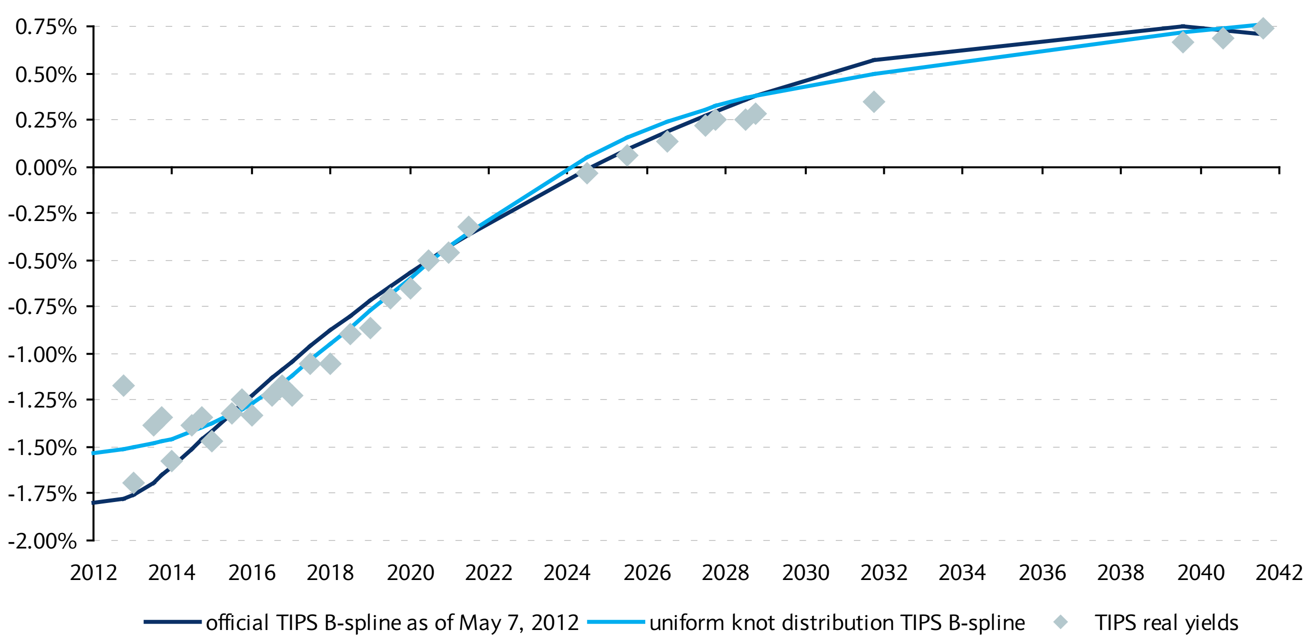
If the curves are fitted in accordance with the bond pricing equation above, the number of parameters is determined by the number of knots in the curve. Too few or too many knots may result in excessive errors or, conversely, over-fitting of the data. The first non-interior knot in the curve is the year fraction zero. And the last, or terminal knot, is either the year fraction of the longest bond rounded up to the nearest whole integer or a custom value.

Barclays TIPS B-spline curve is fit in discount function space with a small number of fixed knot points and no roughness penalty. The curve uses three internal knots: 1.5y, 5y, 31y, and external knots 0y and 35y. The small number of knots makes the curve naturally stiff.

The charts below compare Barclays TIPS real yield curve with a B-spline curve created using uniform knot distribution (ie, knots increase in uniform steps).

FIGURE 1

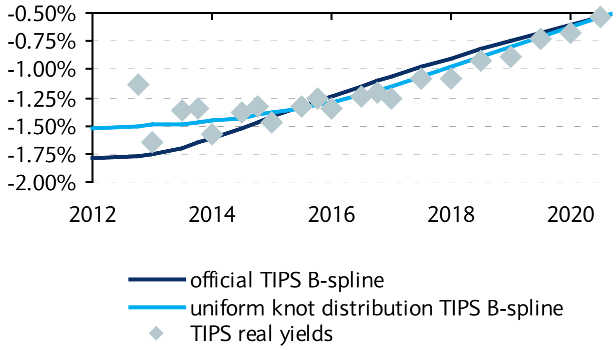
The effect of knot selection on the shape of TIPS real yield B-spline curve



Source: Barclays Research

FIGURE 2

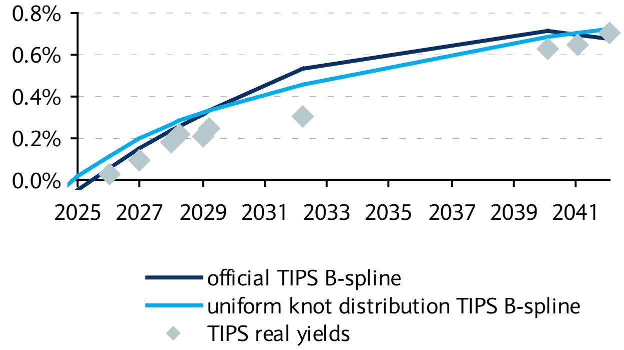
Front-end curve fitting under different knot selections as of May 7 ,2012



Source: Barclays Research

FIGURE 3

Long-end curve fitting under different knot selections as of May 7, 2012



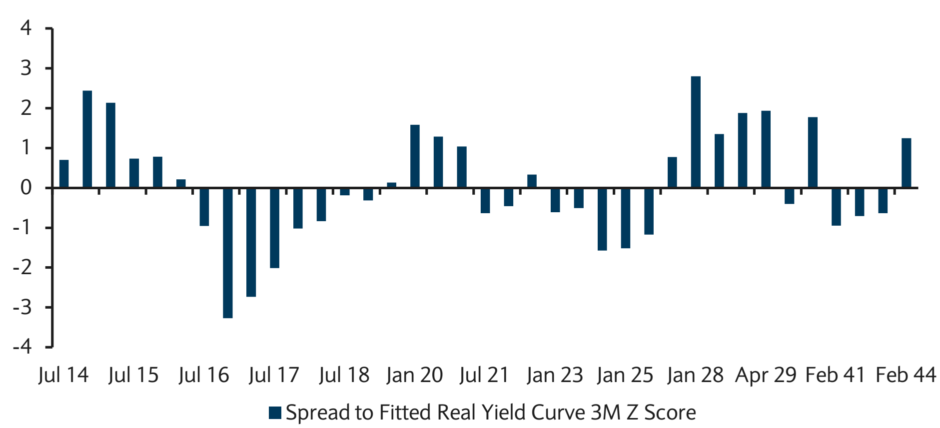
Source: Barclays Research

Use of a TIPS B-Spline curve

A key use of TIPS spline is to assess relative value among TIPS. We use the spline curve to calculate 3m z-scores of individual securities' static spread versus the real spline. Specifically, our micro-relative value framework uses such a measure to identify the recent richening/cheapening moves in TIPS. We use this along with z-score versus a forward spline, as well as a spread versus Z-spread ASWs, to solidify our micro relative value assessment of individual securities. Figure 4 shows that (as of May 29, 2014) the 2y-3y sector is trading rich versus the spline, while the 6-7y sector is trading cheap versus the spline. A positive z-score indicates that securities have cheapened versus the real spline and vice versa. One can also use the real spline and nominal spline to calculate forward spline-based breakeven measures.

FIGURE 4

TIPS z-scores versus a TIPS real spline as of May 29, 2014



Source: Barclays Research

Appendix

The pricing equation

Consider a collection of n bonds. Let bond i have dirty price p_i with m_i remaining coupons c_{ij} to be paid at time t_{ij} (in year fractions in the appropriate basis measured from the settlement date). Then, given an estimate of the discount function $\delta(t)$, the following bond pricing equations hold:

$$p_i = \sum_{j=1}^{m_i} c_{ij}\delta(t_{ij}) + 100\delta(t_{im_i}) + \varepsilon_i$$

where ε_i are the pricing errors resulting from the fact that all coupon payments are discounted using the same function.

B-spline basis generation

Let the N interior knots be denoted $\kappa_0, \kappa_1, \ldots \kappa_{N-1}$ together with the terminal knot τ. The complete set of $N+8$ knots used to define the B-spline basis is defined as follows:

$$\kappa_0 = \kappa_1 = \kappa_2 = \kappa_3 = 0$$

$$\kappa_{N+3} >= \kappa_{N-1}$$

$$\kappa_{N+4} = \kappa_{N+5} = \kappa_{N+6} = \kappa_{N+7} = \tau$$

The two external knots are said to have a multiplicity of four. This ensures that each segment in the curve is covered by exactly four of the basis functions.

The de Boor[1] recursion defines the B-spline basis as:

$$\varphi_i^r(x) = \frac{x - k_i}{k_{i+r} - k_i}\varphi_i^{r-1}(x) + \frac{k_{i+r+1} - x}{k_{i+r+1} - k_{i+1}}\varphi_{i+1}^{r-1}(x)\text{, where}$$

$$\varphi_i^0(x) = \begin{cases} 1, & \text{if} \quad k_i < x \le k_{i+1} \\ 0, & \text{otherwise} \end{cases}$$

Thus, $N+4$ basis functions cover the curve, which itself comprises $N+1$ segments. In the sections to follow, the order of the basis functions r is assumed to be 4, resulting in cubic B-splines. The basis coefficients are calculated as $(4N+4, 4)$ matrix C_{ij}. The columns give the coefficients of the j^{th} power in each of the cubic polynomials. The coefficients for the basis function i that is queried in segment s is found in row $3s+i$. When $i-s<0$ or $i-s>3$, the functions have a value of zero.

Linear combinations of the basis functions are fitted to the discount function $\delta(t)$. And the curve is parameterised as follows:

$$\delta(t) = \sum_{i=0}^{N+3} \varphi_i(t)\beta_i = \boldsymbol{\varphi}(t)^{\mathrm{T}}\boldsymbol{\beta}$$

[1] De Boor, C., "A Practical Guide to Splines", Applied Mathematical Sciences, volume 27, Springer-Verlag, New York, Inc., 1978.

In the preceding equation, $\boldsymbol{\varphi}(t)$ is the vector of B-spline basis functions, of size $N+4$ and $\boldsymbol{\beta}$ is the vector of basis coefficients, of size $N+4$. They determine the extent to which each of the basis functions contributes to the overall fitted curve.

Origin discount factor constraint

Constraints are imposed at the origin of the curve (ie, the settlement date) where $t=0$ such that $\delta(0)=1$. When fitting the discount function, this constraint amounts to $\beta_0=1$, since $\varphi_i(0)=(1,0,...,0)$. In practice, the constraints are implemented by expressing them as $\mathrm{R}\boldsymbol{\beta}=r$, where R is the row vector $(1,0,...,0)$ and $r=1$ is a constant used to impose the unity discount factor constraint.

Pricing error minimization

We seek to find a basis coefficients vector such that the sum of the squared pricing errors and roughness penalty is a minimum. Written in indexed notation, this means finding the beta vector, which produces the following scalar value:

$$\min_{\beta_i}\left[\sum_b\left(p_b-\left(\sum_j\delta(t_j)c_j+100\delta(t\;)\right)\right)^2+\sum_{i,j}\beta_i\beta_jH_{ij}\right]$$

where H is the penalty matrix, determined solely by the knot points and roughness penalty function, of size $(N+4,N+4)$.

If P is the vector of dirty bond prices and $\Pi(\boldsymbol{\beta})$ is the corresponding vector of bond present values (ie, sum of discounted cash flows), then in vector notation assuming no roughness penalty, this is equivalent to:

$$\min_{\boldsymbol{\beta}}\left[\left(P-\Pi(\boldsymbol{\beta})\right)^{\mathrm{T}}\left(P-\Pi(\boldsymbol{\beta})\right)\right]$$

The beta vector that produces this minimum is simply the ordinary least squares (OLS) estimator.

INFLATION PRODUCTS

Building a market-implied BE and CPI swaps curve

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We review a market-implied breakeven curve framework with the addition of seasonal paths, floor, and proceeds ASWs adjustments. It can value inflation-linked cash flows on a mark-to-market basis and provide a reference for forward inflation expectations.

We discuss how to build a market-implied CPI NSA or inflation curve to value cash flows or back out a constant-maturity 5y5y forward breakeven. As of June 9, 2014, our basic framework yielded a forward 5y5y breakeven value of 2.45%, very close to the bootstrapped bonds measure of 2.38%. The framework adds seasonality between TIPS issues and adjusts for deflation floor premiums. One can take a similar approach to building a zero-coupon CPI swap curve by adjusting the aforementioned BE-based curve with the relative proceeds ASWs at the common nodes. Such a curve can be used to mark to market a payer/receiver CPI swap position daily.

Constructing an inflation curve

The following uses an example we developed in 2012 that is just as useful today in describing the framework: As of 2012, there are 35 TIPS bonds outstanding in the market; combining each one with its nominal counterpart (nominal yield-real yield) gives a measure of inflation expectations to the lagged (two to three months) maturity of the bond. We then subtract deflation floor premium to adjust for the exceptional richness of these issues. We use the inflation derivatives market-based floor valuations (available in the weekly *inflation vol packet*). Figure 1 shows outright and adjusted breakeven levels for each issue and projected CPI NSA levels (based on adjusted BEIs) to maturity (years) as of the settle date of May 3, 2012 (Ref CPI NSA: 227.77455). Figure 1 also shows projected CPI NSA prints based on a floor and the proceeds-ASWs-adjusted BE curve (essentially replicating a CPI swaps curve). A trader can synthetically replicate a CPI swaps position by being long BEs using TIPS versus nominal proceeds ASWs, in which case, he is paying the funding differential between TIPS and nominals on top of the BE position (see equations below for these positions). Theoretically, to replicate a CPI swaps position, one should use z-spread ASWs, as they would properly account for the duration difference between TIPS and nominals. In practice, z-spread ASWs are not traded, so proceeds ASWs are used in the calculation of a market-implied CPI swaps curve.

Floor-Adjusted BE = Long TIPS + Short Comparator Nominals + Short TIPS Floor

Replicated CPI Swaps = Floor-Adjusted BE + TIPS Proceeds ASWs – Nominal Proceeds ASWs

Future CPI NSA = Spot Reference CPI NSA * (1 + Adjusted_BEI/2)^(2*Maturity)

We have quite a few pairs of bonds that are one year apart, but we do not have exact market-implied monthly CPI NSA prints between two end points. We can use the forward rate between the two bonds to project these. Although we know that inflation does not grow at a constant forward rate, there are clear seasonal patterns. Inflation prints in the first half of the year tend to be better than in the second (Figure 2). In the next section, we use the 2011 seasonality pattern as a guide to project a CPI NSA path between two bonds' lagged maturity dates.

FIGURE 1

Market-implied CPI NSA levels adjusted for deflation floor values as of May 2, 2012

Bond ID	Mid-maturity CPI prints	BE (%)	Floor value (bp)	Floor-adjusted BE (%)	TIPS ASWs-Nominal ASWs	Approximate CPI swap or BE adjusted for floor and relative ASWs	Floor-adjusted BE estimated forward CPI NSA	Floor and rel ASWs adjusted BE CPI NSA
4/15/2013	Jan-13 - Feb-13	1.64	0.01	1.64	-18.18	1.46	231.35	230.95
7/15/2013	Apr-13 - May-13	2.12	0.00	2.12	9.92	2.22	233.61	233.89
1/15/2014	Oct-13 - Nov-13	1.80	0.00	1.80	14.88	1.95	234.83	235.42
4/15/2014	Jan-14 - Feb-14	1.76	0.45	1.76	12.26	1.89	235.69	236.27
7/15/2014	Apr-14 - May-14	2.00	0.02	2.00	15.23	2.15	237.97	238.76
1/15/2015	Oct-14 - Nov-14	1.86	0.06	1.86	18.22	2.04	239.44	240.62
4/15/2015	Jan-15 - Feb-15	1.83	1.58	1.81	20.31	2.03	240.23	241.77
7/15/2015	Apr-15 - May-15	2.01	0.12	2.01	21.96	2.23	242.80	244.51
1/15/2016	Oct-15 - Nov-15	1.98	0.24	1.98	19.61	2.18	245.03	246.82
4/15/2016	Jan-16 - Feb-16	1.95	2.61	1.93	23.72	2.19	245.70	248.24
7/15/2016	Apr-16 - May-16	2.09	0.39	2.09	23.99	2.33	248.53	251.06
1/15/2017	Oct-16 - Nov-16	2.05	0.51	2.04	25.32	2.30	250.65	253.68
4/15/2017	Jan-17 - Feb-17	2.06	5.00	2.01	27.35	2.33	251.46	255.48
7/15/2017	Apr-17 - May-17	2.18	0.96	2.17	23.00	2.41	254.91	258.07
1/15/2018	Oct-17 - Nov-17	2.11	1.53	2.09	27.66	2.39	256.53	260.79
7/15/2018	Apr-18 - May-18	2.22	2.36	2.20	26.37	2.49	260.90	265.53
1/15/2019	Oct-18 - Nov-18	2.20	2.35	2.17	28.55	2.48	263.32	268.77
7/15/2019	Apr-19 - May-19	2.26	2.05	2.24	26.71	2.52	267.32	272.85
1/15/2020	Oct-19 - Nov-19	2.23	2.43	2.20	26.70	2.49	269.64	275.69
7/15/2020	Apr-20 - May-20	2.30	2.52	2.27	26.96	2.57	274.21	280.84
1/15/2021	Oct-20 - Nov-20	2.23	2.69	2.20	28.62	2.52	275.64	283.17
7/15/2021	Apr-21 - May-21	2.32	3.63	2.28	28.47	2.61	280.74	289.05
1/15/2022	Oct-21 - Nov-21	2.27	3.98	2.23	29.35	2.57	282.61	291.79
1/15/2025	Oct-24 - Nov-24	2.27	0.41	2.26	19.87	2.47	303.23	311.06
1/15/2026	Oct-25 - Nov-25	2.32	0.67	2.31	18.09	2.50	312.18	320.22
1/15/2027	Oct-26 - Nov-26	2.31	0.69	2.30	18.40	2.50	319.08	328.07
1/15/2028	Oct-27 - Nov-27	2.29	1.00	2.28	19.03	2.48	325.03	335.30
4/15/2028	Jan-28 - Feb-28	2.30	0.07	2.30	25.57	2.56	328.07	341.60
1/15/2029	Oct-28 - Nov-28	2.34	1.18	2.33	20.36	2.54	335.43	347.58
4/15/2029	Jan-29 - Feb-29	2.31	0.08	2.31	24.28	2.55	336.11	350.12
4/15/2032	Jan-32 - Feb-32	2.32	0.25	2.31	19.93	2.52	360.63	375.27
2/15/2040	Nov-39 - Dec-39	2.34	1.23	2.33	20.84	2.55	433.82	460.93
2/15/2041	Nov-40 - Dec-40	2.34	1.35	2.33	20.78	2.55	443.72	472.56
2/15/2042	Nov-41 - Dec-41	2.37	1.95	2.35	18.44	2.55	456.79	485.06

Source: Barclays Research

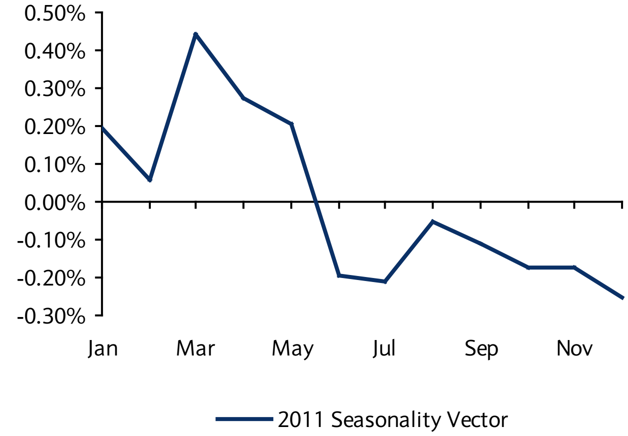
Generating market-implied CPI prints using assumed m/m seasonality

Inflation prints in the first half of the year tend to be better than in the second

We used the difference between 2011 m/m percentage change CPI NSA and CPI SA series as a pattern for future seasonal changes. These assumptions can be changed; 2011 seasonals are used merely as an example. The sum of the seasonal factors over the year was zero, so that there is no net effect on a y/y basis. We used the functional form in Figure 3 (with the assumption of constant seasonality over the month) to bring forth seasonality in a CPI NSA path.

FIGURE 2

M/m CPI NSA – m/m CPI SA, 2011 CPI seasonality



Source: Barclays Research

FIGURE 3

Functional seasonality form

$$CPI(0,T_i) = CPI(0,T_{i-1}) * \exp((T_i - T_{i-1}) * (f_i + s_i))$$

i = 2….360, time frame between any two CPI NSA projections

f **= Annualized Forward Rate between two CPI NSA paths,**

s **= Cumulative annualized seasonality between two time frames.**

Source: Barclays Research

Example

Using Jul13 and Jul14, we get an implied forward breakeven rate of 1.85% between lagged maturities of April-May 2013 and April-May 2014. The projected maturity CPI NSA for Jul13 is 233.6114; for Jul14, it is 237.972. Using the functional form shown in Figure 3, we calculate the CPI NSA path for May-June 2013. April-May to May-June seasonality is +0.05% (annualized).

CPI (May-June 2013) = CPI (April-May 2013) * exp (((1/12)* (1.85%+0.05%))

= 233.6114 * exp ((1/12)* (1.85% + 0.05%)) = 233.98

For the June-July 2013 CPI NSA print, we use the cumulative annualized seasonality from April-May to June-July to project forward.

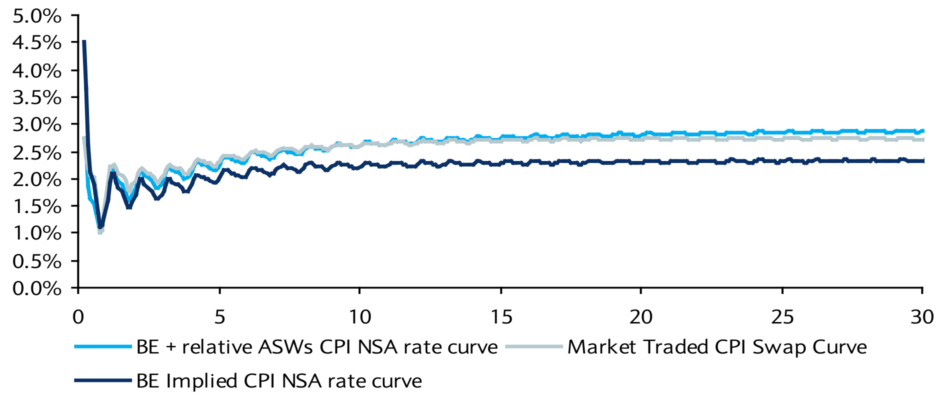
In practice, the Jul13-Jul14 and Apr13-Apr14 issues imply an overlapping, but possibly different, CPI NSA path. In our curve, for all overlapping paths, we took the projected maturity prints and the average of overlapping implied seasonal prints as data points. One caveat is that all of the TIPS issues mature at the middle of any given month, so when creating true seasonals, one should take average of two monthly seasonals. For July maturity, one can take the average of March-April (NSA-SA) and April-May (NSA-SA) m/m seasonality prints.

Resulting curve

Using these market and 2011 seasonality-implied CPI NSA expectations paths, we created an annualized market-implied breakeven curve and a CPI swap curve (Figure 4). We compare these curves with the market-traded CPI swaps curve. The m/m breakeven curve shows a clear seasonal pattern. Also, as one would expect, the market-implied breakeven curve trades below the market-implied CPI swap curve. This differential exists because the CPI swap curve has embedded funding costs (TIPS ASWs minus nominal ASWs.) The market-implied CPI swaps curve lines up with the traded CPI swaps curve. At the longer end, the traded CPI swap curve is cheaper than the implied CPI swap curve, likely because of the convexity adjustment at the longer end. Also, given the scarcity of issues at the longer end, it is difficult to estimate starting forward breakeven rates.

FIGURE 4

Market-implied breakeven and CPI swap curves versus the traded CPI swap curve as of May 2, 2012



Source: Barclays Research

INFLATION PRODUCTS

Real yield and breakeven fair value models

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10y TIPS breakeven model

We use 10y BE fair-value models as a starting point to assess level/value in breakevens. Specifically, we use such factors as growth, market-anticipated Fed reaction function and gasoline moves to assess 10y BE levels relative to history. We then try to develop a forward-looking 10y BE view based on our growth and inflation forecasts in the context of the current FOMC reaction function. We also think it is important to have a view on the volatility of model residuals (though they are mean-reverting) based on other factors to determine whether it is worth taking a market position. This latter revision is a function of learning from the 2008 financial crisis, when model residuals became volatile and indicated 10y BE drivers other than economic fundamental factors.

Prior to the 2008 financial crisis, we had relied on a relatively parsimonious three-factor model for 10y TIPS breakeven fair value (Fed funds slope, global ISM and gasoline prices; Figure 1). However, as bank balance sheets and the liquidity constraints of TIPS versus nominals came to the fore in 2008, this model proved relatively unstable because it failed to capture the relative liquidity factor between TIPS and nominals during a crisis. Figure 1 specifies the model inputs.

FIGURE 1
10y US BE model factors (w/o liquidity factor)

	Coefficient	t-stat		Model Stats
Fed Funds Slope	0.27	6.98	R^2	0.84
Global Industrial Confidence (1m lag)	0.31	5.98		
Gasoline (Log)	0.83	16.33		
Constant	1.54	48.15		
Period	Jan 1998 - June 2008			

Source: Bloomberg, Barclays Research

This model is fine as a stand-alone starting point for fair-value assessment, but during a banking crisis, cash needs and risk tolerance become acute as banks try to shore up their balance sheets with very liquid assets (eg, cash, cash-equivalents, bills) to meet demand from their liabilities and counterparties. In such events, fundamental valuations can diverge sharply from traded valuations as market participants seek the safety of the most liquid assets as risk aversion rises. While TIPS have the same credit quality of nominal Treasuries, they are less liquid so suffer on a relative basis during flights to liquidity.

Even as central banks step in to provide liquidity, investors' behaviour can remain risk-averse for some time, as they closely assess each bank's ability to honour daily settlements, given higher anticipated asset price volatility. Thus, risk aversion is slow to dissipate. In recognition of this factor, in 2009 we introduced a liquidity measure in the form of on/off- the-run Tsy spread in our breakeven model, which would capture acute cash needs (Figure 2). We have since switched to L-OIS spread to better capture liquidity constraint as the Fed's QE has eliminated the use of Tsy on/off the run spread as an explanatory liquidity variable.

Figure 3 shows that the L-OIS-added 10y BE model (Liquidity Model) explained 70bp of additional divergence versus 10y BE market value during the 2008 crisis. The t-stat on this variable is also significant (Figure 2). The one caveat is that in this liquidity-based model, we used a longer period to back out the coefficients with respect to each time series. Specifically, the period we used in the liquidity-based 10y BE Model is January 1998-May 2010, while the fundamental breakeven model used January 1998-June 2008. We used a longer period for the liquidity-based model to assess the coefficient on the liquidity factor. On average, the liquidity factor shows that a 10bp rise in L-OIS leads to compression of about 3bp in 10y breakevens. The sign here makes sense as higher risk-aversion should mean lower liquidity in TIPS relative to nominals, ie, artificial compression of breakevens relative to fair value.

FIGURE 2

10y US BE model factors (with liquidity factor)

	Coefficient	t-stat	Model Stats	
L-OIS	-0.30	-4.37	R^2	0.81
Fed Funds Slope	0.29	6.83		
Global Industrial Confidence (1m lag)	0.32	9.65		
Gasoline (Log)	0.74	13.50		
Constant	1.62	45.00		
Period	Jan 1998 - May 2010			

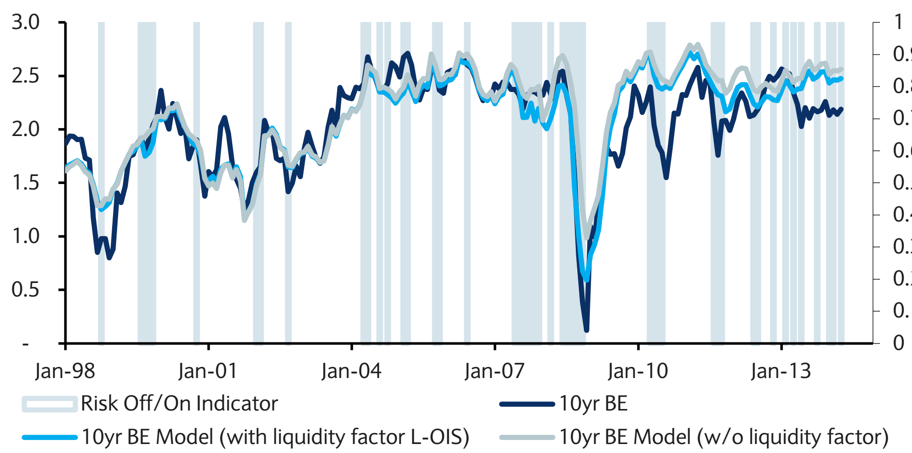
Source: Bloomberg, Barclays Research

Risk-off indicator functions better than linear factor in assessing 10y BE liquidity

Understanding the liquidity effect is useful, but we find this model incomplete. This is because liquidity/risk-aversion tends to have a non-linear effect on fair value at the height of a crisis as investors gravitate to the most liquid assets, ignoring fundamental valuations. In other words, investors seems to either put a significant weight on liquidity concerns or very little. Thus, we think the best approach would be to identify a risk-aversion switch (which we call a risk-off indicator) that can be used to assess whether one should put weight on fair-value model outputs. In a model, one can characterize this as digital option-like behavior, where risk aversion/liquidity factors dominate. Including financials vol and L-OIS index (as risk-aversion factors, similar to on/off-the-run Tsy spread) in our standard breakeven model does not fully explain the 2010 and 2011 breakeven declines, even though these were significant explanatory factors in the 2008 crisis (Figure 3). This supports the argument that it would be a mischaracterization to include a risk-aversion index as a linear factor in a fundamental model. Next, we define what might constitute a broad risk-aversion index.

FIGURE 3

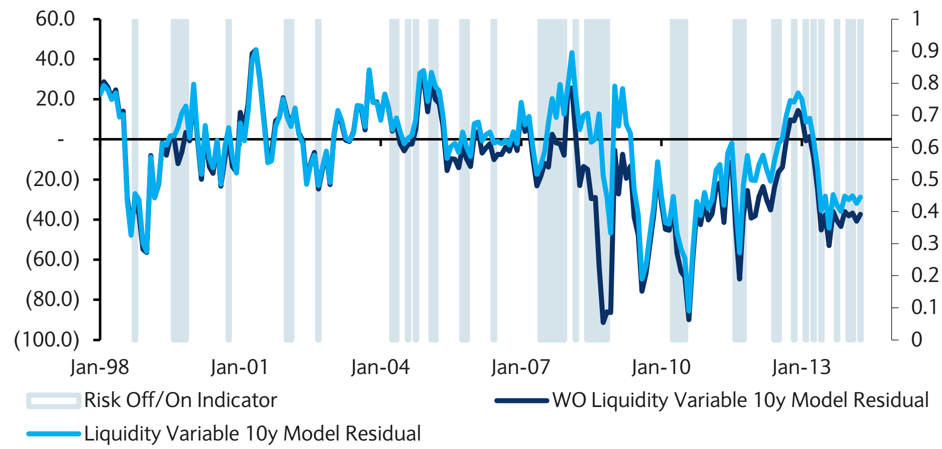
Unlike in the 2008 financial crisis, the 10y on/off–the-run liquidity variable and other vol measures do not capture recent liquidity-based declines in 10y breakevens



Source: Bloomberg, Barclays Research

FIGURE 4

Bank liquidity on/off indicator time series versus BE models (w/liquidity and w/o liquidity) residuals*



Note: * Residuals are large when risk off indicator is turned on. Source: Bloomberg, Barclays Research

Financial stocks volatility and L-OIS widening make good indicators for a potential liquidity event/risk aversion

In our view, the best way to determine the likelihood of a liquidity event is to assess whether banks need/prefer cash over other assets. In times of higher cash needs, a bank would be willing to pay higher interest rates to draw deposits/funding. For example, one can look at 3m Libor or 3m Eurodollar deposit rates to assess this premium for cash/liquidity needs. In our risk index construction, we use the 3m average spread of 3m L-OIS, to capture bank funding needs. We also use S&P financials volatility (daily return, volatility taken over the past month, annualized) to anticipate cash/liquidity needs, as vol tends to cluster and is usually related to equity price declines. Increases in financials' volatility and equity declines could draw concerns about the cash/liquidity needs of individual institutions and increase risk aversion further. For financials to show higher liquidity/cash positions to their counterparties, they are likely to bid higher for deposits. Higher-than-normal levels in both of these factors make persistent risk aversion more likely, in our view.

Specifically, we form a combined risk indicator function using the following conditions: if the current month's average L-OIS spread is higher than the previous six-month average, and if the current month's S&P financials vol is higher than the previous six-month average, a liquidity event could dominate in the near term. Figure 3 and Figure 4 shaded area shows when these risk indicators have been active over the past 10 years.

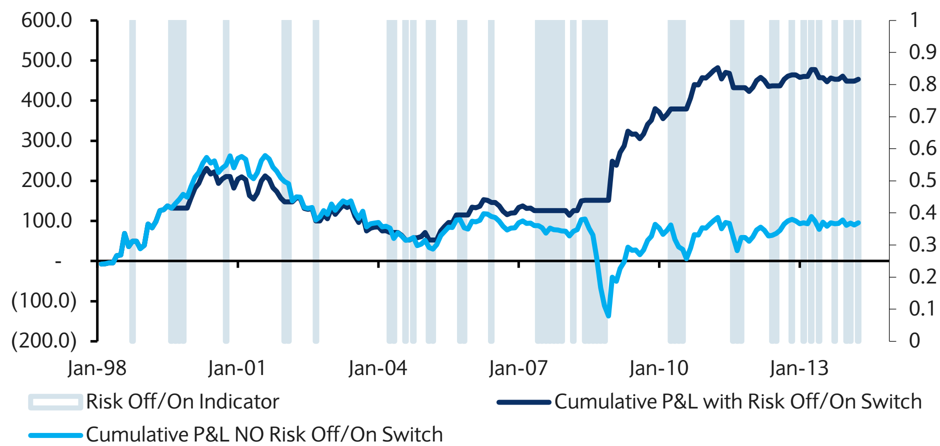
Validity: Risk indicator improves breakeven model return profile

Incorporating this risk indicator function into the fundamental breakeven model (without liquidity factor) improved model returns over time (Figure 5). Specifically, we incorporated the indicator function output into the standard breakeven model as follows. If the standard model indicated breakevens were cheap and the risk event indicator was turned off, we proceeded to hold 10y breakevens for one month. If the standard model indicated breakevens were cheap and the risk event indicator was turned on, we remained neutral on breakevens. If the standard model indicated breakevens were rich and the risk event indicator was turned off, we proceeded to short 10y breakevens for a one-month holding period. If the standard model indicated breakevens were rich and the risk event indicator was turned on, we remained neutral because of model uncertainty (though investors could consider being double short here).

The liquidity indicator (or risk off) was turned on during April-June 2010 and August-October 2011, as the probability of a European banking crisis remains higher than normal, marked by wider L-OIS spreads, increased financials volatility and widening financial CDS spreads. In addition, investors should also continue to monitor market events, specifically fiscal/policy announcements. The indicator function is backward-looking, assessing model valuations based on the past month's averages. A new policy announcement, such as the ECB's extension of 3y loans to banks in the region, may indeed address liquidity risks and thereby reduce the likelihood of breakevens declining further on anticipated risk aversion. We see scope for extending such a liquidity indicator to other risk assets. Figure 5 shows that in late 2011, the fundamental BE model suffered relative to liquidity on/off based model.

FIGURE 5

Cumulative return profile of fundamental breakeven model with/without liquidity indicator-based risk-off switch

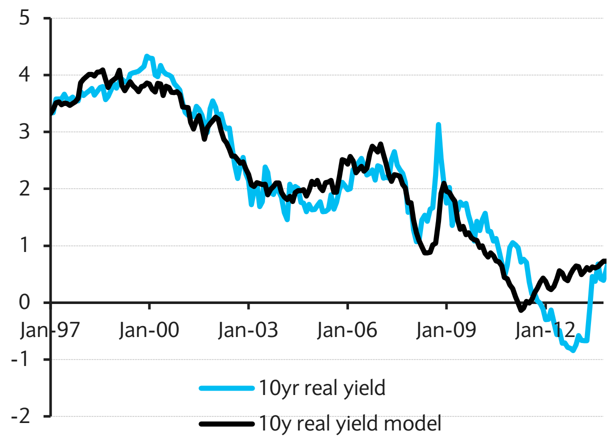


Source: Bloomberg, Barclays Research

10y TIPS real yield model

We retain our broad model specification from the previous edition of this guide, but have re-estimated the model coefficients to the end of 2012. The fed funds rate logically remains the most significant driver of the level of real yields, with the slope of the fed funds futures curve accounting for expectations of future rate moves. We continue to find a strong negative correlation between real yields and gasoline futures, which is consistent with the high pass-through from energy prices into CPI and the consequent influence on carry. The significance of the trade-weighted dollar in the model has fallen. Traditionally, there has been a positive correlation between the level of real yields and the dollar. However, in a risk on/off paradigm, the safe haven status of Treasuries and reserve status of the dollar have resulted in yield rallies coinciding with dollar appreciation. Business loan growth factors as a significant structural driver of real yields, and we retain a 1y lag in the model. In the 2012 users guide, we noted that the improvements in credit conditions since the depths of the financial crisis have resulted in robust US business loan growth since, implying that TIPS real yields are likely to be biased higher over the medium term. We believe this is likely to continue as the unemployment rate continues to fall and inflation moves higher, which should lead the Fed to normalize monetary policy.

FIGURE 6
10y TIPS real yield model



Source: Bloomberg, Datastream, Federal Reserve, Barclays Research

FIGURE 7
10y US real yield model coefficients and summary statistics

	Coefficient	t-stat		Model Stats
Change in nonfinancial business lending (1y lag)	0.02	4.3	R^2	0.87
Gasoline (log)	-1.56	-9.1		
Fed Funds Slope (6m minus front)	0.23	2.8		
Fed Funds	0.25	12.6		
Trade Weighted Dollar	0.02	2.3		
Constant	0.73	0.8		

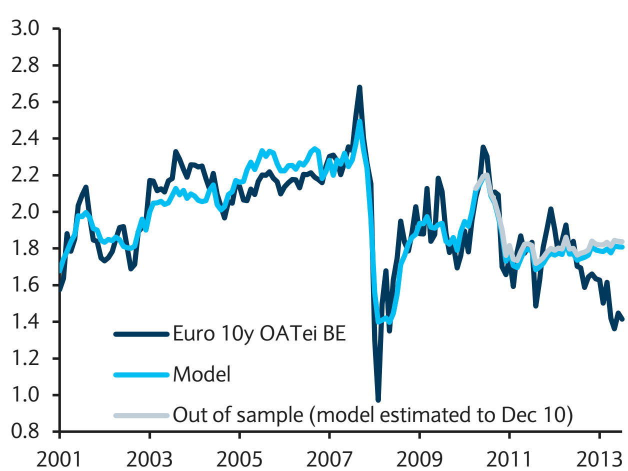
Model: January 1998 – December 2012

Source: Barclays Research

10y euro breakeven model

Modelling euro area breakevens through the euro area debt crisis has been fraught with difficulty, as each component of the multi-issuer market (French, German and Italian) has been influenced by specific factors. The tricky part is that some of those factors are relevant only over specific periods and are difficult to capture quantitatively. Obvious examples are the effect of the ECB's SMP or the run-up to the exclusion of BTP€is from Barclays' main indices. We use the 10y constant maturity OAT€i breakeven data, the longest series on Barclays Live. We adopted a top-down approach, initially considering a wide range of economic and financial market data as independent variables in the model. Our aim was to isolate three factors to capture what we believe are the main structural drivers of breakevens: perceptions of upcoming price pressures, market expectations about the economy and general (not market-related) confidence regarding the broad macro backdrop. After several tests, we retained the following variables:

FIGURE 8
10y euro (OAT€i) breakeven model



Source: Bloomberg, Barclays Research

FIGURE 9
10y EUR BE model coefficients and summary statistics

	Coefficient	t-stat		Model Stats
3m Euribor-Eonia spread	-0.156	-3.4	R^2	0.784
TR/CoreCommodities CRB Index	0.00216	10.8		
Global Manufacturing Confidence	0.0908	4.5		
1y1y Eonia swap rate	0.0954	12.7		
Constant	1.174	20.3		

Model: Oct 2001 – Dec 2013

Source: Barclays Research

1. **TR/CoreCommodities CRB Commodity Index**: This captures price pressures from a wide range of commodities. Unlike for US breakevens, where gasoline prices stand out as the obvious driver of valuations from the commodities sphere, euro breakevens seem more sensitive to an overall commodity index, which has a broader coverage. In addition, the TR/J CRB Commodity Index does a better job than the Euro HICPx index in the model, indicating that the market reacts more to potential upcoming price pressures than past data.

2. **The 1y1y Eonia swap rate:** This is generally linked to interest rate policy expectations in real time. Therefore, the 1y1y swap indirectly reacts to the broad market's varying assessment of improving/deteriorating macro or financial conditions, as those will affect monetary policy. Perhaps counter-intuitively, the coefficient for the euro 1y1y swap rate is positive, meaning that higher breakevens are consistent with tighter monetary policy. This reflects the fact that, at least theoretically, higher interest rates are associated with higher inflation. Also, factors that would push the 1y1y swap rates higher are typically hawkish and therefore either inflationary or, at least, "breakeven friendly".

3. **Global manufacturing confidence index**: We see this as a key indicator of confidence and global growth (not market related), with a positive correlation to euro breakevens. It is more useful within the model if we run it though the pre-crisis period. Its relevance fades post-crisis, as the sovereign debt crisis brought massive volatility to most European markets, including inflation-linked. In a volatile environment, European breakevens have become less reactive to such activity-related indicators, while the relevance of high frequency indicators of risk-on/risk-off has likely increased. That said, with some recent stabilisation trends in European markets, the significance of the global manufacturing confidence index will gradually pick up, in our view.

Overall, the three-factor model works fine as a standalone fair value model before the 2007-08 crisis, but the market environment has changed significantly since then. Liquidity has become a key driver as market participants seek the safety of the most liquid assets as risk aversion rises; the sovereign debt crisis in Europe has extended this fear. Therefore, we include the Euribor-OIS 3m spread to capture the liquidity constraints better. The Euribor-OIS 3m spread incorporates market liquidity conditions into the model. It captures the severe liquidity constraint during the 2007-08 crisis and in 2011-12, when European banks came under pressure regarding their solvency. The negative correlation with breakevens can be interpreted in two ways: 1) a higher Euribor-OIS 3m spread is associated with risk-off moves and, therefore, lower breakevens or 2) liquidity constraints mean that balance sheets need to be shored up, which is negative for linkers versus nominals.

We also run an out-of-sample model forecast from December 2010, using the sample from October 2001-December 2010. The out-of-sample forecast is in line with the model estimation, showing the stability of the coefficients. However, the European sovereign crisis has brought with it many changes in the structure of the market, which means that although fair value models can be useful for a broad assessment of valuations, they fail to capture the increased volatility. As we pointed out earlier, risk-on/risk-off episodes are now more relevant for breakevens. However, the magnitude of breakevens' reaction to those episodes is variable. As a result, the inclusion of variables that reflect the tone in risky markets is not a panacea. For instance, the Euribor-OIS 3m spread was able to capture the concerns driven by speculation regarding the exit of Greece from the euro area and the effect on breakevens. On the other hand, the cheapening of the peripheral spread later on or President Draghi's 'whatever it takes' speech in 2012 seemed to have had an effect on breakevens that was not sufficiently captured by the Euribor-OIS 3m spread within the model.

10y euro real yield model

Euro real yields suffer even more from country-related distortions than breakevens, which makes constructing a viable fundamental fair value model somewhat challenging. The European sovereign debt crisis resulted in a significant widening of individual country yield spreads versus Germany since April 2010, with these spreads often volatile. Although France has been less affected than the periphery, French inflation-linked bonds suffered from the broad dislocations sweeping through markets in the last quarter of 2011, though have subsequently tightened markedly relative to bunds. We use OAT€i linkers as the basis for our model as they have the longest and best-defined curve history of any of the European inflation issuers. Prior to the start of the European dislocation in April 2010, the element of sovereign risk was a relatively minor driver of valuations of French real yields. More recently, while French yields have been more stable than peripheral Europe, France has nonetheless proved susceptible to contagion in periods of severe stress.

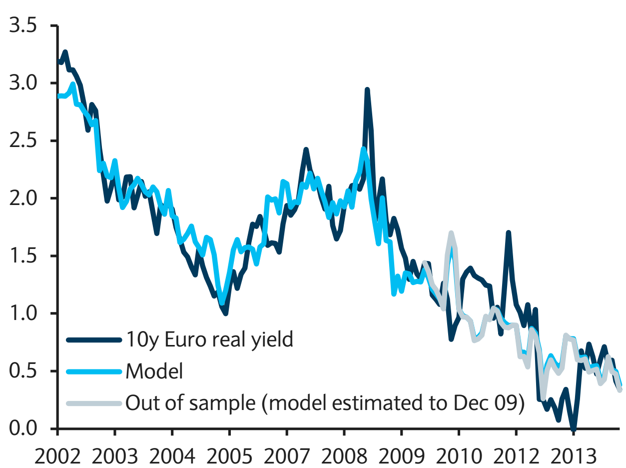
We retain the same specification for our euro real yield model as in the previous edition of this guide. Although there is potential for the dislocation in recent years in European government bond markets to change real yield dynamics permanently, there is little sign of a structural change in the key factors driving core real yields. We have found an inverse relationship between money supply and real yields in the past, consistent with economic theory that suggests that a larger money supply results in lower interest rates. We note a continued correlation between real yields and the ECB refi rate, though this relationship has been weakened by the movements in country spreads. Brent crude remains a driver of valuations, although, as noted in the Energy Hedging primer, the sensitivity of euro area inflation to oil moves is not large. The out-of-sample performance of the euro real yield model has improved since the 2012 Inflation-linked Products User's Guide, likely due to the tightening in French yields relative to Germany.

10y UK breakeven model

UK breakevens have tended to trade directionally with nominals in recent years, and compressed following the expansion of BoE gilt purchases in October 2011. Breakevens fell markedly from May 2012 amid market fears surrounding the RPI formula effect review, but rebounded sharply in January 2013 when the National Statistician announced the calculation of RPI would not be altered, contrary to market expectations. Monetary policy variables have tended to show a decent correlation with breakevens as well as UK

FIGURE 10

10y euro (OAT€i) real yield model



Source: Bloomberg, Barclays Research

FIGURE 11

10y EUR real yield model coefficients and summary statistics

	Coefficient	t-stat		Model Stats
M3 3m change (1m lag)	-0.255	-6.6	R^2	0.837
ECB refi rate	0.550	15.3		
Brent crude (log)	-0.71	-14.3		
Constant	3.72	16.4		

Model: Jan 2002 – Dec 2013

Source: Barclays Research

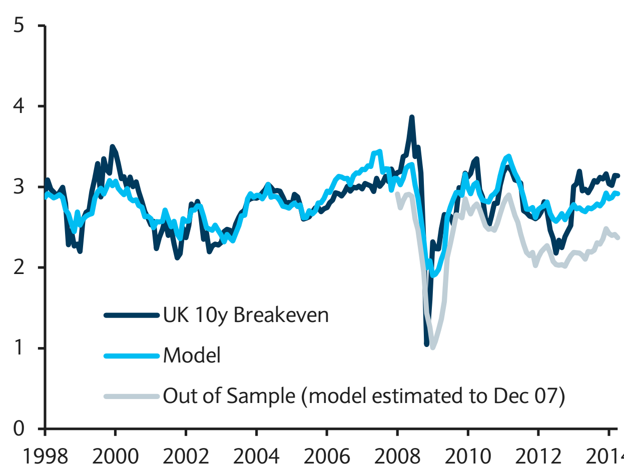
real yields, and we include the Bank Rate and money market slope variables from our real yield model in our breakeven model. We also include Global Manufacturing Confidence and the CRB Raw Industrials index as a proxy for broad inflationary concerns. The UK market is particularly sensitive to domestic supply and demand factors, more so than other comparable inflation markets. The marginal pricers of UK linker real yields, and by extension breakevens, are often domestic investors, and modelling supply/demand dynamics is in practice hard to achieve. This can be seen in the relatively low R^2 value for the UK breakeven model, and we are reluctant to place too much emphasis on its practical utility for investors.

A key consideration when assessing fair value in UK breakevens is the outlook for the RPI/CPI basis, as discussed in the UK market overview in this publication. As a case in point, a 1pp RPI/CPI basis on a 10y breakeven of 3.0% implies that the market is pricing the MPC to hit its inflation target in the medium term; a basis assumption of 0.5pp would imply an overshoot. UK breakevens are, to an extent, sensitive to movements in Bank Rate via the mortgage interest payments component of RPI. Indeed, this component historically has been the key driver of volatility in the basis. When the RPI/CPI basis is close to flat, this can limit tactical interest in UK breakevens as there is a tendency to extrapolate recent readings into the future. Given the relatively low sensitivity of RPI inflation to energy factors and RPI/CPI basis uncertainty, it comes as little surprise that the model is unstable. Monetary policy in the UK has been at its loosest ever, and with inflation having been substantially above target throughout 2010/11, future inflation persistence in the UK remains likely, in our view. The global factors in our breakeven model do not capture such UK-specific risks, and the low level of interest rates is likely implying lower fair value than would be consistent with the balance of inflationary risks as is more appropriately factored into market valuations. The poor out-of-sample performance reflects the fact that the market is pricing nearer-term housing-fuelled inflation pressures, whereas global inflationary dynamics remain relatively benign, particularly in commodity prices which are a key component of our model.

10y UK real yield model

The Bank of England official bank rate is the most significant driver of UK 10y real yield valuations, while the slope of the short sterling futures curve has also been historically significant. Bank Rate reached its effective lower bound in March 2009, but UK real yields have posted significant moves since then. A combination of BoE gilt purchases and euro fuelled risk aversion caused UK real yields to rally to record lows in H1 13, before starting to

FIGURE 12
10y UK breakeven model



Source: Bloomberg, Barclays Research

FIGURE 13
10y UK BE model coefficients and summary statistics

	Coefficient	t-stat		Model Stats
Global Manufacturing Confidence (1mth lag)	0.140	4.5	R^2	0.609
CRB Raw Industrials	0.00284	10.5		
Short Sterling (4th vs 1st)	0.331	6.9		
BoE Bank Rate	0.132	8.4		
Constant	1.203	7.5		

Model January 1998 – December 2013

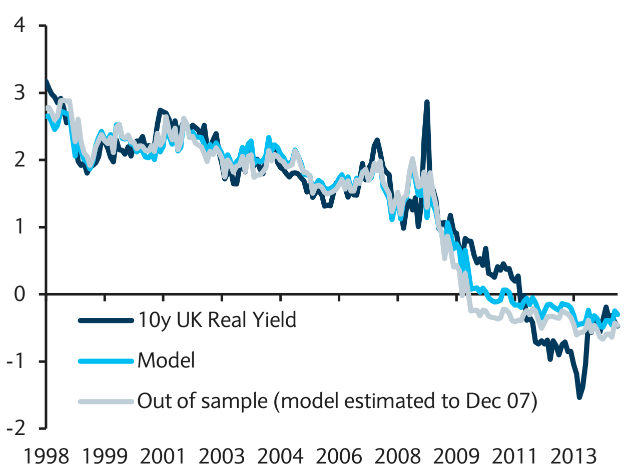
Source: Barclays Research

cheapen alongside most other core market real rates. As near-term inflation pressures have softened, 10y UK real yields have now cheapened to close to fair value. However, given the BoE is now moving toward policy normalisation, further cheapening is likely.

Traditionally, UK real yields have showed an inverse relationship with the FTSE 100, which at first might appear counterintuitive given that rates tend to rally when risk assets sell off. However, the inverse relationship can be rationalised by considering the interaction between pension schemes and linkers, with domestic pension funds historically one of the largest investor bases in the asset class. A rise in equity prices in theory improves pension solvency, and this therefore can generate demand for linkers from pension fund de-risking. This has formed part of a structural shift in pension fund allocations away from equities into fixed income. Although pension solvency has suffered following the sharp rally in UK yields over the past five years, improvement in solvency ratios is likely to see de-risking demand from pension schemes return. We also find our proprietary Global Manufacturing Confidence indicator adds explanatory power to the model, as a broad proxy for economic strength and pipeline inflation pressure.

We estimate the UK real yield model during January 1998-December 2013. This avoids distortions from a structural break following the decision to grant the Bank of England independence in May 1997, and also coincides with the introduction of the minimum funding requirement (MFR) for pension funds. Model coefficients have remained fairly stable over the past few updates of this publication, and the model out-of-sample taken to the end of December 2007 tracks the more up-to-date set of coefficients quite closely.

FIGURE 14
10y UK real yield model



Source: Bloomberg, Barclays Research

FIGURE 15
10y UK real yield model coefficients and summary statistics

	Coefficient	t-stat		Model Stats
BoE Bank rate	0.492	39.9	R^2	0.903
4th-1st SS Contract	0.701	12.8		
FTSE 100	-0.000371	-11.1		
Global Manufacturing Confidence (1m lag)	-0.153	-3.8		
Constant	1.53	7.9		

Model: January 1998- December 2013

Source: Barclays Research

INFLATION PRODUCTS

Valuing front-end linkers

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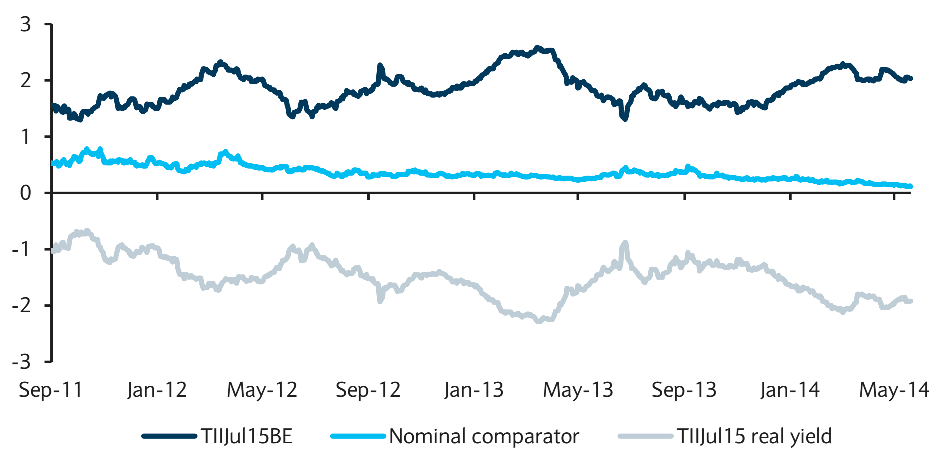
Front-end linkers tend to trade perennially cheap to fundamentals in the US, but not necessarily in the euro area or UK where market dynamics differ. We discuss how we value the short end and look at the drivers of the usual cheapness in the US.

What's real and what's for sale?

Longer maturity inflation-linked securities can be valued separately on a real rate and a breakeven basis. However, because short nominal rates are relatively stable, real rate movements make up most of the volatility in short maturity breakevens, and there is often little difference between the P&L of an outright position and the one expressed as a breakeven (Figure 1). At higher yield levels, the case can be made for separate evaluations, but particularly in the US, short-end real yields, which as of May 2014 are deeply in negative territory and volatile, are a reflection of the fact that short nominal rates are low and stable and breakevens are positive and non-static. Therefore, we value short TIPS almost exclusively on a breakeven basis.

FIGURE 1

TIIJul15s breakevens driven mostly by real yield moves (%)



Source: Barclays Research

At first blush, valuing short breakevens is rather trivial. As the term implies, if the breakeven is higher (lower) than expected, it is fundamentally cheap (rich). However, there are several factors to keep in mind. First, it is important to remember that breakevens, like yields, are quoted on an annualized basis. This means that breakevens with only a few months left to maturity can be much higher or lower than the general trend – for example, a strong print of 0.5% m/m could translate into an annualized inflation accretion rate of 6.17% and, thus, a 1m breakeven would be 6.17%. Seasonality can also have a significant effect on deviations in breakevens from the general inflation trend (for more on this, see the seasonality primer in this Guide). It is also important to line up the dates correctly since TIPS mature mid-month, so the final reference CPI will be close to (but not exactly equal to) the average of the NSA CPI prints from the second and third prior months.

Forecasts must also be updated for moves in energy futures. While we use our economists' NSA CPI forecasts in valuing front-end breakevens, they typically only update their forecasts once or twice per month. If energy futures change significantly from where they were when forecasts were released, they may be stale for the purpose of valuing the short end. In

FIGURE 2

Breakeven cheapness versus base Barclays CPI forecast and forecast adjusted for energy

TIPS maturity	TIPS real yield	BE	BE versus Barclays CPI forecast BE (bp)	BE versus Barclays CPI forecast BE (bp), crude adjusted	BE versus Barclays CPI forecast BE (bp), gasoline adjusted
Jul-14	-4.16	4.20	-9	-9	-9
Jan-15	-1.68	1.75	-19	-31	-27
Apr-15	-1.43	1.51	-36	-44	-42
Jul-15	-1.93	2.06	-27	-32	-30
Jan-16	-1.51	1.75	-32	-34	-34

Source: Barclays Research, as of May 21, 2014

Figure 2, we adjust our economists' NSA CPI forecasts for moves in energy futures, both WTI and RBOB, since the forecasts were released on May 15, 2014 and value front-end breakevens on May 21, 2014 against these adjusted forecasts. The third column shows market breakevens. The fourth column shows breakevens less what Barclays NSA CPI forecasts imply for inflation to maturity of each security. A negative number means that breakevens are lower than Barclays' inflation forecasts and this implies they are fundamentally cheap. The final two columns adjust Barclays' forecasts for moves in oil (WTI) and gasoline (RBOB) futures since the latest forecast update. The table shows that, in this example, TIIApr15s were about 40bp cheap to Barclays' forecasts. We include a version of this table in our *Inflation-linked Daily*.

It is also important to account for carry when looking at spot breakeven moves. In a period in which a 1y breakeven has positive carry of, say, 100bp, breakevens could drop 80bp and a long position still would have outperformed the forwards. This is especially something to consider when looking at breakeven changes from Thursdays to Fridays of large (positive or negative) carry months. Continuing with the example of carry of 100bp in a month, or about 3bp/day, a long weekend would mean breakevens could drop 12bp from Thursday (Friday settle) to Friday (Tuesday settle) without a long BE position experiencing a P&L loss. It is therefore important to value short breakevens by lining them up against NSA CPI inflation forecasts to the specific maturity of the security because inflation over that specific period might be very different than the general inflation trend.

Cheap, but cheap enough?

We find that front-end breakevens typically trade cheap to fundamentals. The reason for this, in our view, is that there is essentially a structural demand vacuum on that part of the TIPS curve. Most inflation-linked indices are 1y+ benchmarks, so passive index managers are forced to sell them and active managers would likely only hold them if they were cheap. In nominal space, there is a natural transfer at the 1y point from intermediate investors to money market funds, but most money market funds either cannot buy linkers until the final cash flow is known (which means demand is usually strong inside of 1m to maturity) or they do not want to take on the volatility of short TIPS. Most cash in the front end of the nominal market is there specifically to avoid volatility, so to be enticed into TIPS, those real money funds who can buy them demand significant compensation for the volatility. Hedge funds used to be more active in the inflation market and could largely hedge out the effect from energy price swings, but because they are less involved than before the crisis, they no longer provide such a corrective force when issues get cheap. For these reasons, many investors do not get interested in short TIPS unless breakevens are more than 50bp cheap to fundamentals.

More recently, short breakevens have tended to trade less cheap than they did in the past. One reason for this might be the growth in TIPS funds benchmarked against a shorter dated index such as the 0-5y TIPS index as investors look to increase their inflation exposure and decrease their duration risk. This trend of increasing structural demand may continue and lead to less perennial cheapness over time. Regardless, at this time the market continues to present enough opportunities for investors to get involved at levels that appear cheap to expected inflation.

Front end EUR linkers… no clear cut cheapness

Similar to the US market, front end linkers in the euro area usually trade at a discount to fundamentals implied, for instance, by economists' forecasts. The main reason is the lack of a deep natural investor base once those linkers drop from 1y+ bond indices. However, their cheapness is not always as clear-cut and compelling as in the US. Some short-end investors do get involved in the euro linker market once the apparent discount to front end nominals becomes large enough. Also, with the existence of an active asset swap market for euro linkers, some issues are held to a large extent on that basis within hold-to-maturity positions. This means that even as those issues drop from 1y+ indices, the available float is not large enough to generate a sizeable discount to nominals.

One thing to bear in mind is the non-negligible maturity mismatch that most euro linkers tend to have versus their nominal comparators. For example, French linkers redeem on 25 July, but their nominal comparators typically mature on 25 April. For long-dated linkers, this mismatch can be overlooked, but for front-end issues, it can be sizeable in relative terms; a few extra months versus the nominal comparator cannot be ignored if the residual maturity of the linker is, say, below 1y. In that case, and unlike for TIPS, it is therefore not suitable to simply compare the headline breakeven of the front end euro linker against the remaining inflation accretion that is implied by, for example, economists' monthly forecast profiles.

To assess the cheapness of a front end euro linker, we proceed by projecting its remaining cash flows in nominal terms. Using the projected cash flows and its current full market price, we can then calculate an implied nominal yield to maturity or money market yield. Those yields can then be compared to similar maturity nominal bonds or bills to gauge the richness/cheapness of the linker versus the nominal market. To project the linker's cash flows, we traditionally use our economists' forecasts. In addition, with growing liquidity in sub-1y euro HICPx swaps ("inflation resets market"), projections can also be made using those (effectively, the analysis then becomes analogous to a relative z-spread calculation). The resets market provides a transparent and tradable metric of euro HICPx projections, which means that tactical investors can eventually choose to trade front end breakevens via either the cash or derivatives market. We note though that some months on the resets curve may be biased by inflation swap supply generated by asset swap activity; one has to bear that in mind when using the sub-1y euro HICPx curve as the basis for linker cash flow projections.

Figure 3 below illustrates front end fair value calculations for the BTP€i 15 September 2014. We assume that the calculations are done from the perspective of a short end investor choosing between either front-end inflation-linked or nominal Italian linker securities. Therefore, we have used the offer price of the BTP€i14 and compared its implied money market yield to the offer money market yields of nominal securities. It is very important to used tradable offer/bid rather than mid prices when making such calculations. This is because mid-to-offer or mid-to-bid spreads can be very wide on front end instruments in yield terms. In other words, what can appear very appealing versus nominal at mid price may not be so attractive once realistic tradable prices are used.

Our calculations show that the BTP€i14 offers a small discount versus nominals if we use the euro HICPx forecasts of our economists. However, it is relatively rich under projections from the resets market. Given that the BTP€i14 was a bond that was heavily bought, probably within hold-to-maturity positions, following the ECB's 3y LTRO operations, its available float on dealers' books may not be so large. This may explain its relatively unappealing valuation.

Looking ahead, we believe that front end euro linkers may tend to offer a greater discount versus nominal than in the past. This is because dealers now have more balance sheet constraints than in the past, making it more difficult for them to hold those cash-intensive instruments once then drop out of bond indices. Furthermore, in the past, a large enough discount usually prompted buying interest. However, given that euro area inflation has become more difficult to forecast in the recent past (and has, more often than not, surprised to the downside), even a large discount versus nominal that is implied by euro HICPx forecasts may not be enough to entice buyers.

FIGURE 3

BTP€i14 fair value calculations - relative cheapness versus nominal market not obvious

Bond	BTP€i14
Maturity	15 September 2014
Annual coupon rate	2.15%
Coupon frequency	Semi-annual
Base euro HICPx reference	96.07202
Trade date	30 May 2014
Settlement date	04 June 2014
Remaining days to maturity	103
Clean price before inflation adjustment	100.49
Full invoice price	**123.385...**

	Calculations using monthly euro HICPx from:	
	Barclays' economists' forecasts	Mid euro HICPx resets y/y prices
June 2014 euro HICPx index forecast	117.83	117.667...
July 2014 euro HICPx index forecast	116.97	116.948...
Expected index reference for 15 September 2014	117.42867	117.33181
Expected index ratio for 15 September 2014	1.22230	1.22129
Expected cash flow on 15 September 2014 (including coupon)	123.54397...	123.44188...
Corresponding money market yield	0.450%	0.161%
Corresponding nominal yield to maturity	0.457%	0.163%

Close maturity nominal instruments	Offer money market yields
BTP 4.25% 1 August 2014 (nominal comparator)	0.352%
CTZ 30 September 2014	0.360%
BTP 6% 15 November 2014	0.424%

Illustrative calculations as of 30 May 2014

Source: Barclays Research

Front-end UK linkers – Some additional complexity

Dynamics specific to the UK linker market mean that, in general, front-end UK breakevens do not tend to trade notably cheap to inflation forecasts as they approach maturity. Redeeming UK linkers to date have all been old-style 8m lag issues, where conventions and thus valuation differs from Canadian model bonds; thus, a different method must be used for assessing fair value. In the UK markets, the most widely tracked indices are the FTSE Actuaries all-linker and over-5y indices, the former including sub-1y maturity bonds. As such, index-related selling of bonds is most prominent as their residual maturities approach 5y. This can result in bonds cheapening sharply as a result of the selling pressure; this typically unwinds if the cheapening results in the bond offering economically attractive breakeven value, on which hold-to-maturity investors can capitalise. Equally, if the bond in question offers cheap asset swap value relative to conventional gilts, then this can also generate sizeable demand. In past significant over-5y bond index drops, asset swapping has provided an important demand cushion for absorbing the float of bonds created by selling from passive indexers. Those with active benchmarks in general tend to sell or underweight bonds approaching a 5y residual maturity in advance to avoid selling the bond at a cheap valuation. In other markets, indexation to >1y indices is common, and as outlined above, this has tended to cause short breakevens to trade cheap close to maturity.

As discussed in the UK country section of this publication, for old-style UK linkers, the real yield is derived via a model employing a 3% inflation assumption. This means the real yield must be adjusted after each RPI release to account for the deviation of the latest print from this underlying assumption. This causes notable distortions as the bond approaches maturity. For assessing fundamental value, we prefer to calculate the money yield of the bond using our RPI forecasts and then compare this either with maturity-matched OIS or a similar short-dated gilt. The spread of the forecast-implied money yield to the comparison nominal rate then gives the cheapness of the old-style linker. The implied money yield to maturity can be calculated on Bloomberg using the YA (yield analysis) screen. Under 'economic factors', the current RPI print field should be set to the forecast RPI print fixing the final value of the bond – for the UKTI 2.5 Jul 2016, this would be the November 2015 RPI forecast. Additionally, the 'Assumed inflation rate' must be set to zero rather than 3%, as we are specifying the full inflation accrual for the bond. This will then calculate the money yield implied by this RPI forecast, which is equivalent to the nominal yield to maturity that will be released should RPI inflation print in line with the forecast.

INFLATION PRODUCTS

Capturing "core" breakevens

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Why calculate "core" breakevens

Using headline BEs and food and energy futures curves, one can derive market-implied "core" breakevens. Market participants tend to have more certainty about near-term forecasts for core inflation (excluding food and energy), because trends for this item are more persistent. Hence, when the market is implying a low or high core breakeven versus the recent trend and/or the near-term core inflation forecast, investors can enter/exit a front-end breakeven trade with more confidence. To address this need, we calculate core breakevens by using food and energy futures curves.

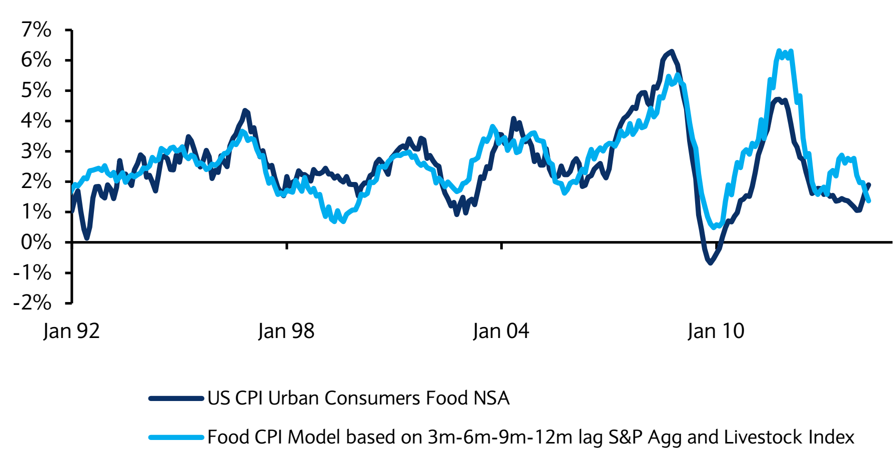
Modelling food inflation

To get a market-based measure of expected food CPI inflation (which makes up about 13.9% of headline CPI), we establish a relationship between food-related futures and food CPI. Using the S&P Agriculture and Livestock index returns (SPGCAL Index y/y) at various lags (3m, 6m, 9m and 12m) as independent variables against food CPI (y/y) as a dependent variable, we can forecast the behavior of near-term food CPI (Bloomberg: CPRFFOOD Index) reasonably well (Figure 1). We take this model one step further using food futures to predict the 2y path of market-implied food inflation. Below, we note our approach to produce food futures-based food CPI forecast.

The SPGCAL index's main constituents are wheat, corn, soybean, live cattle and sugar. Using these food futures, one can replicate the SPGCAL Index (Figure 2). In this instance, we assigned relative weights of 23% to corn, 21% to wheat, 20% to sugar, 19% to cattle and 17% to soybeans. These are normalized from the S&P Agriculture and Livestock index components. We use these main futures for two reasons: they make up the majority of the SPGCAL index at over a 75% aggregate weight;, and two-years' out futures contracts exist for all of these components. For this analysis, we use December 2015 maturity futures to back out (from a model) market-expected food inflation two years out. Figure 3 shows that (as of May 27, 2014) for a 2y period, food futures imply roughly 2.1% food inflation (annualized).

FIGURE 1

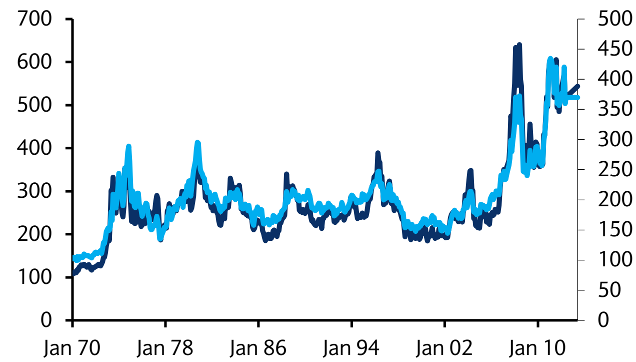
Food inflation is well predicted by the lagged S&P Ag & Livestock index



Source: Bloomberg, Barclays Research

FIGURE 2

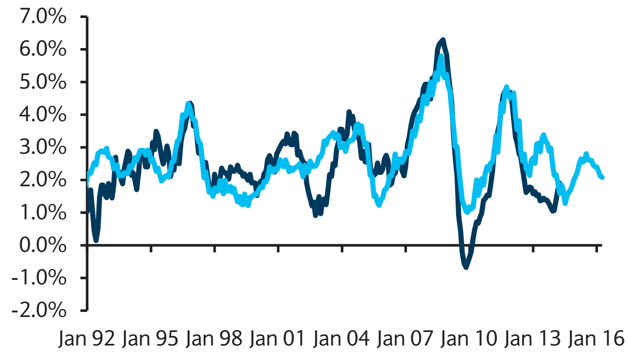
S&P GSCI Agg and Livestock index well replicated with five food futures (sugar, corn, livestock, soy and wheat)



Source: Bloomberg, Barclays Research

FIGURE 3

Predicting food CPI inflation using food futures



Source: Barclays Research

Modelling Energy Inflation

To get a market-based measure of energy inflation (which makes up about 9.5% of headline CPI), we establish a relationship between crude futures and energy CPI. Figure 4 shows that y/y crude futures pass through to energy CPI by about 30%. Using the crude futures curve, we can back out future energy inflation. One can also do the above exercise with Motor-Fuel CPI and crude/gasoline futures, which has a tighter correlation.

Example: Calculating "Core" Breakeven, "Ex-Energy" Breakeven and "Ex-Food" Breakeven

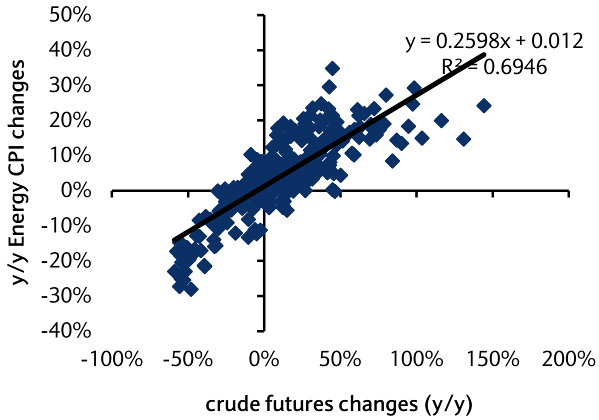
Given the 13.85% food CPI weight in the headline CPI basket and 1y food inflation of 2.2% and the April15 breakeven rate of 1.42% (as of May 27, 2014), we can back out the market-expected 1y ex-food breakeven to be about 1.3%.

- 1y Breakeven = (1-W1) * Ex-FoodBreakeven + W1* 1yrFoodCPI
- W1: weight of Food CPI, 13.85%
- 1y Breakeven: 1.42%
- 1y Food Inflation: 2.2%
- Solve for 1y Ex-Food Breakeven: 1.3%

Similarly, using energy futures 1y out, one can model market-implied 1y energy inflation (1.24%) and back out ex-food and ex-energy breakevens. As we have shown in past articles, on a y/y change bases, the crude pass-through into energy CPI is about 30% (Figure 4). The weight of energy in the headline CPI basket is about 9.53%. Crude futures 1y out (Mar 2015) are at 102.92 and the spot crude (Mar 2014) basis was at 101.67 (as TIPS accrue CPI on a 2-3m lagged basis); this translates into market-implied energy inflation (annualized and assuming 30% crude pass-through) of about 0.37%. Using energy CPI and food CPI weights of 9.53% and 13.85% respectively and market-implied energy and food inflation rates of 2.2% and 0.37% respectively, we calculate the market-implied core breakeven at 1.41%.

FIGURE 4

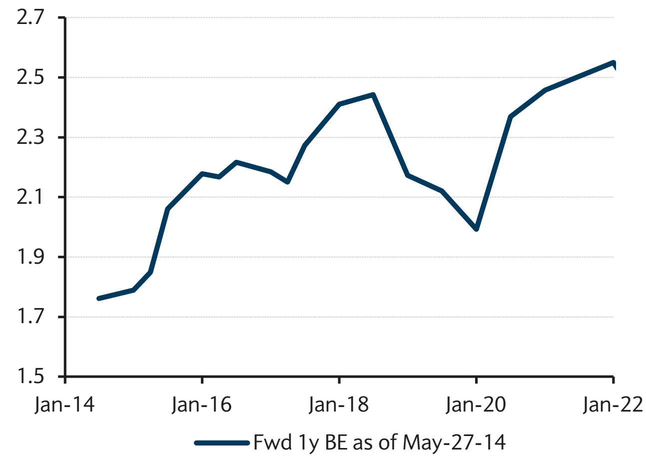
Energy inflation versus y/y crude futures changes (1m lag)



Source: Bloomberg, Barclays Research

FIGURE 5

1y fwd 1y BE matching 1y core BE



Source: Barclays Research

- 1y Breakeven = (1-W1-W2)*1yCoreBreakeven + W1*1yFoodInf + W2*1yEnergyInf
- W1: Weight of food in headline CPI, 13.85%
- W2: Weight of energy in headline CPI, 9.53%
- 1yFoodInf: Food futures market implied 1y food inflation rate, 2.2%
- 1yEnergyInf: Energy futures market implied 1y energy inflation rate, 0.37%
- 1y Breakeven: 1.42%
- Solve for 1y Core Breakeven: 1.41%

In summary, the markets (TIPS and food/energy futures) show the 1y headline breakeven at 1.42%, the 1y ex-energy breakeven at 1.5% and the 1y core breakeven (ex-food and energy) at 1.41%. Figure 6 shows core breakeven table for 1y and 2y.

FIGURE 6

Core breakeven table as of May 27, 2014

TIPS Security	Apr15	Apr16	Apr15-Apr16
Headline Breakeven	1.42%	1.65%	1.88%
Core Breakeven (Ex-energy and Ex-food Inflation)	1.41%	2.01%	2.54%
Breakeven Ex-Energy	1.53%	2.02%	2.49%
Breakeven Ex-Food	1.29%	1.58%	1.83%
Model implied Energy Inflation (pass-through 60%, energy weight: 9.53%)	0.37%	-1.90%	-3.94%
Model Food Inflation (food weight: 13.85%)	2.20%	2.10%	2.21%

Source: Bloomberg, Barclays Research

INFLATION PRODUCTS

Hedging energy risk in breakeven positions

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Why energy hedge?

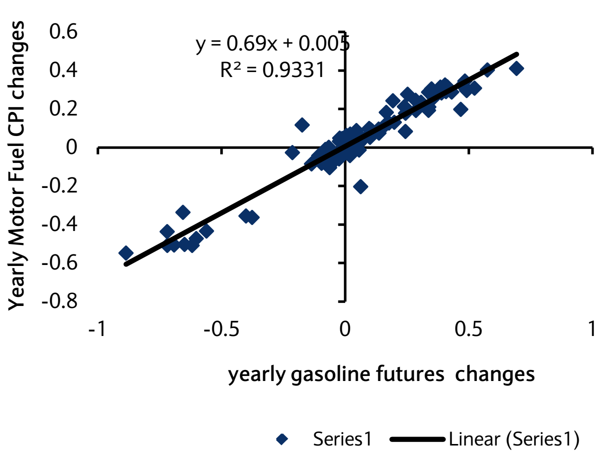
Historically, front-end breakeven positions have been quite cheap to the expected near-term inflation forecasts. One reason is that TIPS shorter than 1y in maturity fall out of the TIPS index, which usually translates into large dealer inventory. Additionally, these securities tend to be quite volatile because of their sensitivity to moves in energy and/or food commodity prices. This is because one CPI print matters much more for a 1y or 2y tenor TIPS than it does for, say, a longer-dated 10y, 20y or 30y TIPS. Moreover, core CPI tends to be persistent relative to headline CPI in the near term. Thus, food and energy commodities moves can lead to volatile front-end valuations. For investors who cannot hedge against moves in energy, higher volatility leads to a repricing of risk premium on the security. Using historical pass-throughs (from energy futures into energy CPI or motor fuel CPI) and the energy/motor-fuel weight in CPI, one can energy-hedge front-end TIPS trades to reduce volatility. From time to time, we think investors can capitalize on this higher risk premium on front-end US breakeven positions by energy hedging.

Approach to energy hedging

The intuition behind energy hedging is that for a held-to-maturity 1y breakeven position, the investor will be indifferent to the rate of energy (motor fuel) inflation if the hedge works as expected. By selling matched-maturity gasoline or crude futures (or buying gasoline or crude puts) versus a front-end breakeven position, one can hedge against motor fuels CPI. Our analysis indicates that there is an ~70% pass-through of gasoline futures into y/y changes in motor fuel CPI (Figure 1) with a fairly close fit. Figure 2 shows an ~60% pass-through of crude futures into y/y changes in motor fuel CPI. One important aspect of hedging is to find a contract closest to (or slightly longer than) the matched energy futures (gasoline or crude) to the 2-3m lagged maturity of the TIPS security. The choice of crude or gasoline will depend largely on the liquidity of the available contracts; crude futures tend to be more liquid. An investor might also choose one over the other if they have a view on crack spreads. As of May 2014, motor fuel CPI makes up about 5.375% of headline CPI (see page 10 of http://www.bls.gov/news.release/pdf/cpi.pdf). Assuming Figure 1's regression

FIGURE 1

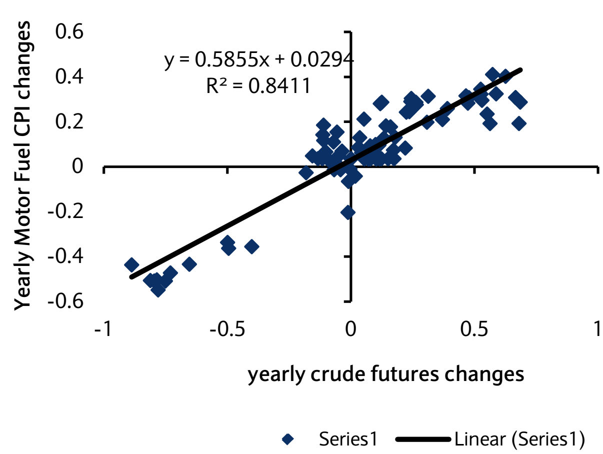
Motor fuels CPI changes (%) versus gasoline futures changes (%), pass-through is about 70%



Note: From October 2005 to April 2014 Source: Bloomberg, Barclays Research

FIGURE 2

Motor fuels CPI changes (%) versus crude futures changes (%), pass-through is about 60%



Note: From October 2005 to April 2014 Source: Bloomberg, Barclays Research holds, a 1% gasoline futures change passes through to motor fuel CPI at the rate of about 69%. Hence, for a 1y breakeven position, a 1% change in gasoline futures is worth about 4bp (1% gasoline futures change * 5.375% motor_fuel CPI Weight * 69% pass-through).

Determining the number crude/gasoline futures needed to hedge a front-end breakeven position

Using the aforementioned approach, we can derive how many gasoline/crude contracts one needs to hedge a held-to-maturity front-end breakeven position.

How many gasoline futures contracts to sell?

For example, as of May 28, 2014, to hedge a $100mn TIIApr15 breakeven position (underlying CPI is the mid of January and February 2015 CPI), the nearest maturity gasoline futures contract is XBH5:

1. **Determine the gasoline futures with which to hedge**. For our example, the nearest maturity gasoline futures contract is XBH5 (the last trade date is February 27, 2015). Our assumption is that gasoline futures are liquid. If they are not, we would use December contracts, which tend to be more liquid, or do this exercise with crude/Brent futures (see steps below).

2. **Translate 1% change in gasoline futures to 1y CPI change:** A 1% change in gasoline will move 1y CPI about 4bp (1% gasoline futures change * 5.375% motor_fuel CPI Weight * 69% pass-through).

3. **Translate 4bp CPI change to TIIApr15 BE move:** Using the sensitivity calculations above for a 1y security, we can estimate how much a 1% change will affect TIIApr15s by dividing the 4bp change by the current duration (as of May 28, 2014) of TIIApr15s. That is about 0.88y, so a 4bp change is worth about 4.55bp (4bp/0.88y) for a long TIIApr15 BE position.

4. **Translate the 4.55bp change into the dollar sensitivity amount on a $100mn TIIApr15 position.** This is about $44,271 (4.55bp * $100mn * 0.973/$10000); where 0.973 is the Apr15DV01.

5. **Calculate the dollar sensitivity of 1 gasoline futures contract to a 1% change in the gasoline futures price.** A 1% change in 1 XBH5 contract (priced at $265.01 as of May 28, 2014 for 42,000 gallons) is worth about $1113 (1% * 42000* $2.65).

6. **Using the dollar sensitivities in steps 4 and 5, derive the number of gasoline contracts needed to hedge:** We simply divide the 4.55bp sensitivity, or $44,271, (for a 1% change in gasoline futures) by the sensitivity of 1 gasoline futures contract ($1113): $44271/$1113, or about 40 XBH5 contracts to hedge a $100mn TIIApr15 BE position.

How many crude futures contracts to sell?

For example, as of April 24, 2012, to hedge a $100mn TIIApr15 breakeven position (underlying CPI is the mid of January and February 2015 CPI), the nearest maturity crude futures contract is CLH5.

1. **Determine the crude futures with which to hedge**. For our example, the nearest maturity crude futures contract is CLH5 (the last trade date is February 27, 2015).

2. **Translate a 1% change in crude futures to the 1y CPI change:** A 1% change in crude will move the 1y CPI about 3.2bp (1% crude futures change * 5.375% motor fuel CPI Weight * 59% pass-through).

3. **Translate the 3.2bp CPI change to the TIIApr15 BE move:** Using the sensitivity calculations above for a 1y security, we can estimate how much a 1% change will affect TIIApr15s by dividing the 3.2bp change by the current duration (as of May 28, 2014) of

TIIApr15s. This is about 0.88y, so a 3.2bp change is worth about 3.6bp (3.2bp/0.88y) for a long TIIApr15 BE position.

4. **Translate the 3.6bp change into the dollar sensitivity amount on a $100mn TIIApr15 position.** This is worth about $34,920 (3.7bp * $100mn * 0.973/$10000); where 0.973 is the Apr15DV01.

5. **Calculate the dollar sensitivity of 1 crude futures contract to a 1% change in crude futures price.** A 1% change in 1 CLH5 contract (priced at $96.02 as of May 28, 2014 for 1000 barrels) is worth about $960 (1% * 1000* $96.02).

6. **Using the dollar sensitivities in steps 4 and 5, derive the number of crude contracts needed to hedge:** We simply divide the 3.6bp sensitivity, or $34,920, (for a 1% change in crude futures) by the sensitivity of 1 crude futures contract ($960): $34920/$960, or about 36 CLH5 contracts to hedge a $100mn TIIApr15 BE position.

Ideally, for a held-to-maturity position, we prefer to hedge directly using ATM crude/ gasoline futures puts because from a long-breakeven position perspective, we are concerned only with downside risks in inflation. Typically, when front-end breakevens are cheap, we have found that the cost paid for a put on an energy futures contract is quite small versus the expected gain on a front-end breakeven position.

Reducing the hedge during the final 2-3 months of a held-to-maturity position

Example: How to roll off the energy hedge on Jul14s in April and May 2014?

As the termination period for Jul14s approaches, we discuss how one can roll off the energy hedge on this position linearly. The final prints that matter for the Jul14s terminal payoff are April and May CPI. Thus, on April 1, 2014, there are about 60 days left of energy price uncertainty. Using the approaches discussed above, we first determine the P&L should the gasoline futures (here, XBM4 is used to hedge Jul14s) instantaneously change by 1% for the entire 60-day period (from April 1 to May 31). Given the current price of 3.00 for XBM4, a 1% change in this gasoline future price equals roughly a $1260 change in 1 XBM4 contract P&L.

Assuming this 1% shock persists for the coming 60 days, one can expect a pass-through of gasoline through motor fuel CPI of about 69% (see the historical relation in Figure 1). Motor fuel CPI makes up about 5.375% of headline CPI. So a 1% change in $100mn Jul14 position equals about $100mn * index_ratio * (1%ChangeRBOB *5.375% MotorFuelCPI Weight * 69% pass-through) = $46k.

In RBOB terms, this translates to about 37 XBM4 contracts ($46k/ $1260 per contract).

The above can be summarized with the following equation.

#of XBM4 Contracts * XBM4Price * 420 * 1% contract price change = Jul14 Position * (1%HoldingPeriodGasolineMove*5.375% MotorFuelCPI Weight * 69% pass-through)

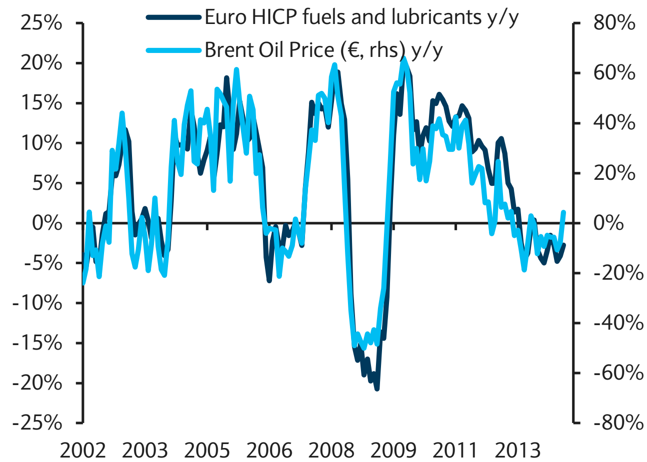
This applies for the entire 60-day period, but what if there are only 45 days left through the end of May? In this case, we should reweight the 1% holding period gasoline move (on the right side of the equation) by 1% * (45/60). More simply, since this is a multiplier term, we can reduce the 37 contracts position to 28 contracts (37 XBM2 contracts * 45/60). One subtlety in the above calculation is that gasoline futures feed into motor fuel CPI with a 1w lag. So after the third week in May 2014, an investor who is long Jul14s (July 2014 maturing security) does not need to energy hedge a Jul14 BE position.

Hedging in euro and UK inflation markets

At first glance, there is a strong correlation between movements in oil prices (denominated in the domestic currency) and the energy components in euro area HICP and UK RPI. However, energy hedging of breakeven positions is less common in European inflation

FIGURE 3

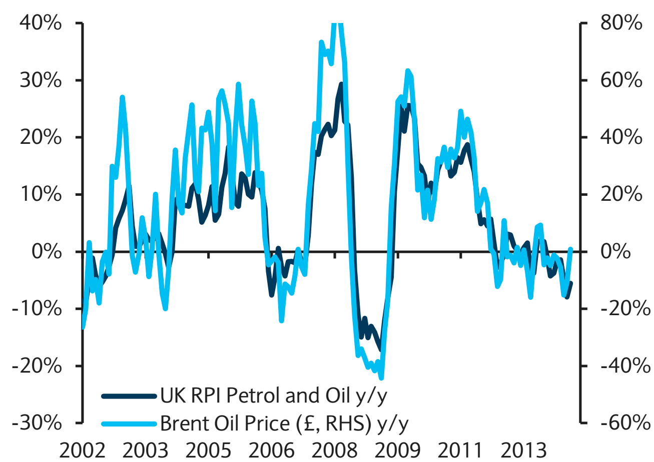
Euro energy price pressures have subsided



Source: Eurostat, Bloomberg, Haver Analytics, Barclays Research

FIGURE 4

UK petrol prices broadly correlated with oil



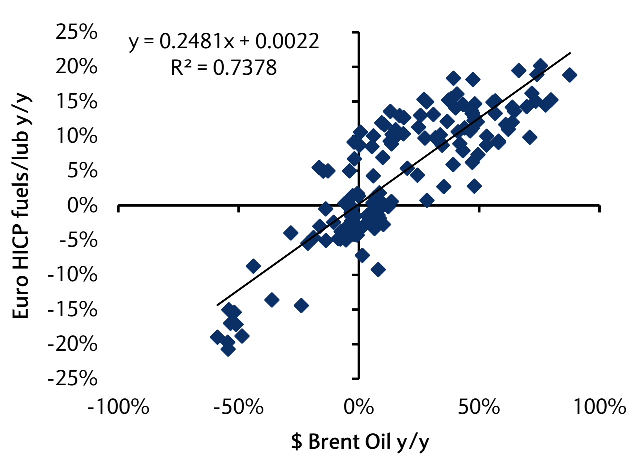
Source: ONS, Bloomberg, Haver Analytics, Barclays Research

markets than for US TIPS. One reason is currency risk, given that oil prices are expressed in US dollars and the sensitivity of price indices to oil is denominated in the local currency. Over the past 10 years, energy has comprised 9.4% of euro HICPx and 8.1% of UK RPI on average, with this weighting increasing as energy prices have broadly increased. Sensitivity in both indices to energy prices arises from household tariffs and motor fuels. The former tends to be less volatile and subject to regulation, particularly in Europe. As countries particularly in the periphery have faced fiscal deterioration, a quick solution has been to raise taxes levied on energy prices. In practice, anticipating and hedging this is difficult, while the pass-through to indices tends to be gradual. We therefore focus on the sensitivity of motor fuel prices to movements in oil, as this tends to be the primary source of short-term realised volatility in CPI energy.

As Figures 5 and 6 show, while the connection between consumer price energy and oil appears strong, statistically the pass-through is less so. Motor fuels constitute 4.8% of euro HICPx and 4.3% of UK RPI. This implies that a 10% rally in oil would, ignoring currency effects, add 12bp to both euro HICPx and UK RPI, which is well within the bounds of forecast error even at short horizons. In all likelihood, the medium-term effects of any move

FIGURE 5

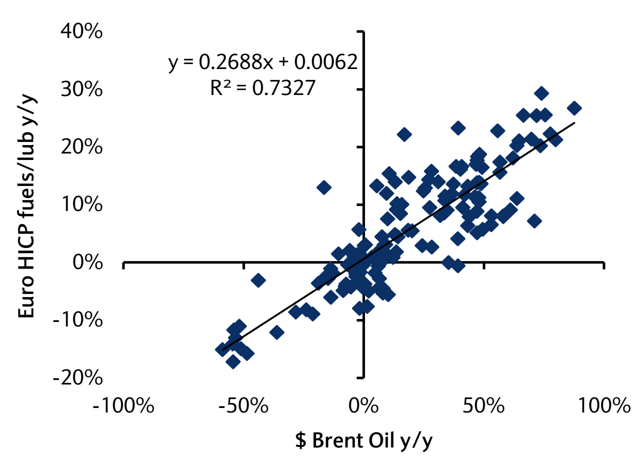
10y Euro HICP fuel/lubricants vs. Brent oil ($)



Source: Barclays Research

FIGURE 6

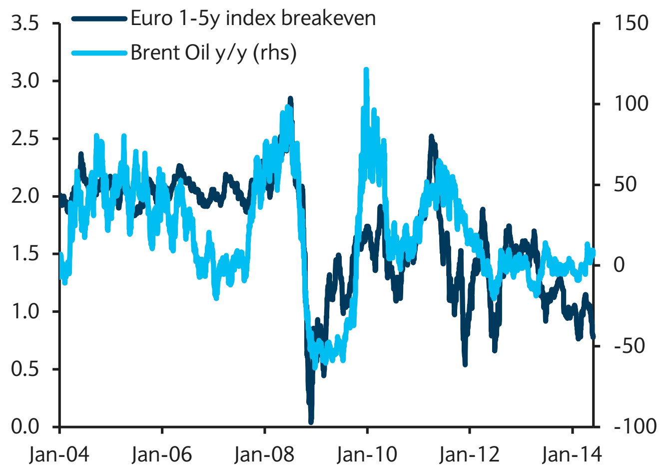
UK RPI petrol and oil vs. Brent oil ($)



Source: Barclays Research

FIGURE 7

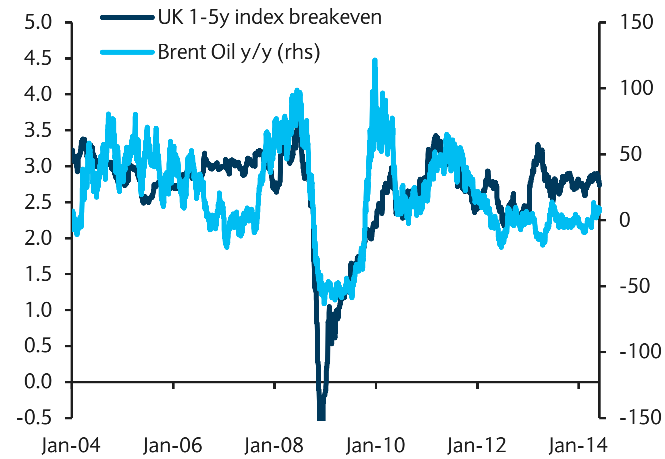
Short euro breakevens show some directionality



Source: Bloomberg, Barclays Research

FIGURE 8

UK breakevens less directional



Source: Bloomberg, Barclays Research

on broader energy price inflation would be more, but the uncertainty surrounding changes in taxes and producer responses means that this analysis is not likely to be of significant practical utility for those taking short-term positions. The lesser sensitivity of motor fuel prices to moves in oil stems partly from currency effects, but is more a function of the taxation levied on fuel prices, particularly in the UK. Historically, tax has accounted for a significant proportion of UK pump prices. Petrol is subject to VAT at 20% currently, as well as fuel duty of just under 60 pence per litre. Consequently, almost 60% of the petrol price paid at the pump by British consumers is from tax. As such, the pass-through from oil, particularly in periods of low volatility, is not significant. As Figures 7 and 8 show, short-dated breakevens in the euro and UK markets exhibit some directionality with large moves in oil, but prior to the crisis tended to be comparatively range-bound and less responsive to moves in oil. Thus, top-down and bottom-up analyses imply a low pass-through of oil prices to consumer prices and short-dated breakevens in the near term, implying energy hedges are not particularly beneficial for tactical trades in markets other than US TIPS.

INFLATION PRODUCTS

How to construct forwards

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Forward breakevens are an important market-based measure that the Fed and investors use as a gauge of and/or trading vehicle for inflation expectations. In addition to closely following the 5y5y forward breakeven – which the Fed has historically cited as its preferred forward measure – we find plotting forward 1y breakevens useful in evaluating the path of inflation that the market is pricing in and spotting relative value among various TIPS issues. Given the importance of forward inflation expectations, we discuss our approach to approximating and tracking forwards using cash TIPS. Figure 1 shows the 5y5y fwd breakeven measure implied from cash breakevens versus the Fed's spline-based 5y5y, and Figure 2 shows a curve of forward 1y breakevens as of January 14, 2010. Figure 1 confirms that our tradable measure tracks the spline-based theoretical measure of forward breakevens closely. Figure 2 shows that the Jan15-Jan16 forward breakeven is fairly rich, in our view, versus forwards created using pairs of surrounding issues. Below, we discuss how we calculate and trade a forward breakeven and then explain the nuances of why we believe this approach works in a practical sense.

An example of Jan15-Jan16 forward breakevens

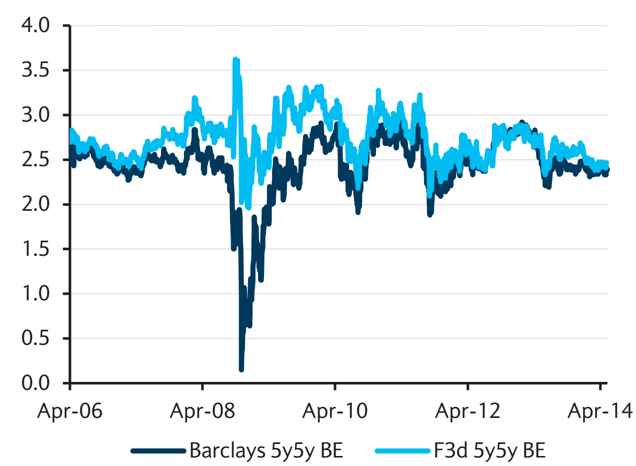
On January 14, 2010, the Jan15-Jan16 forward breakeven measure was trading at about 3.35%, the highest level in the past three months (Figure 3). We construct this measure by weighting breakevens using relative modified durations of each TIPS security.

$$\text{Jan15-16 fwd breakeven} = \frac{(\text{Jan16ModDur} * \text{Jan16 BEI} - \text{Jan15ModDur} * \text{Jan15BEI})}{(Jan16ModDur - Jan15ModDur)}$$

When we recommended this as a trade, weexpected this rate to retreat to 2.60% and used a stop-loss of 3.70%. Figure 4 shows details of the trade at the time. To approximate the forward rate, we use a 100:103.9 notional ratio on the TIPS legs, then DV01 weighting to get the nominal notional legs. The TIPS notionals have been weighted by relative index ratios. While close, this trade is not cash neutral (as shown by the net residual cash amount). Figure 5 shows that overtime (time series upto May 1, 2012) the Jan15-Jan16 short FWD BE trade P&L (assuming the initial setup outlined in Figure 4) has tracked very closely to the anticipated trade P&L based on the Jan15-Jan16 fwd BE time series. Below, we discuss why having an

FIGURE 1

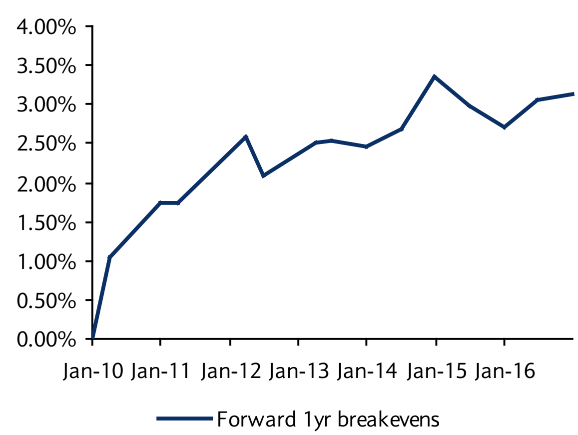
Our conceptual measure tracks the Fed's spline-based 5y5y fwd breakevens closely



Source: Federal Reserve, Barclays Research

FIGURE 2

Breakeven forwards that are one year apart

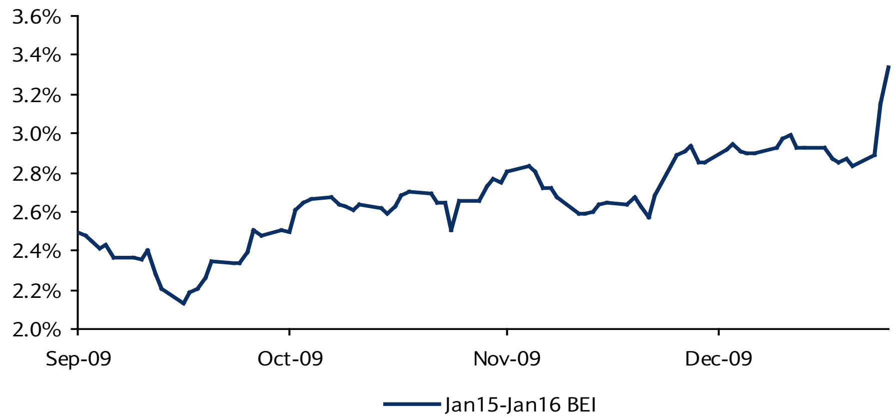


Source: Barclays Research

index ratio-neutral trade makes sense in approximating a forward breakeven. Essentially, we want to have zero P&L attributed to inflation accretion prior to the forward settle date. The only way this can happen is if both breakeven legs of the trade accrete inflation-related notional changes by the same amount. Both issues have off-the-run comparators, which should minimize any repo-based technical forward breakeven increase.

FIGURE 3

On Jan 14, 2010, the Jan15-Jan16 breakeven curve was at a 3-month high



Source: Barclays Research

FIGURE 4

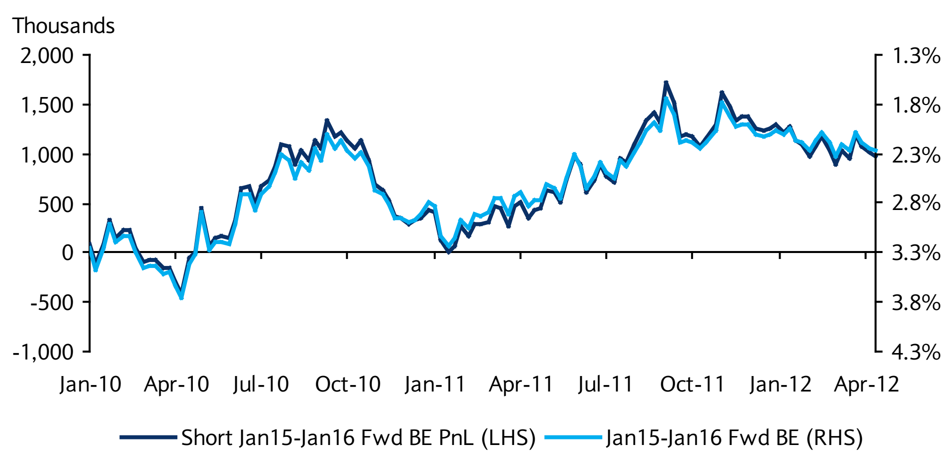
On Jan 14, 2010, the Jan15-Jan16 forward breakeven trade table

Bond Type	Issue	Price (decimal)	Yield	DV01	Index ratio	Par weights	Cash value ($)	Modified duration
Long TIPS	TII 1.625 Jan 15	105.11	0.59%	5.73	1.13250	100.0	119.1	4.81
Short, nominal	T 4 Feb 15	107.37	2.45%	4.95		115.7	126.1	4.54
		Breakeven	1.87%			Residual	6.95	
Short-TIPS	TII 2 Jan 16	106.84	0.83%	6.60	1.08952	103.9	121.0	5.67
Long, nominal	T 2.625 Feb 16	98.37	2.91%	5.51		124.4	123.6	5.55
		Breakeven	2.08%			Residual	(2.56)	
		Fwd BEI	3.35%			Net (Residual)	4.38	

Source: Barclays Research

FIGURE 5

Weekly Jan15-Jan16 FWD BE measure tracks the cumulative P&L earned on a Jan15-Jan16 Fwd trade setup initiated on Jan 14, 2010…



Source: Barclays Research

Creating a forward breakeven rate using TIPS and nominals

In order to fully appreciate forward breakeven (BEI) rates, one has to understand how spot breakeven trades are constructed. We define breakeven rate as the difference between comparable TIPS (real yield) and nominal Treasury yields.

Spot breakeven rate = nominal yield – real yield

Essentially, this is the market's expectation of inflation over a given period, plus an inflation risk premium, less a liquidity premium differential. One can capture a breakeven rate movement by DV01 weighting the TIPS versus nominals, similar to capturing the relative spread movements of 2s10s. If you expect the breakeven rate to widen, you would expect nominal yields to move higher relative to real yields, so you would go long TIPS and short a DV01-weighted amount of nominals. One can also do a TIPS beta-weighted trade, but here, we assume that the trade is DV01 weighted.

There will be some residual starting cash flows (because of dirty price mismatch), as well as coupon accrual differential depending on the path of inflation and reinvestments. The return attribution to this residual when compared with realized – expected breakeven returns will be small. A breakeven position can really be thought of as a synthetic par breakeven bond. The risk measure of such a bond would be:

Breakeven_DV01 = Breakeven_ModDur * Index_ratio

Figure 6 shows a breakeven position (short) for TIIJul14s (5y). The breakeven rate is 1.87%, and the residual is $3.1 (borrow).

FIGURE 6

A standard breakeven position

Bond Type	Issue	Price (decimal)	Yield	DV01	Index ratio	Par weights	Cash value ($)
TIPS	TII 2Jul 14	122.72	0.43%	5.31	1.14721	100.0	122.7
NOMINAL	T 2.625Jul 14	102.59	2.30%	4.33		122.7	125.9
		Breakeven	1.87%			Residual	3.1

Source: As of January 14, 2010. Barclays Research

FIGURE 7

Long 5y5y cash breakeven trade, as of January 14, 2010

Bond Type	Issue	Price (decimal)	Yield	DV01	Index ratio	Par weights	Cash value ($)	Modified duration, (BEI_DV01)
TIPS	TII 2 Jul 14	122.72	0.43%	5.31	1.14721	100.0	122.7	4.32, (4.96)
Nominal	T 2.625 Jul 14	102.59	2.30%	4.33		122.7	125.9	4.22
		Breakeven	1.87%			Residual	3.1	
TIPS	TII 1.875 Jul 19	106.84	1.34%	9.24	1.01278	113.3	121.0	8.71, (8.82)
Nominal	T 3.625 Aug 19	100.28	3.74%	7.95		131.6	132.0	7.90
		Breakeven	2.40%			Residual	(11.0)	
		Fwd BEI	2.92%			Net (Residual)	(7.9)	

Source: Barclays Research

Calculating forward breakeven rate

A long forward breakeven rate position is essentially a position on a forward starting breakeven contract at the present time. The P&L of such a trade will be realized as the market's expectation of this forward breakeven rate changes. Here, we go through the steps to create such a forward.

Forward breakeven contract = ForwardBEIRate + residuals (bp)

Residuals (bp) is the offsetting residual costs of two simultaneous breakeven positions (two are needed to construct a forward breakeven rate) described above. These residuals exist because we are approximating forwards using cash coupon bonds, whereas bootstrapping spot rates to create forwards is only accurate using zeros. An approximate *ForwardBEIRate* can be derived in the same way as forward nominal rates using zeros. Here, we assume zero breakeven rates (BEI) to be spot breakeven rates of equivalent maturity bonds. We further assume constant rates and continuous compounding to arrive at a *ForwardBEIRate*.

$$EXP\,(\text{ForwardBEIRate} * (T_2 - T_1)) = \frac{EXP(BEI_2 * T_2)}{EXP(BEI_1 * T_1)} = EXP\,(T_2 * BEI_2 - T_1 * BEI_1)$$

$$\text{ForwardBEIRate} = \frac{(T_2 * BEI_2 - T_1 * BEI_1)}{(T_2 - T_1)},\ T_2 > T_1$$

For zero-coupon bonds, the modified duration (D) is roughly equal to its time to maturity. So the time component in the above formula can be replaced with modified duration (breakeven modified duration). We use TIPS modified duration for approximation purposes.

$$\text{ForwardBEIRate} = \frac{(D_2 * BEI_2 - D_1 * BEI_1)}{(D_2 - D_1)},\ W_1 = \frac{(D_1)}{(D_2 - D_1)},\ W_2 = \frac{(D_2)}{(D_2 - D_1)}$$

$$\text{forwardBEIRate} = W_2 * BEI_2 - W_1 * BEI_1,$$

For a 5y5y fwd breakeven rate (as of January 14, 2010), with respective modified durations for 5y and 10y of 4.33 and 8.73, the above weights (W_1 and W_2) would have roughly a 2-to-1 ratio, meaning the *Breakeven_DV01* of the longer security has to be twice that of the shorter security. This forces the inflation-adjusted notionals of the two TIPS securities involved in forward breakevens to be the same. This is an important step for a forward position because equal TIPS notionals force the accrual inflation gains/losses prior to the forward start date to be zero. For a forward breakeven position, we want inflation exposure to be defined from the forward start date and not prior.

Inflation Sensitivity = Jul19Notional * Jul19_IdxRatio - Jul14Notional * Jul14_IdxRatio

= 113.3*1.01278 – 100*1.14721 = 0,

In other words, until the maturity of TIIJul14, the position will not incur any P&L due to net notional inflation accretion. In Figure 7, we show how this translates to notionals on a 5y5y fwd breakeven trade.

Next (Figure 8), we look at how this position performs in various breakeven curve shifts and changes in forward rate. Given the index ratio-weighted positions ($100mn to $113.3mn) on each breakeven leg with modified durations of 4.32 and 8.71, if breakevens across the curve rise in parallel by 10bp (fwd breakeven will rise by 10bp), the long position in 10y will rise in value by $1mn, and the short position in 5y will lose $0.5mn, netting $0.5mn of positive P&L. If the 5y breakeven falls by 10bp while the 10y breakeven is unchanged, the forward breakeven will also rise by 10bp (breakeven curve steepens), and the 5y leg incurs positive P&L of $0.50mn. This P&L matches the net P&L of a 10bp parallel shift in forward breakeven position. We also show the declining forwards (-10bp) scenario through parallel curve shifts, as well as curve flattening. In both 10bp fwd breakeven narrowing scenarios, the trade loses $0.50mn. Therefore, we feel confident that the above-described weighting method approximates forward rate exposure, even though we are using cash bonds rather than zeros.

FIGURE 8

Index ratio-weighted breakeven position gives inflation exposure only

	$100mn short TII Jul14 position (BEI_DV01: 4.96)	P/L ($mn)	$113.3mn short TII Jul19 position (BEI_DV01: 8.82)	P/L ($mn)	Fwd BEI rate	Overall P/L ($mn)
At entry	1.87%		2.40%		2.92%	
+ 10bp parallel BEI shift	1.97%	(0.50)	2.50%	1.00	3.02%	0.50
5y BEI falls 10y unchanged	1.77%	0.50	2.40%	0.00	3.02%	0.50
- 10bp parallel BEI Shift	1.77%	0.50	2.30%	-1.00	2.82%	(0.50)
10y falls by 5bp, 5y BEIs unchanged	1.87%	-	2.35%	(0.50)	2.82%	(0.50)

Source: Barclays Research

Creating a specified DV01 trade using the above approach

We would use the following approach to find relative notionals to create a specific DV01 forward breakeven rate trade.

- July14 has DV01 of 49,600 per $100mn
- July19 has DV01 of 88,200 per $100mn
- July14 index ratio is 1.14721
- July19 index ratio is 1.01278
- Relative index ratio (July19/July14) is 0.8828
  - 50k DV01 trade = 88,200 x July19 Notional – 0.8828 x July19Notional x 49600
  - Jul19Notional = $112.58mn
  - Jul14Notional = 0.8828 x Jul19Notional = $99.38mn
  - Check that the relative index ratio weight is maintained = $99.38mn/$112.58mn = 0.8828. So that the inflation sensitivity of this trade will be zero until the maturity of the first bond.
  - Check that the DV01 of the trade adds up to $50k DV01
  - 50k = 88,200 x 1.1258 – 49600 x 0.9938

INFLATION PRODUCTS

Seasonality: Estimation and adjustment

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Seasonality is an important factor for several areas of inflation-linked markets because such bonds and swaps are typically linked to non-seasonally adjusted inflation indices. This influences the level of breakevens across the year and micro valuations on the curve. It is also very important for valuing non-annual inflation swap points, with a seasonal model needed to build the infrastructure for inflation swaps.

Inflation indices usually have persistent deviations from trend at specific times of the year, termed seasonality. Seasonal adjustment attempts to isolate such patterns from a time series by detrending it, filtering out any seasonality. This process typically will employ an algorithm or model to search for these seasonal patterns, including statistical diagnostics. There are two ways to construct a seasonal vector: additive and multiplicative. Additive seasonality is used when the index is stationary and the amplitude of seasonal adjustments constant. Most price indices, however, have a marked long-run upward trend, meaning that multiplicative adjustment should be used, that is, calculating factors that seasonally adjust the index by multiplying it. Seasonality is most commonly quoted either in vector form (the degree to which the underlying index has to be adjusted to create a seasonally adjusted series) or as an average month-on-month factor. While this can be confusing, a direct transformation between these two formats is mathematically straightforward. The vector format is most useful in assessing relative seasonal value between different maturities, whereas the m/m factors highlight the seasonal trends that will be reflected in bond carry.

To the extent that seasonal trends are predictable, an efficient market ought to price these in. However, observing seasonality is not always straightforward. Even in countries where statistics agencies publish full seasonality estimates, there is uncertainty as to how this seasonality will develop over time. Typically, bond and swap markets price in significantly less seasonality for future years than statisticians would estimate, based on current data. However, there is an argument that certainty over the seasonal vector declines over time, so any forecasted seasonal factor should contain a decay component. A counter-argument is that there is no reason to dampen an unbiased estimation, while from a practical perspective evidence in many countries shows the magnitude of seasonality has tended to increase in recent years. We believe it is appropriate to assume a static seasonal vector and to adjust this as more information becomes available.

Four methods of seasonal adjustment are common: ratio versus moving average (or sum); regression using dummy variables; variants of the US Census Bureau's X-12-ARIMA; and the Bank of Spain's TRAMO/SEATS procedure. X-12 is the most widely used by statistics agencies, having existed in some form since the late 1960s (although many agencies use the less complex X-11 variant), while TRAMO/SEATS is widely used in Europe. The main difference is that TRAMO/SEATS estimates and fits an ARIMA model to the data to derive an estimate of seasonality, whereas the core seasonal adjustment method underlying X-12 uses a series of non-parametric moving average filters, with fitting an ARIMA model being optional (full details are available on the US Bureau of the Census website). This makes X-12-ARIMA more useful when constructing a seasonal vector – it includes individual components that do not exhibit highly statistically significant seasonality, but still show discernible patterns, for which the vector needs to account.

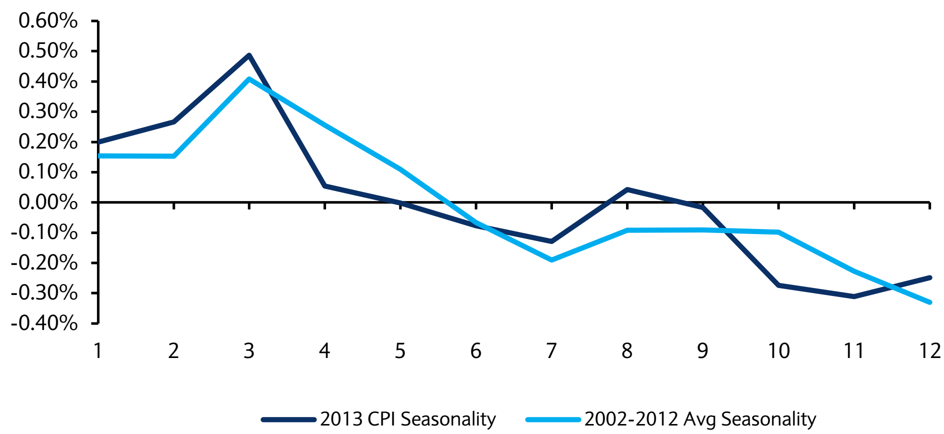
Generally, we prefer to use seasonality estimates from statistics agencies if they are published in sufficient detail, but where these do not exist, we suggest using an X-12 estimation at as low a level of aggregation as feasible. Estimation on an aggregate series on average tends to produce a slightly higher seasonality than considering sub-components, whether or not the sub-component approach estimates all variables or only those with significant seasonal components. Problems can arise in adjusting an inflation index constructed from an unchained series using a set of weights, then chained at the index level. Successive unchaining and chaining of series is not only laborious, but can bias the end result (due to the Cauchy-Schwarz inequality). This can, however, be circumvented by estimating a seasonal vector for each component of the index, then aggregating each one by the index weights to give an overall seasonal vector for the index.

United States

Consumer inflation, as measured by the Consumer Price Index, follows a regular seasonal pattern. One way to visualise the typical seasonal pattern is shown in Figure 1, which plots the average difference between the Not Seasonally Adjusted (NSA) and Seasonally Adjusted (SA) monthly percentage change in the CPI. While seasonals vary over time, prices have tended to rise more quickly in the early part of each year, with seasonality negative from July onwards. The NSA CPI tends to rise most notably between February and May, but decline significantly in November and December.

FIGURE 1

CPI seasonals, 2002-13 (difference between m/m NSA and SA% chg)



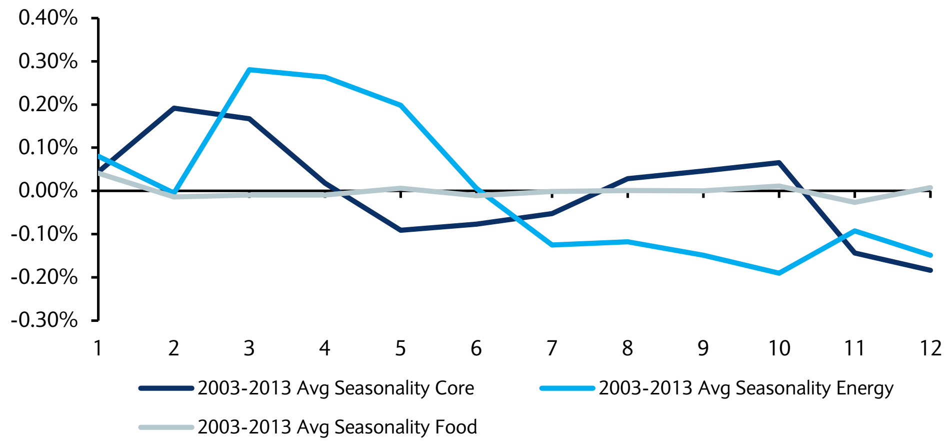
Source: Bureau of Labor Statistics, Haver Analytics, Barclays Research

The Bureau of Labor Statistics (BLS) estimates the seasonal factors by applying the X-12-ARIMA seasonal adjustment model, which attempts to adjust for monthly distortions, at an individual component level. Where appropriate, an intervention analysis is used, which adjusts for sharp and permanent shifts in the underlying trend. These have the potential to distort the results of the seasonal adjustment and are accounted for via regression-ARIMA models. Seasonal factors are estimated and published at the start of each year, coinciding with the January data release and causing a change in the historical seasonally adjusted series. The adjustment is applied to subcomponents of the index and then aggregated, which tends to produce a slightly more conservative estimate of seasonal factors than top-down estimation, even before the dampening effect of the intervention analysis is considered.

Figure 2 shows a breakdown of the estimated seasonal contributions from the main CPI components. They are calculated as the implied difference between the NSA and SA percentage changes for these components, weighted by their relative importance in the headline CPI. Seasonal fluctuations in the headline index are driven mainly by movements in core and energy prices during the year; food prices, in contrast, are relatively stable. Energy prices tend to rise most significantly in April-June, as the anticipation and onset of the summer driving season tends to put upward pressure on retail gasoline prices in those months. In contrast, energy prices tend to fall off in the fourth quarter. The seasonal pattern of home heating oil is generally the reverse of gasoline but has a much smaller weight, so gasoline is the dominant factor. However, while the seasonality of energy is larger than for other components, it is also relatively less stable over time.

FIGURE 2

Contributions of components to headline CPI seasonal pattern, average 2003-13 (difference between m/m NSA and SA % change of CPI components)



Source: BLS, Haver Analytics, Bloomberg, Barclays Research

As can be seen in Figure 2, NSA core inflation tends to rise significantly in February and March, fall off in May-July, rise in October, and fall sharply in November and December. Figure 3 shows the most important factors behind this: shelter and apparel costs. Seasonality in shelter is mainly driven by out-of-town lodging, which tends to soften in September-December, as demand falls off when the summer travel season ends. December marks the low point of the year for out-of-town lodging costs, presumably because travellers tend to stay with family rather than in hotels during the holiday season. Shelter costs begin to rise early in the year as travel patterns start to normalise. As for apparel, these prices fall off in November-January as holiday discounting dominates, then rise notably in February and March. They fall off again in June-July as summer merchandise is cleared ahead of the back to-school season, when they pick up again.

Seasonality and TIPS

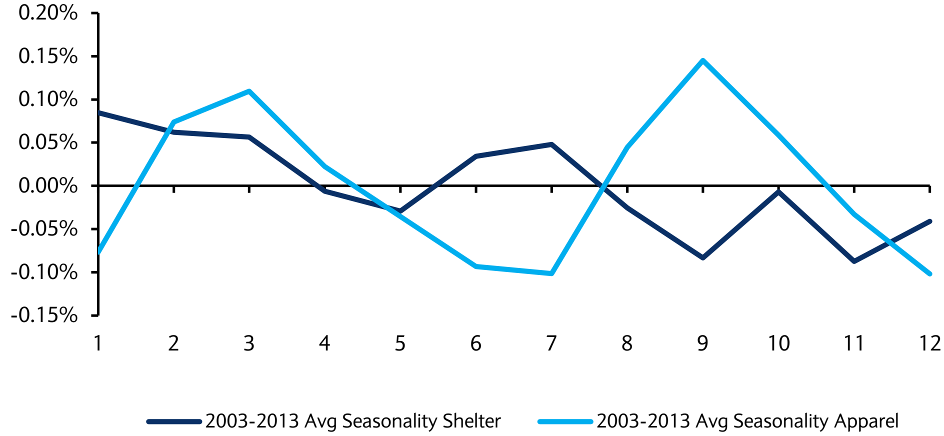
TIPS accrue inflation off the NSA CPI, so the seasonal patterns in inflation can affect valuations. Generally, inflation tends to be higher in the first half of the year. Initially, as the TIPS market was starting out, the market took some time to adjust to this (Figure 4).

This trend also shows up is in differences between issues that mature in different months because seasonal factors do not tend to change much from year to year. For example, because July maturity TIPS pick up one extra good spring carry period, they should, all else equal, trade rich to TIPS with January and April maturities.

In February 2014, the BLS released 2013 seasonal vector. The largest differences, in terms of the effect for TIPS, in 2013 relative to 2010-2012 appear in the March through May seasonal factors (Figure 6).

FIGURE 3

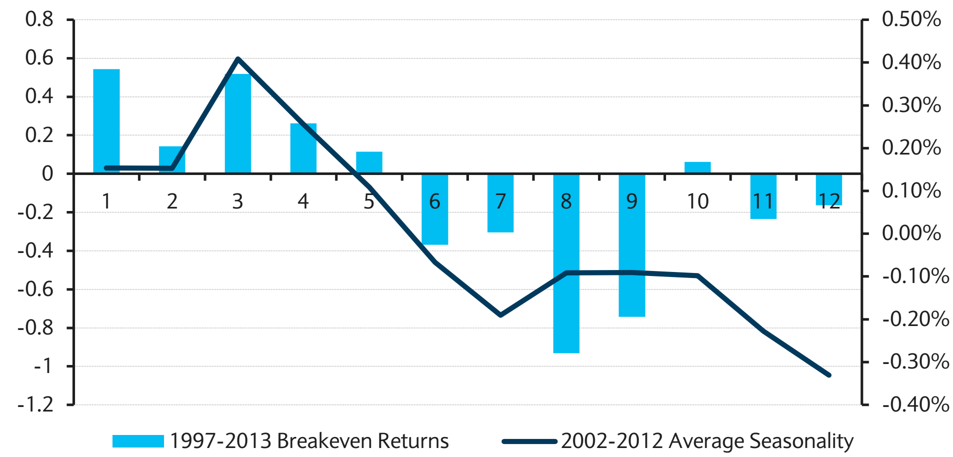
Contributions of core components to headline CPI seasonal pattern, average 2003-13 (difference between m/m NSA and SA % change of CPI components)



Source: BLS, Haver Analytics, Bloomberg, Barclays Research

FIGURE 4

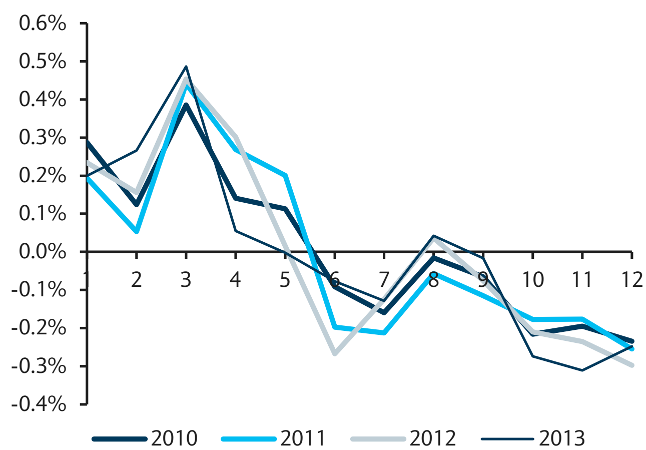
Average monthly breakeven returns are higher in the first half of the year – Efficient markets



Data: From Jan 1998 to Apr 2014. Source: Barclays Research

FIGURE 5

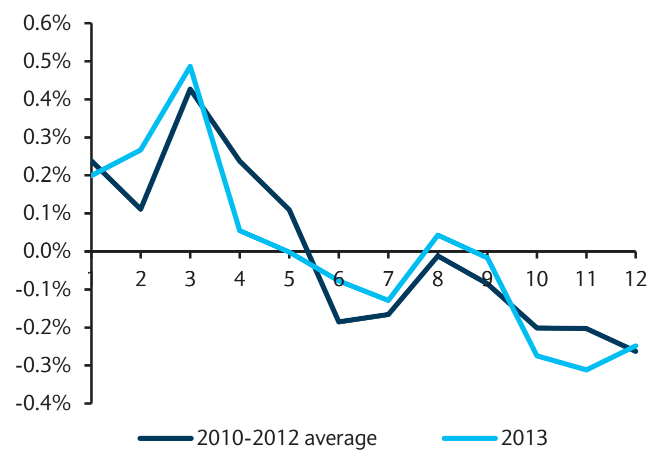
Annual seasonal patterns (m/m NSA – m/m SA)



Source: BLS, Barclays Research

FIGURE 6

Recent seasonal patterns



Source: BLS, Barclays Research

Previously, we stated that we found July maturity issues considerably and consistently cheap relative to other TIPS with other maturity months ("Christmas in Julys", *Market Strategy Americas,* November 19, 2009) because we believe the market does not price seasonality correctly. We still believe July issues are cheap. For example, using the methodology described below, we find the TIIJul15s about 25bp cheap to the TIIJan15s after adjusting for seasonality. However, using the same methodology, we believed six months ago they were about 13bp cheap. Some of the volatility in our measure of what the market is pricing in for seasonality is due instead to issue specific relative value rather than seasonality so it is not a precise metric. Over time, we expect seasonality to continue to be priced in more fairly. As July issues remain cheap (Figure 7), in our view, we maintain our recommendation to hold longs in these TIPS relative to those with January maturities.

FIGURE 7

Cheapness of July issues versus January issues after adjusting for seasonality

Issue	Seasonal mispricing, using 2013 seasonal vector	Seasonal mispricing (using avg of 2009-11 factors), Apr 27, 2012	Seasonal mispricing 6mo ago (using avg of 2008-10 factors) , Sept 27 2011
Jul15s	25.0	13.3	14.1
Jul16s	17.7	10.7	10.6
Jul17s	14.5	6.2	6.5
Jul18s	17.8	9.1	13.4
Jul19s	2.5	4.7	6.9
Jul20s	-5.3	2.2	4.0

Source: Barclays Research

Methodology for calculating seasonally adjusted value

This example calculates the TIIJul15 seasonal fair value based on 2013 seasonality assumptions and the trend BEI rate between Jan15-Jan16.

To judge bonds versus the seasonality of any given year, we start by looking at bonds that are one year apart in maturity (Apr12-Apr13, Jan14-Jan15, etc). For example, using Jan15-Jan16, we can estimate what the Jul15 breakeven should be assuming 2013 seasonality. Over a one-year cumulative period, the seasonality between Jan15 and Jan16 should be zero. Using current market-implied breakeven rates for Jan15 and Jan16 and referencing CPI for a May 30, 2014, settle date (236.19545), first we estimate what the market-expected maturity NSA CPI is for each of the bonds. Jan15 and Jan16 BEIs are 1.43% and 1.66%, respectively. The final maturity CPI date that matters for Jan15 is mid-October-November 2014 and for Jan16 is mid-October-November 2015. We have assumed annual compounding for ease of understanding; the exact calculations should be done with semi-annual compounding.

Reference CPI: Reference CPI for May 30, 2014 settle date: 236.19545

$\text{Jan15MaturityCPI} = 236.19545 * (1+1.43\%)^{T1} = 238.3182$

$\text{Jan16MaturityCPI} = 236.19545 * (1+1.66\%)^{T2} = 242.61643$

T1~ Time to Maturity from settle to the maturity of Jan15, 0.63y

T2~ Time to Maturity from settle to the maturity of Jan16, 1.63y

From the Jan15 and Jan16 maturity CPI NSAs, we get a 1y CPI rate between Jan15 and Jan16 of about 1.79%.

Deriving the 2013 seasonality vector

With this 1y trend rate of c.1.80% (between Jan15 and Jan16) and our 2013 seasonality assumption, we can determine CPI prints for each month from the middle of October-November 2014 to October-November 2015. First, we determine what the seasonality vector is for 2013. For this, we need 2013 CPI NSA and 2013 CPI SA prints. We take m/m changes in each series in 2013 and then take the difference between NSA m/m and SA m/m. Once we know the m/m seasonality (as shown in Figure 1), we can form a seasonality multiplier vector (see the derived 2013 seasonality vector in Figure 8).

FIGURE 8
2013 CPI seasonality vector

Dec-12	100
Jan-13	100.21
Feb-13	100.48
Mar-13	100.97
Apr-13	101.02
May-13	101.02
Jun-13	100.94
Jul-13	100.81
Aug-13	100.85
Sep-13	100.84
Oct-13	100.56
Nov-13	100.25
Dec-13	100.00

Source: Barclays Research

With the trend rate of 1.79% between Jan15-Jan16 and cumulative seasonal accretion of 0.61% between January (mid-October-November multiplier) and July issues (mid April-May multiplier), we can determine what the maturity CPI NSA should be for Jul15 (assuming a 2013 seasonality vector). Knowing the Jul15 maturity CPI NSA, we can figure out what the breakeven (or inflation) rate is from the settle date's reference CPI and compare this 2013 seasonality derived breakeven with where the market Jul15 breakeven is priced. Specifically, we start with the Jan15 maturity CPI NSA of 238.3182 and grow it exponentially by 1.79% * T3 plus the cumulative seasonality of 0.61%. T3 is the time to maturity from Jan15 to Jul15, roughly 0.5y.

Jul15MaturityNSACPI = Jan15MaturityNSACPI * exp (T3*1.79% + *0.61%*) = 241.2947

May 30 settle reference CPI = 236.19545

Using the Jul15Maturity NSA CPI divided by spot reference CPI, we get an annualized breakeven rate of 2.15% (Jul15 annualizing time-to-maturity factor is 1.13y). Currently, the market traded Jul15 breakeven rate is 1.92%, cheaper by ~24bp versus the 2013 seasonality derived breakeven rate of 2.16%.

Euro area

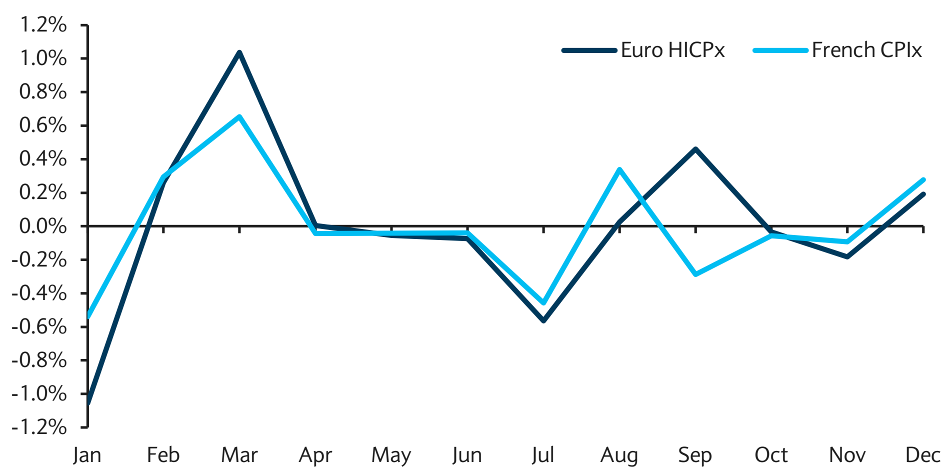
Eurostat does not publish an official seasonally adjusted HICP series, but the ECB does publish them for headline HICP and HICPx, using the latter to adjust bond breakevens in its macro analysis. These indicate that there is now more seasonality in the euro area than in the US. They use an X-12-ARIMA model similar to that in the US, but conducted at a higher level of aggregation (only five sub-sectors) and excluding energy, as the ECB argues that there is no evidence of seasonality in this series while estimation is volatile. Relative to the BLS estimation at the lowest possible level of aggregation and with more intervention, the

ECB methodology may produce a slightly higher estimate. However, the exclusion of energy components is somewhat controversial and tends to reduce aggregate seasonality. An X-12 analysis of the energy series suggests that any seasonality is highly unstable and unlike the US, there are few months in which the sign of the month-on-month seasonal has stayed the same over the long term. On the other hand, there has been, for example, a strong tendency for petrol prices to rise in the three months to June for the past 10 years, increasing an average 5%, but offset by a similar fall in the three months to January.

Seasonality in euro area HICPx increased in the early 2000s, due mainly to changes in measurements and the deregulation of retail prices. Eurostat has encouraged a standardisation of processes across Europe, leading to more seasonality in the aggregate series, due to the timing of distortions being more consistently measured. This has lessened the tendency of the aggregate index to be smoothed out. The clearest example is that until 2001, Italy and Spain did not include apparel sales prices in their data, but there has been a tendency towards increasing volatility of retail prices in other countries, as well. More recently, EC Regulation No 330/2009 on the treatment of seasonal products came into force on HICP indices for Member States with the January 2011 index. ‘Seasonal products’ are defined by Eurostat as “goods and services that are available for purchase in some period of the year, but are not available for purchase, or purchased in small or negligible volumes, for certain periods in a typical annual cyclical pattern”. The regulation allows for the application of two calculation methods: strict annual weights and class-confined seasonal weights. The end result of the changes is that seasonality can be imputed into price indices even if the underlying trend in prices is stable when the goods are not available. Overall, this increases the amplitude of seasonality in indices, which in practical terms exacerbates positive and negative periods of seasonal carry.

FIGURE 9

Normalised 2013 m/m seasonality estimates for Euro HICPx and French CPIx



Source: Eurostat, ECB, Insee, Barclays Research

We are relatively comfortable using the ECB data for HICPx seasonality for considering valuations within the euro inflation market, but given the exclusion of energy components we caution against comparison with seasonals in other countries that include this sub-sector. Figure 9 shows monthly seasonality estimates for Euro HICPx and French CPIx, respectively, for the past three full years of data. The trends have become relatively similar in recent years. The differences stem mainly from varying sales periods and a greater upward bias for euro (particularly German) prices for Christmas and Easter that are subsequently unwound.

Example of seasonal adjustment for euro linkers

The first step toward seasonally adjusting a specific bond is to calculate a cumulative vector. Typically, we estimate m/m vectors to provide a clear illustration of seasonality patterns, but given the cumulative nature of inflation accrual on linkers, each m/m seasonal preceding a given month needs to be multiplied together. In mathematical terms:

$$Cumulative\ Seasonal(m) = \prod_{1}^{12} [1 + MoM\ seasonal(m)\ ]$$

FIGURE 10

Euro HICPx m/m and cumulative vectors

	M/M seasonal vector (%)	Cumulative vector
Jan	-1.055	-1.055
Feb	0.260	-0.797
Mar	1.036	0.231
Apr	0.005	0.236
May	-0.055	0.181
Jun	-0.073	0.107
Jul	-0.565	-0.458
Aug	0.025	-0.433
Sep	0.460	0.025
Oct	-0.034	-0.009
Nov	-0.183	-0.192
Dec	0.192	0.000

Source: Barclays Research

Taking as an example a settlement date of 4 June 2014:

Settlement: 4 June 2014
3m lag seasonal: 0.231 (March)
2m lag seasonal: 0.236 (April)
Interpolation factor: (D-1)/Dm = (4-1)/30 = 0.100
Interpolated spot seasonal: (1 – 0.100)* 0.231 + 0.100*0.236 = 0.231

FIGURE 11

Seasonal adjustment of euro linkers

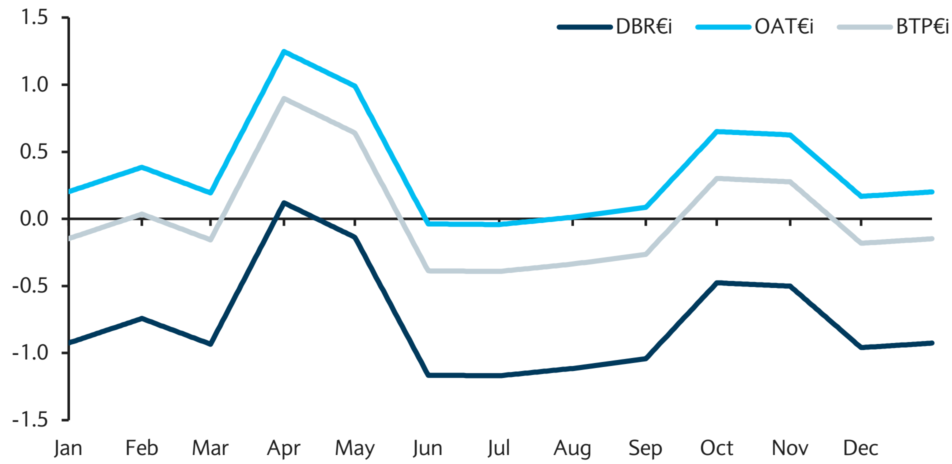
Settlement : 04 June 2014			
	OBL€i18	OAT€i18	BTP€i18
Maturity	15/4/2018	25/7/2018	15/9/2018
3m lag seasonal	-1.055 (Jan)	0.236 (Apr)	0.107 (Jun)
2m lag seasonal	-0.797 (Feb)	0.181 (May)	-0.458 (Jul)
Interpolated Maturity Seasonal	-0.934	0.193	-0.156
Interpolated Spot Seasonal	0.231	0.231	0.231
Spread to Current	-1.17	-0.0383	-0.388
Modified Duration	3.8	4.1	4.1
Seasonal (bp)	-30.3	-0.9	-9.4

Source: Barclays Research

The outright seasonal of the specific bonds is not variant intra-year, but clearly the spot seasonality at any point in time varies, as does inflation accrual. Figure 12 shows the seasonality of German, French and Italian euro HICPx-linked issues at each settlement point throughout a given year in price terms. For a particular issue, this value is simply divided by the modified duration of the bond to give the seasonal value in bp. At the point where the settlement date corresponds to the maturity date (eg, 15 April for German linkers), there is no spot seasonal bias; thus, the seasonal is zero. For European inflation markets, seasonality in the bond markets gives rise to significant optical distortions and explains why German breakevens can sometimes appear cheap to other issues, when in fact once accounting for seasonality they are not. Typically, given the magnitude of seasonal differentials in Europe, markets tend to factor in these distortions accurately, as otherwise there would be a clear potential arbitrage.

FIGURE 12

Evolution of relative euro linker seasonality versus settlement date (pts)



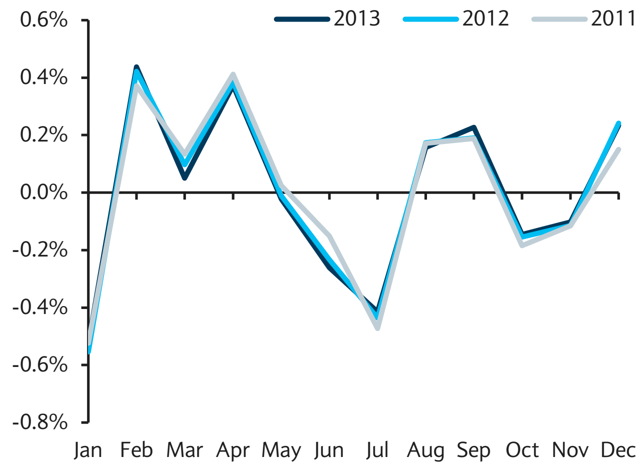
Source: Barclays Research

United Kingdom

For the UK, seasonal adjustment of the overall RPI Index derives statistically significant seasonality, but the Office for National Statistics (ONS) does not produce a seasonally adjusted RPI series. To gauge the stability and drivers of seasonality, we created a seasonal vector by using X-12 to adjust the key components of the RPI, then aggregating these vectors using the official index weights. We avoided deploying an ARIMA model as part of the X-12 process, as for some components there was no evidence of an underlying ARIMA process, which would mean an inconsistent estimate.

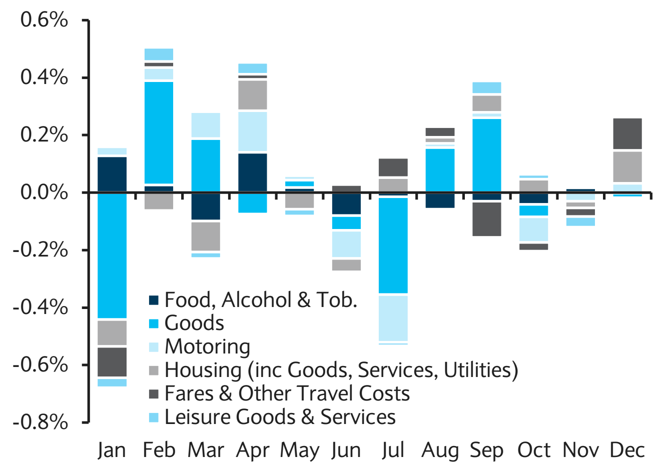
Figure 13 shows the estimated seasonality for the past three years and indicates that the seasonal vector is reasonably stable, although an estimation without stripping out mortgage interest payments would be notably less so. The relatively long sample period of 1987-2013 allows for a more accurate estimation of the underlying trend and seasonal factors than in the euro area. Even so, seasonality appears to be also more stable than in the US and most large euro countries. Figure 14 shows the contribution of the various key components of RPI to the month-on-month seasonality. As can be seen, there is a strong upwards April effect in housing due to council tax, alcohol and tobacco and also motoring due to duty changes in the UK Budget, although these have been fairly modest in the past few years. Goods show a strong downwards January effect due to seasonal sales; this is also seen in July. The ONS produces a seasonally adjusted series for RPIY, which excludes indirect taxation, as well as mortgage interest payments, but as a significant element of UK seasonality is driven by tax factors, we prefer to use our own series.

FIGURE 13
Barclays estimated UK RPI m/m seasonality



Source: National Statistics, Barclays Research

FIGURE 14
Key contributions to 2013 RPI seasonality vector



Source: ONS, Barclays Research

The ONS has implemented changes for treatment of seasonal products similar to those mandated by Eurostat for HICP. This has resulted in an increase in seasonal distortions, particularly in volatile series such as clothing and footwear. Dispersion in the subgroups of such indices has also consequently increased, resulting in the formula effect between RPI and CPI becoming more pronounced. An additional consideration for estimating seasonality in UK inflation has been alterations in VAT. The Labour government cut VAT to 15% effective January 2009 for a year in an effort to shore up consumption, restoring the previous 17.5% rate at the start of 2010. The coalition government subsequently increased this to 20.0% effective January 2011 to bolster the public finances as part of the ongoing fiscal consolidation package. This is likely to have biased seasonals, particularly in January; as such, calculations of seasonality may underestimate the recent strong January effect. In practice, controlling for the effects of VAT would add complexity to the estimation of seasonality, and the practical benefits of this would likely be small. There is no guarantee that seasonality will be statistically stable over time, and any estimate is inherently backward looking. Therefore, we see little benefit in adding a VAT dummy to our estimates.

Estimating seasonal effects on UK linkers

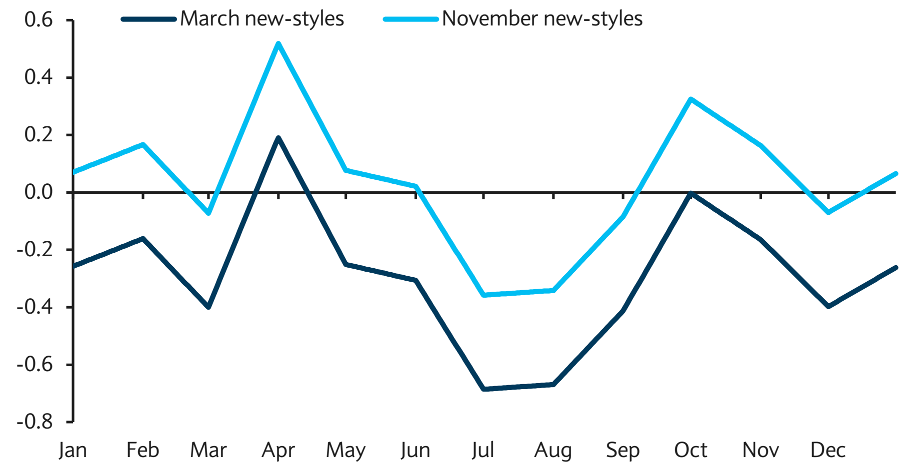
Caution needs to be applied when considering the effect of seasonality on UK linkers. The indexation models of old- and new-style linkers are not directly comparable; therefore, considering seasonal differences between the two differing lines is not meaningful. Seasonal analysis is useful for new-style UK linkers, which follow the standard Canadian model with both March and November maturities issued. March issues suffer seasonally disadvantaged accrual relative to November lines and, as such, tend to trade cheap on curves. Calculation of the seasonal bias is calculated similarly to the examples for the euro issues presented above, with the practical seasonality experienced illustrated below.

Japan

As is the case with consumer prices elsewhere, the Japanese core CPI (CPI excluding fresh food) exhibits fairly regular seasonal patterns that reflect corporate sales practices, as well as consumer habits and preferences. Historically, seasonality has been "most negative" in the first quarter of the year; ie, Japanese consumer prices in Q1 tend to be lower than prices in other months, regardless of whether the year as a whole exhibits positive, flat or negative inflation rates. The primary reason is that in January-March, prices of Japanese goods (especially clothing) tend to fall sharply due to the effect of New Year and year-end inventory clearance sales. Prices of services also tend to decline overall in Q1, as fees for entertainment facilities, where usage declines in winter, decrease.

FIGURE 15

Relative seasonality of March/November UK linkers



Source: Barclays Research

In contrast, seasonality tends to improve from the second quarter of the year and becomes "most positive" (or strongest) during August-December. This reflects price hikes in clothing from April, as well as the fact that during the summer vacation season of July-August, leisure-related service prices, such as travel, tend to increase significantly. On the other hand, prices of goods tend to decline due to the effect of sales following summer bonus payments and clearing sales on summer clothing. Clothing prices subsequently rebound with winter lines coming in, and prices of goods such as food and rice tend to rise as preparations for the New Year holidays get underway, a development that pushes consumer prices significantly above the year's average in the last quarter of the year.

Australia

Australia differs from other inflation markets because the CPI is released quarterly, but standard adjustment techniques can be applied to quarterly series to produce a seasonality vector in the same manner as for monthly CPI series. Australia has a developed market in zero coupon inflation swaps (ZCIS); therefore, although quarterly inflation indices exhibit less volatile seasonality than monthly indices, constructing a seasonality vector is important to value ZCIS trades. Relative value distortions arising from seasonality have tended to be less important for the valuation of Australian linkers, with the bulk of issues maturing in Q3 (specifically, August or September) and, thus, with final indexation to the Q1 CPI print. A new linker maturing 21 February 2022 was launched in February 2012 and thus, will have its final value determined by the Q3 21 CPI. If a February maturity is favoured for any future issues, seasonality could become a more important practical consideration.

The Australian Bureau of Statistics (ABS) publishes seasonally adjusted estimates of Australian inflation, periodically updating and altering the methodology underpinning these estimates. The sixteenth series CPI methodology was published in September 2011, and having considered various recommendations, the ABS announced it will calculate an All groups CPI seasonally adjusted figure by "aggregating the seasonally adjusted and non-seasonally adjusted expenditure classes together using the weighting pattern (seasonally adjusted) at the weighted average of eight capital cities level from the September quarter 2011." The seasonally adjusted series are subject to revision, whereas the original NSA series is not. The aim of the series is to account for regular price changes, such as systematic increases in education prices in March. Full details of the methodology are available from the ABS website.

Other inflation markets

Sweden's seasonality is relatively extreme for inflation-linked bonds. Most bonds redeem at a seasonally favourable point, maturing on 1 December, hence based on September CPI, which consistently has a strong increase due mainly to clothing price increases that are larger than in most other countries. However, the now small old 2014 bond redeems on 1 April and, thus, captures the worst seasonal elements of the year for January.

In general, seasonality is less important in emerging markets, due to more unstable inflation and less regular distortions. Brazil has less statistically significant seasonality in IPCA inflation than in any other major economy, with an X-12 estimation of seasonality across the year varying by less than 0.4%. Despite measurement changes in Argentinean CPI, this also demonstrates very limited seasonality, while seasonality in Mexico and Colombia are of a similar order of magnitude to that in the US, despite notably more volatile inflation. The Latin American country with the most extreme seasonality is also the one with the lowest and most stable inflation trends, Chile. Here, the trend is for prices to rise from February through September before seasonals turn negative for each of the following five months; since 2003, prices have on average fallen in this negative seasonal period despite inflation averaging almost 4%. Hence, a UF bond redeeming in November would have about 1.9% better seasonals than one maturing in April.

In the more recently launched inflation-linked markets, seasonality has encouraged investment during positive carry periods but has not been that important relative to the underlying volatility of the inflation indices. For instance, in South Africa, the dispersion of seasonality is the same order of magnitude as in the US despite inflation being about four times as volatile. There is also a higher degree of uncertainty of seasonality due to the significant change in inflation measurement that occurred from the start of 2008, which we attempt to minimise by considering seasonality in CPI excluding housing. Nonetheless, December maturing bonds still have more favourable seasonality than those redeeming at the end of March by more than 1%. In recent years, Turkish and South African inflation has been similar volatility, but Turkish seasonality is almost twice as strong. With Turkish linkers being short dated, the sensitivity to this seasonality is relatively high. Prices tend to fall in summer as occurs elsewhere in Europe such as Poland, but more dramatically due to the particularly heavy weight of food in the Turkish CPI basket and to a sharp rebound in October. August maturing bonds ought to have the most favourable seasonality, although February is almost as positive, whereas if a bond were issued with a maturity at the start of December, its seasonality would be worse by up to 2%.

Normalised Seasonality Estimates

FIGURE 16

Estimated m/m normalised seasonals - 2013

Developed Markets	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
US CPI	0.201%	0.267%	0.488%	0.056%	-0.001%	-0.076%	-0.128%	0.044%	-0.016%	-0.273%	-0.311%	-0.247%
Euro HICPx	-1.055%	0.260%	1.036%	0.005%	-0.055%	-0.073%	-0.565%	0.025%	0.460%	-0.034%	-0.183%	0.192%
France CPIx	-0.540%	0.295%	0.654%	-0.043%	-0.042%	-0.040%	-0.457%	0.339%	-0.288%	-0.057%	-0.093%	0.278%
UK RPI	-0.525%	0.437%	0.050%	0.373%	-0.022%	-0.262%	-0.415%	0.157%	0.227%	-0.146%	-0.102%	0.233%
Japan CPI ex-fresh food	-0.310%	-0.008%	0.394%	0.092%	0.092%	-0.209%	-0.108%	0.192%	0.091%	-0.009%	-0.207%	-0.008%
Canada CPI	0.089%	0.340%	0.251%	0.332%	0.087%	-0.402%	0.006%	0.006%	0.006%	-0.075%	-0.156%	-0.481%
Sweden CPI	-0.924%	0.489%	0.253%	0.172%	-0.033%	-0.190%	-0.340%	0.000%	0.481%	-0.093%	-0.028%	0.221%
Denmark CPI	-0.078%	0.946%	0.267%	-0.019%	-0.119%	-0.308%	-0.259%	0.014%	0.152%	-0.106%	-0.258%	-0.225%
Australia CPI			0.17%			-0.22%			0.17%			-0.12%
New Zealand CPI			0.15%			0.00%			0.25%			-0.40%

Emerging Markets	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Brazil	0.208%	0.143%	0.031%	0.148%	-0.065%	-0.257%	-0.354%	-0.190%	-0.011%	0.078%	0.115%	0.157%
Chile	-0.024%	-0.034%	0.024%	0.182%	-0.150%	0.003%	-0.227%	0.002%	-0.061%	0.186%	0.198%	-0.098%
Colombia	0.325%	0.412%	0.001%	0.113%	-0.099%	-0.050%	-0.201%	-0.160%	-0.111%	-0.195%	-0.188%	0.156%
Israel	-0.331%	-0.136%	0.155%	0.285%	0.265%	0.201%	0.178%	0.082%	-0.181%	-0.083%	-0.425%	-0.006%
South Korea	0.504%	0.216%	-0.055%	-0.150%	-0.061%	-0.234%	0.051%	0.157%	0.203%	-0.379%	-0.314%	0.063%
Mexico	0.190%	0.026%	0.006%	-0.475%	-0.749%	-0.125%	0.002%	-0.045%	0.077%	0.216%	0.528%	0.356%
South Africa	-0.057%	0.402%	0.696%	-0.142%	-0.244%	-0.117%	0.323%	-0.238%	-0.040%	-0.069%	-0.235%	-0.274%
Thailand	0.156%	0.115%	0.136%	0.294%	0.200%	-0.081%	-0.049%	0.021%	-0.218%	-0.115%	-0.358%	-0.100%
Turkey	0.545%	-0.219%	-0.097%	0.115%	0.065%	-1.081%	-0.857%	-0.225%	0.393%	1.638%	0.040%	-0.292%

Source: National Statistics Agencies where available, Barclays Research estimates from Jan 2000 – Dec 2013 otherwise.. Note: Australia and New Zealand CPIs are quarterly series; the presentation of these estimates reflects this.

INFLATION PRODUCTS

Beta calculations, drivers, and uses

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We discuss measurements and trends in betas used in computing nominal effective durations of linkers.

Effective nominal duration of inflation-linked bonds

Measuring the duration of a nominal bond when trying to determine the change in market value for a given change in the nominal yields, is a straightforward concept. When it comes to inflation-linked bonds, however, things are not always so simple. We first need to decide whether we are calculating for a given change in real or nominal yield. If the analysis is on real yields, typically used when comparing one linker with another or trading breakevens, then the approach is still straightforward. However, for any given move in nominal yields, usually part is a change in real yields and part is breakevens, though at times these two factors can move in opposite directions. This means that, typically, breakevens are directional with nominal rates. Investors attempting to take directionality out of a breakeven position or incorporate linkers into a nominal portfolio might want to use the linker's effective nominal duration. To determine the effect of a change in nominal yields on an inflation-linked bond's market value, though, we first have to decide how much of the move is expected to come from a change in real rates. That relationship between real yields and nominal yields is called beta.

Mechanically, calculating the real duration of a Canadian model inflation-linked bond with respect to changes in real yield is done in the same way as calculating the nominal duration of a nominal bond. For the same maturity, the duration of a linker is likely to be longer than that of a standard nominal coupon bond, as the yield and coupon of the linker are likely to be lower. An example of this is in the US, where in February 2014 the real modified duration of the TII 1.375% Feb 2044 was 24.5, compared with the nominal modified duration of the nominal T 3.625% Feb 2044 of 18.2. While the real duration is useful in itself, for instance in calculating carry effects or approximating the market value effect of a change in real yields, it does not offer an adequate solution for estimating the effective nominal duration of a linker. This effective duration depends on the relative volatilities of real yields and breakevens and the covariance between them, but these are not necessarily stable.

In most circumstances, the effective nominal duration of an inflation-linked bond should be lower than its real duration. This can be seen from the most simplified form of the Fisher equation:

Nominal yield (y) = Real yield (r) + Breakeven inflation (bei).

Consider the variances of both sides of this equation:

Variance (y) = Variance (r) + Variance (bei) + {2 x Covariance (r, bei)}

This formula shows that provided the covariance between the real yield and breakeven inflation is not sharply negative, real yields will be less volatile than nominal yields. We can see in Figure 1 that this was usually the case on the TIIJul14s but this changed in 2008 first because of a sharp flight to quality in nominals where TIPS did not participate, then later once the issue rolled into the very short end. In other words, the yield sensitivity, or "beta", of an inflation-linked bond to a change in the equivalent nominal yield will usually be less than one but not necessarily. If this beta were always a stable number, it would be easy to calculate the equivalent nominal duration for an inflation bond. However, if it were that easy, then there would be no additional value to inflation-linked bonds as a diversified asset class.

FIGURE 1

Realized volatility (bp/day)

Source: Barclays Research

The only mathematically correct way to report duration for a mixed portfolio of nominals and linkers, in a way that adds useful information, is to drop the standard duration figure and instead show two new numbers: duration with respect to real yield and with respect to inflationary expectations. These are the two main partial derivatives of the Fisher equation. On the other hand, using yield beta as shorthand to convert real yield duration into nominal space is useful as long its limitations are remembered. Figure 2 shows that the pre-crisis covariance between real yields and breakevens was relatively low. However, Figure 3 illustrates that since the crisis began in 2008 (to 2011), not only has volatility increased, but covariances have been significantly negative. Since 2011, vols have declined.

FIGURE 2

Volatility composition in the US, France, the UK, and Japan (1999 to 2007)

	US	UK	France	Japan
Vol of nominal yield	5.5	2.7	2.7	1.3
Vol of real yield	3.0	1.6	1.7	1.0
Vol of breakevens	1.9	1.3	1.0	1.0
2 x Covar (RY, BE)	0.7	-0.2	0.1	-0.7

Note: Figures based on monthly changes for 1999 to 2007, except Japan from April 2004 to January 2008, for inflation-linked indices in each country versus maturity-matched nominal comparators. Variances are in non-annualized bp.
Source: Barclays Research

FIGURE 3

Volatility composition in the US, France, the UK, and Japan (2008 to 2011)

	US	UK	France	Japan
Vol of nominal yield	8.9	4.9	4.7	1.3
Vol of real yield	8.8	4.0	4.9	10.5
Vol of breakevens	10.5	4.4	4.6	10.9
2 x Covar (RY, BE)	-10.2	-3.4	-4.7	-19.7

Note: Figures based on monthly changes for 2008 to 2011 for inflation-linked indices in each country versus maturity matched nominal comparators. Variances are in non-annualized bp. Source: Barclays Research

FIGURE 4

Volatility composition in the US, France, the UK, and Japan (2011 to May 2014)

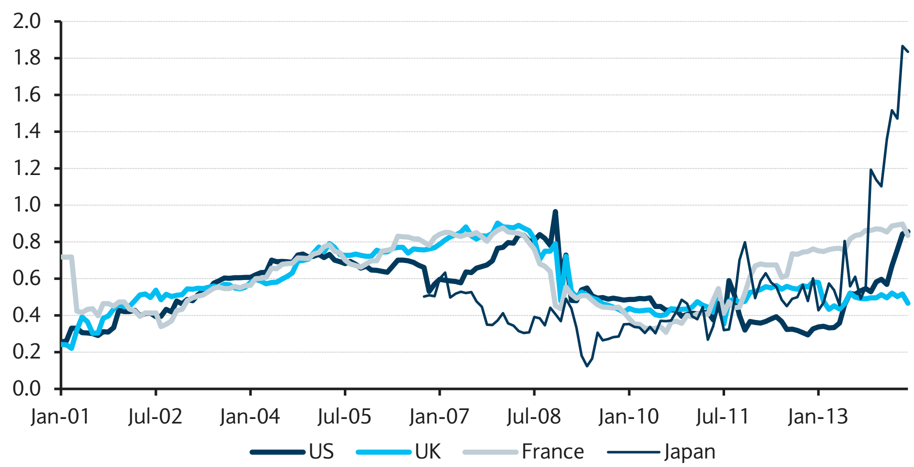
	US	UK	France	Japan
Vol of nominal yield	3.9	3.3	4.6	1.0
Vol of real yield	4.1	2.6	4.7	4.2
Vol of breakevens	2.5	2.7	2.8	3.9
2 x Covar (RY, BE)	0.70	0.43	0.53	2.47

Note: Figures based on monthly changes for 2011 to 2014 for inflation-linked indices in each country versus maturity matched nominal comparators. Variances are in non-annualized bp. Source: Barclays Research

Rolling regressions using monthly yield change data (Figure 5) show that pre-crisis betas in the US, UK, Europe, and Japan were 0.6-0.8, but have become less stable since the crisis began. The regression is also sensitive to the period covered. Daily or weekly yield change data will give different results for the same period. Another form of beta used widely in the inflation-linked market uses the level rather than the change in yields. While this is a statistically biased method, it has the advantage of picking up potentially important trend data that are lost in pure volatility analysis, but is not appropriate for the long term, where the bias can become too extreme.

FIGURE 5

Whole market yield betas based on two-year monthly changes



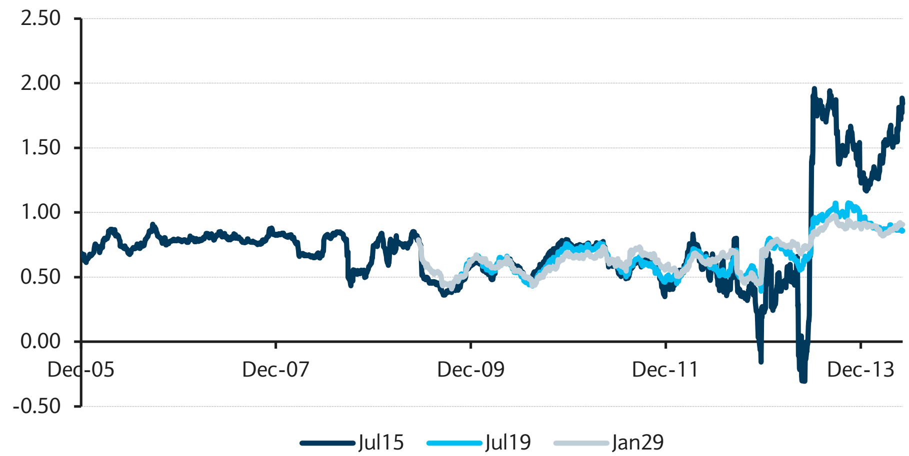
Source: Barclays Research

An alternative measure of beta that is arguably preferable is a calculation based on the volatility of relative returns, rather than yields. This has the benefit of directly including inflation carry data, a particularly important factor when considering shorter maturities but also for longer-term analysis, where inflationary trends can be an important factor. The adjustment to be made from a beta calculated from returns is very different from a yield beta analysis, though, particularly at longer maturities. The yield beta provides an estimate of the multiple that should be applied to real duration to get an equivalent nominal duration, whereas the returns beta provides a direct estimate of the relative volatility of the two bonds (or indices, as appropriate).

The estimate of beta is sensitive to the methodology used, but also to the period and maturity assessed (Figures 6 and 7). Beta should never be considered a stable relationship, but the most appropriate type of beta depends on its use. For a trader looking for a short-term hedge for linker exposure with nominal futures or bonds, a short-term yield beta estimation (eg, based on daily changes over one to three months) may make sense. However, in periods of extreme carry, a returns beta may be more advisable. For active money managers, a three- or six-month yield daily or weekly change beta may be the most representative, and this is also the time horizon over which yield level betas are most commonly used, as stable yield trend regimes typically last three months to a year. For longer-term total return investors, a two-year or longer monthly total return volatility beta is a logical starting point for asset allocation. For those with long-term real return aims or inflation-linked liabilities, real, not nominal, duration should arguably be the more appropriate measure for assessing risk, with a returns beta to compare the two.

FIGURE 6

Three-month yield change betas

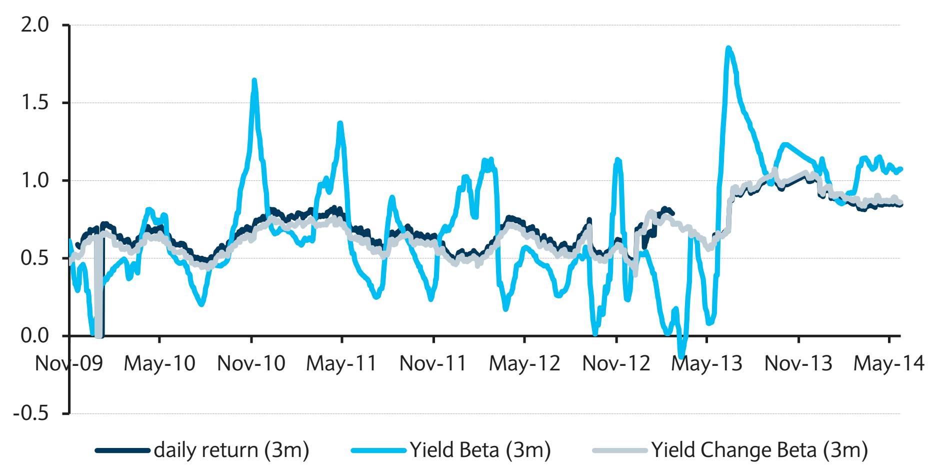


Source: Barclays Research

Betas will vary due to many factors, but one of the most significant is the type of investor in the asset class. Betas are usually lowest when real money, real yield investors are predominant. In most markets, these are most prominent at longer maturities, often leading to lower betas at the long end of the curve. At the short end, inflation uncertainty becomes an increasingly significant factor relative to the decline in nominal price volatility; indeed, for very short-dated bonds, betas will often be significantly above 1 or below 0 as a result.

FIGURE 7

Different 3m betas for TIIJul19s



Source: Barclays Research

INFLATION PRODUCTS

The elusive inflation risk premium

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Although inflation risk premia may be difficult to measure, using the CPI swap curve and survey expectations can provide a guide to what the market is pricing.

Long-term investors care primarily about the purchasing power, or real value, of their investments. Inflation-linked bonds provide a predictable real return to maturity, while nominal bonds do not; therefore, nominal bonds should be seen as relatively riskier investment from a real return perspective. Long-term nominal Treasury investors then should be compensated for taking on this additional risk by demanding a yield differential above actual expected inflation. This yield differential is known as the inflation risk premium, which, when positive, should lead breakevens to be higher than inflation expectations (elsewhere in this guide, we discuss the liquidity premium differential, which, because nominal Treasuries are more liquid than TIPS, should push down on breakevens and offset the inflation risk premium).

While we generally think of the risk premium as a positive factor that should increase with maturity, it may reasonably be negative at the front end of the curve. Most money managers who invest at the front end of the curve have a nominal return mandate and are therefore taking on risk by investing in real securities. Because short TIPS are correlated to energy prices, they tend to be much more volatile than nominals, whereas front-end investors typically have their money there because they want to avoid volatility. These investors would need to be compensated for this risk and volatility by demanding a higher real yield. This would lead breakevens to be lower than inflation expectations and helps explain why short TIPS usually trade cheap to fundamentals.

Finding the inflation risk premium has always been something of an academic “holy grail.” Beware those who claim to have found it because the path is fraught with difficulties. We do not question the premise that investors might be prepared to pay a risk premium for inflation protection or that the premium may vary through time. That is a logical concept, as is the argument that the premium should be a function of inflation uncertainty, which, in turn, is likely to be correlated with the recent experience of inflation volatility and, even more importantly, central bank credibility. However, these ideas get us no closer to attaching a value to the premium.

The problem is that true market inflation expectations are not observable. We cannot precisely disaggregate a breakeven inflation rate into its three components: inflationary expectations, the inflation risk premium and the liquidity premium differential between TIPS and nominals. We might have an economists’ “consensus” for this year’s or next year’s inflation (which is usually just a modal forecast rather than a probability weighted one), but there is no guarantee that this is either up to the minute or in agreement with the market’s consensus. Some have tried to estimate risk premiums by using survey measures of inflation expectations, such as the 5-10y median inflation expectation component of the University of Michigan consumer sentiment survey or inflation expectations from the Survey of Professional Forecasters. However, the stability in these surveys, in addition to other factors, makes them unreliable indicators of inflation expectations, though they are not without information content.

For an inflation bond market, even considering breakeven inflation rates as representative of the expectations and risk premia of marginal investors is overly simplistic, despite often being used as the starting point for academic studies. This is because issuers as well as investors have reaction functions based on their expectations and risk preferences. As governments can issue either nominal or inflation-linked bonds, the ratio is dependent on their views, even if it can be accepted that their total funding needs are determined exogenously. While this is not likely a factor in near-term issuance in the US, it may be in the longer term and can matter in the near term in countries where governments are openly opportunistic in their issuance patterns. Additionally, issuance can weigh on markets into auctions as investors build in a concession. Therefore, in the very short term and in the medium to long term, supply can be a driver of breakevens.

Many inflation-linked bond markets appear to have had breakeven inflation levels that were below what was commonly perceived to be expected future inflation in the relatively early stages of their development. We believe this is because the inflation risk premium was dominated by the liquidity discount relative to nominal bonds. However, it is quite possible to reason how this could occur, even without considering liquidity factors that may skew preferences towards nominal debt. If a government values the portfolio diversification of increasing the amount of its inflation-linked debt, it may be willing to pay a premium to issue it. In addition, the issuer may be willing to accept relatively cheaper issuance in the early stages of a program in order to establish it in the hope of more attractive funding levels in the future. Thus, it may issue at a breakeven rate below the expected inflation level. Even while many investors may be willing to pay a risk premium in this environment, if supply in the short term is greater than that sought by such investors, the market-clearing breakeven level may still be lower than consensus inflation expectations.

An additional computational bias tends to understate inflation expectations using bond breakeven inflation. Convexity means that forward bond curves understate true expectations of the path of rates. As the value of convexity is a function of volatility and real yields are generally less volatile than nominal yields, there is less convexity effect on the real curve than the nominal curve. Hence, the yield on a long-dated nominal bond is biased down more due to convexity than that of a similar maturity inflation bond. The breakeven inflation implied by the yield spread is, thus, somewhat lower. In practical terms, the effect at shorter maturities is minimal, but for 30y breakevens, it is a factor that should not be ignored.

Despite the problems of convexity, the shape of the breakeven inflation curve may indicate whether there is an inflation risk premium in the market and how it changes over time. In particular, the breakeven slope beyond five years in a liquid market may be a reasonable guide to developments in risk premia because there is unlikely to be a strong belief in the market about inflation trends after the current economic cycle. The slope of the forward breakeven curve beyond five years would be a purer measure, but constructing this for bonds is a relatively complex process that, in practice, can create more distortions than it solves due to the need to fit multiple curves. Instead, we discuss below how one might use the CPI swap curve to catch sight of the “grail,” even if not to hold it.

If it weighs the same as a duck…

While we do not claim to be able to measure the inflation risk premium accurately, we believe it is currently lower than pre-crisis levels, though should move higher. This means that if the market’s fear of downside risks continues to decline and liquidity continues to improve, breakevens could consistently trade above inflation expectations and the curve could be steeper than it otherwise would be.

One way to approximate the inflation risk premium is to look at spreads of short breakevens in forward space. Arguably, if one looks far enough into the future, inflation expectations should be constant and the spread of forward rates should reflect inflation risk premiums and convexity. For example, it is unlikely to have a view that 1y inflation 15 years ahead will be different than 1y inflation 20 years ahead. Figure 1 shows the spread of different forward 1y rates. The pre-crisis average of these spreads implies that the inflation risk premium on a 10y breakeven had been 25-30bp but is now negative or close to zero (Figure 1).

FIGURE 1
Spread of forward 1y CPI swaps

	Jan 05 - Jul 08 average	As of April 30, 2012	As of June 6, 2014
10yF1y-7yF1y	9.8	-3	12
15yF1y-10yF1y	15.5	-2	-4
20yF1y-15yF1y	12.6	-2	-5
25yF1y-20yF1y	9.7	-1	-3

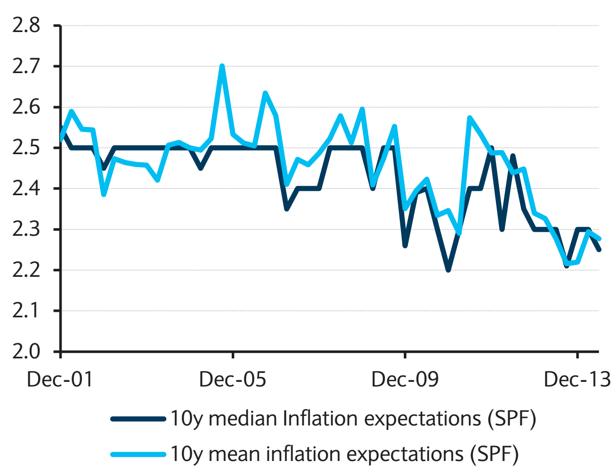
Source: Barclays Research

Another way to approximate the inflation risk premium is to use survey measures of inflation expectations since market inflation expectations are not directly observable. One source for 10y inflation expectations is the Philadelphia Fed's quarterly Survey of Professional Forecasters (SPF). Specifically, we use the mean of that survey because the median at times has been too static to be believable (Figure 2) and the market is more of a mean (though a weighted one), rather than a median metric. Subtracting the survey measure from 10y breakevens produces a fairly consistent negative value, though this can be because breakevens also contain a relative liquidity discount that tends to offset the inflation risk premium. If we subtract the survey measure from CPI swaps instead, we get a (usually) positive measure (Figure 3), which is about 20bp, down 15bp since last Q1.

Low 5y5y BE implies that either the market expects the Fed to miss its target or that the inflation risk premium is negative

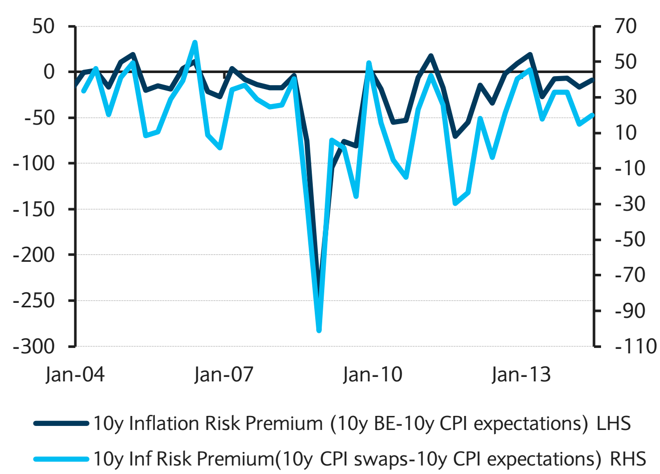
We can also compare forward breakevens with the Fed's target. For example, 5y5y breakevens, using Barclays measure found on BCAP2 on Bloomberg, is 2.36%. If the market were pricing in exactly the Fed's target of 2% on PCE inflation, the 5y5y BE should be about 2.40%, given the historical CPI/PCE basis. That 5y5y is below this implied means that either the market expects the Fed to miss its target or that the inflation risk premium is negative. Similarly, 10y10y cash breakevens, at 2.33%, imply either that the market thinks inflation will be higher in the medium term than it will be in the longer term or that the inflation risk premium is negative.

FIGURE 2
10y inflation expectations from the Survey of Professional forecasters



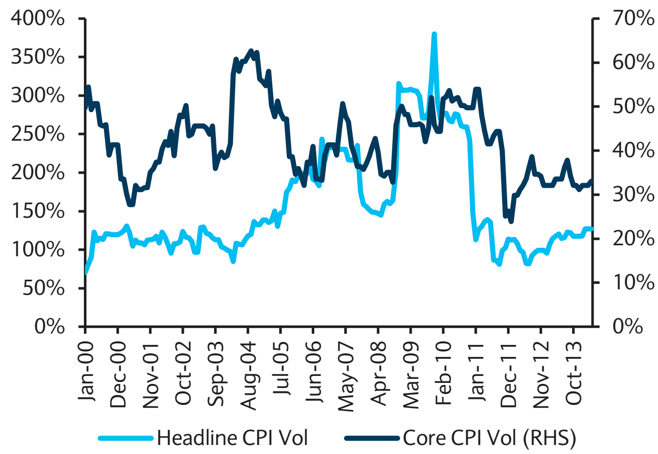
Source: FRB Philadelphia, Barclays Research

FIGURE 3
10y inflation risk premium



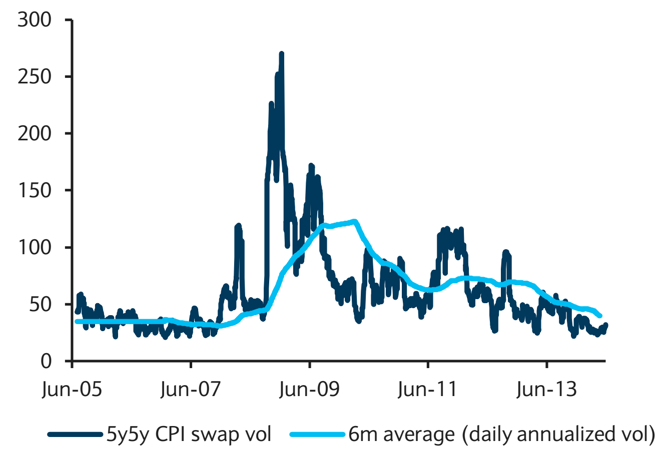
Source: FRB Philadelphia, Barclays Research

FIGURE 4
Headline and core CPI vol



Source: BLS, Barclays Research

FIGURE 5
5y5y CPI swap vol is lower, bp

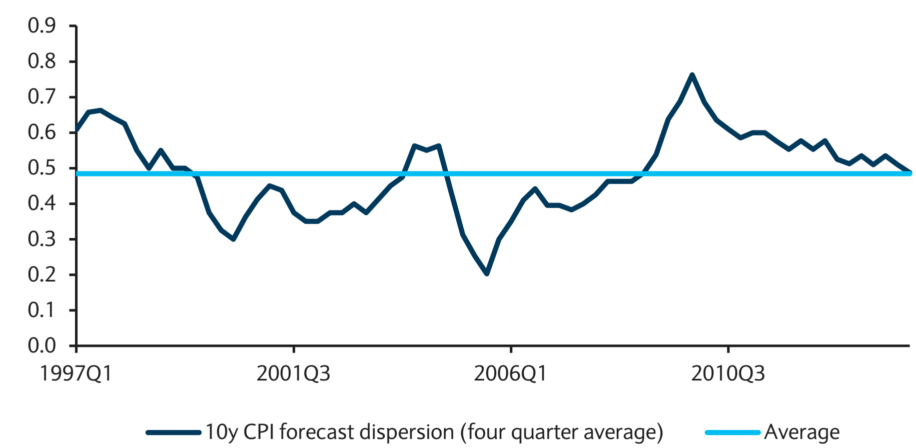


Source: Barclays Research

Low volatility justifies low risk premium

The metrics above all seem to imply that the inflation risk premium has declined and is low or negative. While we think it should be higher because of the uncertainty of a potential policy mistake as the Fed exits its current stance, recent market and inflation trends can explain low inflation premium. Inflation itself has been low recently; thus, it makes sense that the risk of high inflation is lower on investors' radar screens. Inflation volatility has also been relatively low (Figure 4) and if investors expect this to continue, they should demand less of an inflation risk premium. Uncertainty about the medium-term inflation outlook also appears to have declined recently. This can be seen in realized 5y5y CPI swap volatility (Figure 5), as well as a measure of dispersion within the Survey of Professional Forecasters (Figure 6). Again, if investors have more confidence about the inflation outlook, then it seems logical that they would demand less of a premium.

FIGURE 6
10y SPF CPI forecast dispersion



Source: FRB Philadelphia, Barclays Research

Perfect, now change

While we do think there is justification for a decline in inflation risk premium (though not to negative levels), they are likely to rise over time. Inflation has already begun to rise and, as a result, inflation volatility is off its lows. We expect inflation to continue to increase in the coming year. We believe the tick up in realized inflation levels and volatility will translate into higher inflation market volatility, particularly as we get closer to Fed rate hikes, which will likely introduce inflation uncertainty. These factors should push up on inflation risk premium and breakevens with them. In addition to our view that inflation expectations will increase along with realized inflation, a rise in the inflation risk premium would support our outlook that TIPS should continue to outperform nominal Treasuries this year.

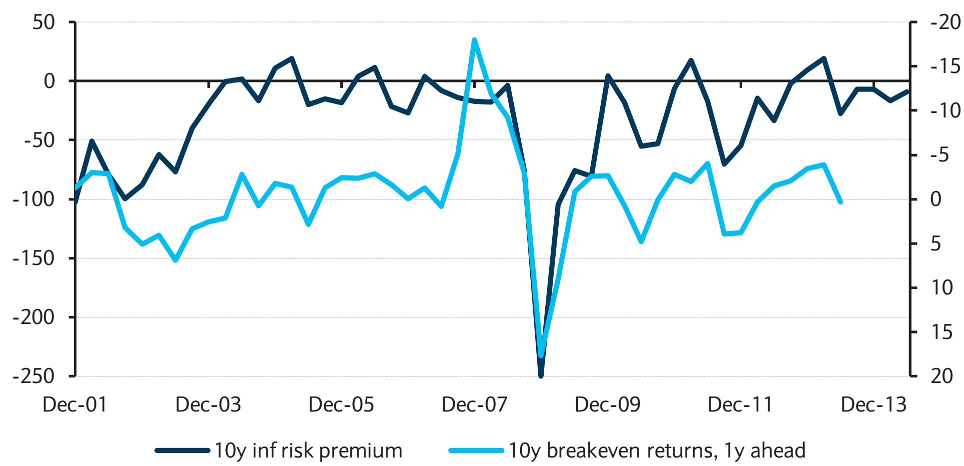
Inflation risk premium and subsequent breakeven returns

The correlation between the inflation risk premium and subsequent breakeven returns is about 60%

In the *2014 US Inflation outlook (page 5),* we highlighted the utility of the real risk premium in forecasting the year-ahead 10y TIPS returns. We concluded that TIPS returns were likely to be more positive versus the previous year, as the real risk premium had risen significantly by late 2013. The real risk premium measure was derived by subtracting the Survey of Professional Forecasters (from FRB Philadelphia) based real rate expectations from the market observed 10y real rates. Specifically, the real rate expectations were derived by subtracting the 10y T-bill return expectations from 10y CPI expectations. We think a similar approach is useful in forecasting the year-ahead 10y breakeven returns. Figure 7 shows the high degree of correlation between the SPF-based 10y inflation risk premium and the year-ahead 10y breakeven returns. The correlation between the two series over the shown period has been close to 60%, indicating that the inflation risk premium is useful in forecasting breakeven returns. The inflation risk premium has been lower the past year, suggesting that breakeven returns are likely to be higher in the coming year.

FIGURE 7

10y inflation risk premium and the year-ahead 10y breakeven returns correlation is close to 60%



Source: FRB Philadelphia, Haver Analytics, Barclays Research

INFLATION PRODUCTS

Measuring the relative liquidity premium – the other Holy Grail

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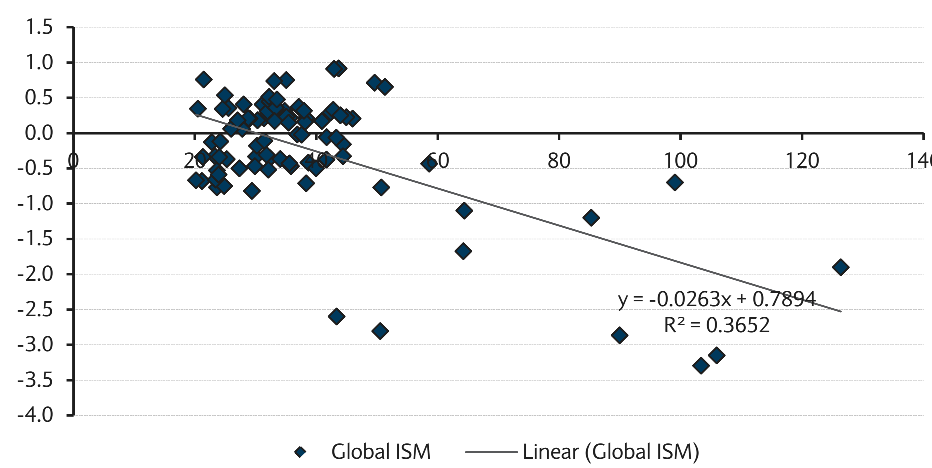
For investors considering the fair value of linkers versus nominals or issuers considering ex-ante costs, inflation risk and relative liquidity premiums are important but both are difficult to measure. Here, we examine liquidity premiums.

Breakevens are equal to inflation expectations plus a liquidity-adjusted inflation risk premium. We can further break down the second factor into the inflation risk premium and the liquidity premium differential, where the former generally is positive for breakevens while the latter is negative. Because these factors usually push in opposite directions, the liquidity-adjusted breakeven can end up positive or negative and breakevens can be higher or lower than inflation expectations. We focus on the risk premium in "The elusive inflation risk premium" elsewhere in this guide; here we discuss how much investors are willing to pay for the better liquidity of nominal Treasuries relative to TIPS.

In a working paper[2], Carolin Pflueger and Luis Viceira attempt to estimate the liquidity premium differential component of 10y breakevens – ie, the premium investors are willing to pay for nominal Treasuries relative to TIPS because the former are more liquid. We believe their estimate, in a May 2011 version of the paper[3], of "around 40 to 70 basis points in normal times" is unrealistically high, though it is closer to reality, in our view, than the results in the March 2011 version of the paper[4], in which they estimated it to be about 70bp. Relative asset swaps (a better measure we think) indicate that the premium is closer to 20-30bp, and we believe even this measure overstates the liquidity premium.

In estimating the liquidity premium differential, Pflueger and Viceira run a regression on breakevens against a set of variables, such as the spread between on-the-run and off-the-run nominal Treasuries, which is related to investors' demand for liquidity in nominal

FIGURE 1
Correlation between Global ISM and nominal/TIPS relative ASWs



Source: Barclays Research

2 An Empirical Decomposition of Risk and Liquidity in Nominal and Inflation-Indexed Government Bonds, Harvard Business School, July 2010
3 *http://www.people.hbs.edu/lviceira/PV-TIPS-20110523_authors_all_and_appendix.pdf*
4 *http://www.hbs.edu/research/pdf/11-094.pdf*

Treasuries. Because the variables are related to liquidity preferences, the authors believe they have isolated changes in breakevens caused by changes in the liquidity premium. Instead, because investor preference for liquidity is often related to financial market stress and, over the past several years, financial market stress has been related to concerns about the economy, the liquidity variables end up acting as direct measures of liquidity premiums and proxies for economic concerns. Using relative asset swaps between TIPS and nominals as a measure of financial market distress and using Barclays' Global ISM index as an indicator of economic conditions, Figure 1 shows this strong relationship between financial market and economic stress.

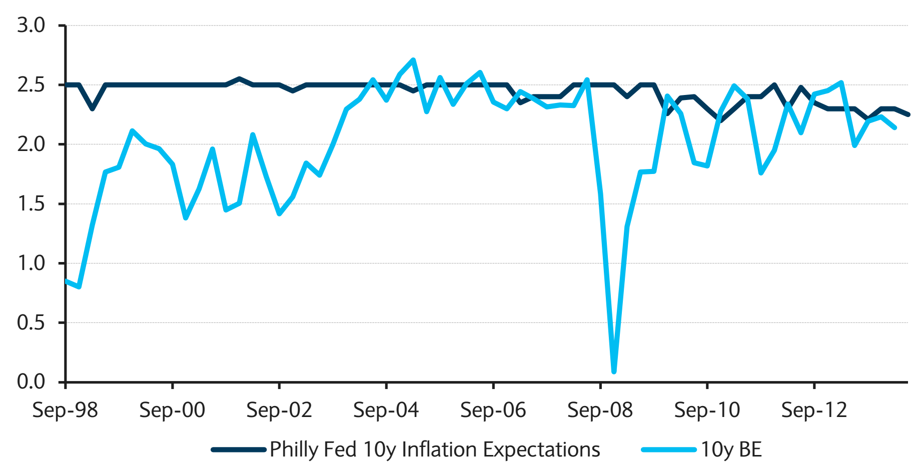
The authors believe they have isolated liquidity because when they add the 10-year forward inflation expectation from the Philadelphia Fed survey of Professional Forecasters, the model coefficients do not change significantly. We believe this is a bit misleading because, in our view, the results of that survey are unrealistically stable. Figure 2 shows that from June 1998 through September 2009, the median 10-year-ahead headline CPI inflation forecast from that survey remained in a 10bp range and was 2.5% in 38 out of 46 of those months. While 10-year forward inflation expectations might be stable because of Fed credibility, we find it unlikely that market inflation expectations for 10-year-ahead inflation were virtually unchanged over an 11-year span that included energy shocks and the great recession. Therefore, we do not agree with the results of Pflueger and Viceira's model, which found that most of the fluctuations in breakevens can be explained by changes in the liquidity-premium differential.

In our view, this "double counting" of liquidity variables – as a measure of liquidity preference and as a proxy for economic concerns – has led to a significant overestimation of the liquidity premium differential between TIPS and nominals. For example, suppose a shock to financial markets causes investors to flock to the liquidity of nominal Treasuries and also leads to a decline in growth and inflation expectations. Also, let's assume that the liquidity premium and inflation expectations change so that each causes a decline in breakevens of the same magnitude. The regression coefficient would be double what it should be if preferences for liquid instruments were not correlated with economic concerns.

Double counting is evident in Pflueger and Viceira's estimation of the coefficient on the relative ASW between TIPS and nominals. We believe this spread is the best direct (though not exact) measure of the liquidity-premium differential. They note that the theoretical value of the coefficient should be -1 (when the relative spread widens, breakevens should go down an equal amount); however, the authors find that left unconstrained, the coefficient is -1.6 (when

FIGURE 2

10y BE and inflation expectations from the survey of professional forecasters



Source: Philadelphia Fed, Barclays Research the relative spread widens, breakevens should go down 1.6x the spread widening). We have run similar regressions and also get an unintuitive coefficient with an absolute value greater than one (Figure 3) when we use only liquidity variables to model breakevens. We ran the model using the Fed's 10y breakeven (which compares an off-the-run nominal curve with a TIPS curve that does not strip out off-the-runs), as the authors did, and using traded breakevens, which are more relevant for measuring liquidity premiums between on-the-run TIPS and on-the-run nominals. However, when we include relative ASWs in our fundamental breakeven model, we get the theoretically intuitive result of -1. Note that when we incorporate ASWs in a fundamental model on 10y CPI swaps, the coefficient is near zero and the t-stat is insignificant. In our view, this indicates that, though not perfect, relative ASWs are a fairly accurate indicator of the liquidity premium between TIPS and nominals. Figure 4 shows the results of our ASW-augmented fundamental model versus actual breakevens over time. It indicates that 10y breakevens are about 25bp cheap.

FIGURE 3

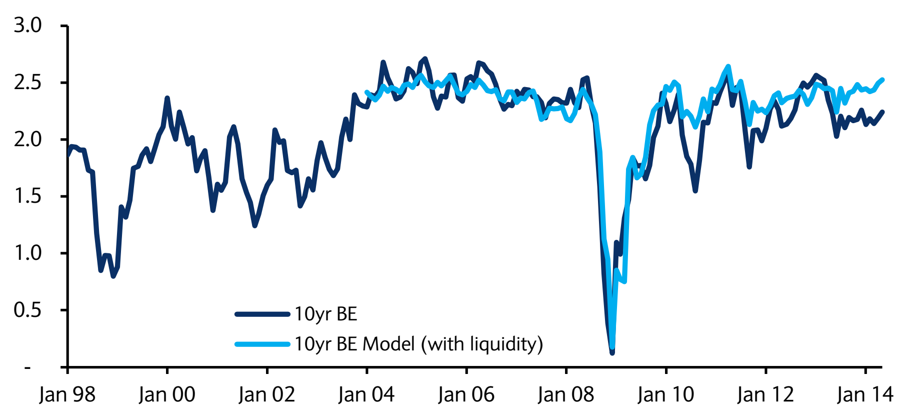
Breakeven model results

Dependent variable			Liquidity variables		Economic variables			
	10y		On-/off-the-run spread (bp)	Relative ASWs (TIPS minus nominals, bp)	Global ISM	FF6-FF1	Ln Gasoline	R^2
Model 1	Fed BE	Coef	-0.01	-0.01				80%
		t-stat	-3.24	-7.03				
Model 2		Coef		-0.010	0.310	0.140	0.368	87%
		t-stat		-5.256	5.031	2.639	3.253	
Model 3	Cash BE	Coef	-0.01	-0.01				84%
		t-stat	-3.97	-7.84				
Model 4		Coef		-0.011	0.323	0.151	0.369	90%
		t-stat		-6.104	5.943	3.227	3.702	
Model 5	ZC CPI Swap	Coef	-0.011	-0.005				53%
		t-stat	-3.07	-2.30				
Model 6		Coef		-0.001	0.292	0.149	0.361	72%
		t-stat		-0.827	5.237	3.091	3.532	

Source: Barclays Research

FIGURE 4

10y breakeven and ASW-augmented fundamental model of 10y breakeven



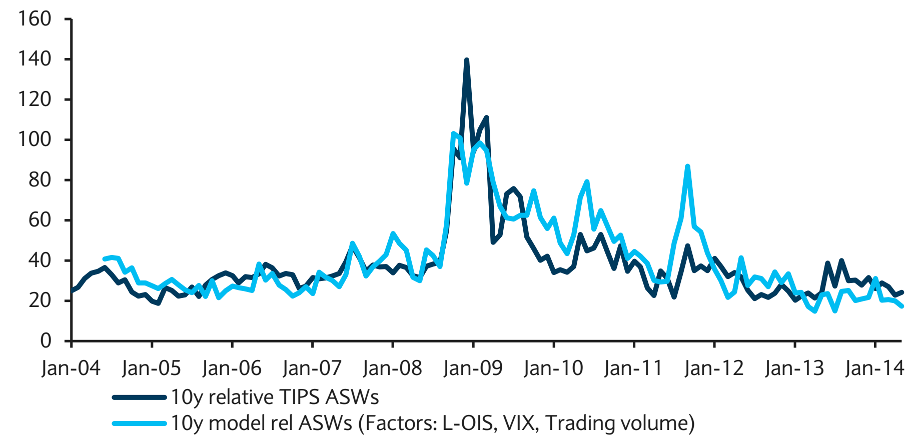
Source: Barclays Research

Modeling relative ASWs

We expect TIPS liquidity to increase over time and, therefore, we expect that TIPS relative ASWs will compress. Due to the importance of relative ASWs in measuring TIPS liquidity as highlighted above, we have come up with a fair-value model for TIPS relative ASWs (Figure 5). TIPS relative ASWs show a firm correlation with various liquidity measures such as TIPS trading volume, VIX and L-OIS. The coefficients of this model make sense. For example, the beta of trading volume with respect to relative ASWs is negative, which makes sense as trade volume rises, TIPS liquidity improves and the relative ASWs compress. A negative beta is also there versus 3m L-OIS spread, which also tends to widen during a crisis. With respect to the VIX index, TIPS have a positive beta, which indicates that as the market volatility increases, relative ASWs widen. By June, 2014, the VIX index is trading at a local low while the L-OIS spread has remained fairly subdued. TIPS trading volumes have been rising steadily as the Treasury remains committed to the TIPS program. With these factors, 10y relative ASWs fair-value is about 17bp, while the market is trading at roughly 21bp. This indicates that relative ASWs can richen further from here.

FIGURE 5

10 relative ASWs changes are well explained by TIPS trading volume, VIX and L-OIS spread



Source: Barclays Research

INFLATION PRODUCTS

New linker issue pricing

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We discuss the process of estimating fair value on new inflation-linked issues and the factors that drive the roll.

When a new issue is brought to market there is a price discovery period. Prior to the auction of new US TIPS and European linkers brought via auctions, this price discovery period includes trading in the so-called when-issued (WI) market. In other cases, new linkers may be brought via syndication, with the syndicate of banks involved working in consultation with the issuer to glean feedback on demand prior to and during a book-building process in order to fix an initial price. We consider several factors involved in estimating fair value of a new issue relative to existing bonds, specifically considering US TIPS, followed by extending the analysis to Europe.

Estimating TIPS rolls

A new issue yield is usually quoted as a spread to the current on-the-run security, when this spread is known as the roll. This is true of both nominal and inflation-linked issues but with linkers there are additional factors to consider. The four main factors that determine the fair value of a nominal roll are: curve, carry, liquidity premium, and adjustment for bad days. For Treasury Inflation Protected Securities (TIPS), one also needs to take into account the relative contribution of seasonality of inflation accrual, as well as the relative value of the deflation floor premium. We discuss each of these factors in detail and, by example, show how we came up with our estimate of the TIIApr17s in April 2012.

Curve

Factors driving the fair value of the roll

In general, investors demand additional yield moving out the curve to compensate for the higher duration exposure. Since the WI issue is a more recent security, its duration exposure is higher (with the potential exception of long bonds if yields have risen sufficiently for the new issue to have a notably higher coupon); therefore, the curve component should generally be positive. This is not always the case: the curve may be downward sloping if the market was expecting a weaker economy or a steady decline in inflation, and this component could therefore be negative. The curve can be roughly estimated using the difference in yields between pairs of similar maturity differences in that part of the curve. For instance, before the announcement of the TIIApr17s, the TIIJan16/TIIJan17 spread was 17.5bp and the TIIJul18/TIIJul17 spread was 18.4bp. One could take an average of the two as a guide to the curve between the Apr16 and Apr17 issues. However, there are various issues with such an approach that must be kept in mind:

- First, if the curve is highly concave, the shape of the curve may be changing rapidly. Hence, the estimation using previous pairs may be misjudging the true curve.
- Second, even if the previous pairs are equidistant in terms of maturity as the WI and the OTR, they may not be in terms of duration. For instance, if rates moved substantially from the previous auction, the coupon on the WI and the OTR would be very different. If the market had sold off, the coupon would be higher and, therefore, the duration of the WI might not be very different from the on the run, despite having a higher maturity.
- Third, part of the difference between these or other pairs could be due to issue-specific relative value. Even annual pairs, where seasonality would not come into play, could be distorted by coupon differentials, liquidity factors or micro richness/cheapness of specific issues.

We believe a superior approach that accounts for these issues is to price the curve value between the WI and OTR issue off a real spline or the swap curve, using the maturity and expected coupon, and compute the difference between the two yields. Computing a nominal Treasury roll using a spline curve is usually sub-optimal to the swap curve because the former might be distorted by liquidity premiums, but this is less of an issue in TIPS. Using the spline curve approach, we found the TIIApr16/TIIApr17 curve to be worth 17.5bp, matching the spread of the TIIJan16/TIIJan17 pair.

Liquidity premium

WI issues generally command a liquidity premium

The liquidity premium arises from the preference for owning the more recent issue due to ease of trading; therefore, there is generally a preference to owning the WI relative to the OTR. If that is the case, the roll would not be as high as the curve component suggests and should therefore be adjusted downwards to reflect this premium. However, because issue sizes have grown, new issues may initially trade at a discount as the market could take time to absorb a significant amount of supply. While there is no market traded instrument that can be used to extract the premium directly, we can estimate it from the premium in the current and old OTR pair.

The outright yield spread between the current and old OTRs will have a curve component in addition to the liquidity premium; therefore, it cannot be directly used as an estimate of the liquidity premium. Instead, the spread between asset swap levels should be a good proxy because the curve component that arises from the duration exposure will have been eliminated as fixed cash flows are transformed into floating rate cash flows. What is left should largely be the liquidity premium. We say “largely” and not “fully” because the asset swap curve in itself need not be flat but may have a shape as well.

Carry

Converting the estimate of the roll at settlement to the roll at announcement

The above analysis gives the roll estimate (curve + liquidity premium + adjustment for bad days) as of the settlement date of the auction, which needs to be translated into a roll at announcement date as the roll begins to trade at the announcement date. The difference arises from the loss (or gain) of carry on the current OTR because the new issue will not settle until sometime after the auction. When an investor buys the roll, the transaction involves buying the WI for forward settle and selling the current OTR for regular settle. If the carry in being long OTR is positive, the investor loses that carry in this transaction and, therefore, should be compensated by being offered a higher yield on the WI. Hence, the roll at announcement should be higher than the roll at settlement if the carry is positive and lower if it is negative. In the current example, because April 2012 was a strong inflation accrual month, the carry on the TIIApr16s from the announcement settlement date of April 13, 2012 to the auction settlement date of April 30, 2012 was 4.5bp. This is another way of saying the forward (April 30, 2012 settle) yield on the TIIApr16s was 4.5bp higher than the spot (April 13, 2012 settle) yield on announcement date of the new issue.

Bad days

An adjustment is needed to account for the relative number of bad days in the WI and the OTR

The roll estimate (true curve + liquidity premium) is applied to the true yield of the current OTR to get the true WI yield at announcement. However, the quoted yields could be different from the true yields; therefore, the quoted roll could be different as well. The *true* yield methodology discounts bond cash flows off of their holiday-adjusted payment dates, which would push the cash flow forward. The *quoted* yield methodology discounts bond cash flows off of their unadjusted payment dates. Since the true yield methodology pushes cash flows forward, the discounting yield should be lower to get the same market price. Hence, if there are “bad days,” the quoted yield would be higher than the true yield.

The effect of the roll will depend on which bond has more bad days, the WI or the current OTR. If the WI has more bad days, its quoted yield will be higher than the true yield by a higher amount and the roll will need to be adjusted upwards, and vice versa. In the TIIApr17 example, neither issue involved in the roll has any bad days.

Some more adjustments for inflation-linked securities

The roll factors discussed above are applicable for both nominal and inflation-linked securities. However, one needs to be cognizant of two more factors when looking at linkers: seasonality of inflation accrual and deflation floor premium.

Inflation compensation: TIPS inflation accrual is paid based on the non-seasonal CPI print. CPI prints in the early part of the year are generally above their seasonally adjusted prints, and those towards the end of the year are lower. Seasonality does not matter if the current on-the-run and to be newly issued TIPS have the same maturity month. However, if these are different, one should account for the seasonality patterns. This is currently an issue at the 10y point in the US because the Treasury issues January and July new 10y TIIPS. July issues trade rich to January and April issues, and January issues trade rich to April issues. Hence, the roll (computed versus a January issue) based on a similar analysis as that described earlier for nominal securities should be adjusted downward if the new issue is a July issue and upwards if it is an April issue. One can look at the difference between seasonally adjusted CPI (CPI SA) and CPI NSA m/m for a starting impact of seasonality. Also, one can look at how consecutive January/April/July issues trade at other maturity points. More detail on computing the effect of seasonality can found in the Seasonality article in this Guide.

Deflation Floor: TIPS and linkers in some other markets have a deflation floor; ie, the face amount returned at maturity will be the maximum of the par amount or the inflation indexed par amount. Hence, over the life of an issue, if the CPI index has declined, the investor will still obtain par even though the inflation-adjusted par will be below 100. Hence, if the OTR and WI issues' index ratios are at a different distance from 1.0, one needs to account the relative value of the deflation floor. For instance, if the CPI index has declined since the most recent auction, the OTR index ratio will be below 1 and its deflation floor will be more valuable. The roll should therefore be adjusted upwards, as the OTR will be trading at a premium. In the current example, we estimated the floor value on the TIIApr16s to be about 3.5bp, whereas the floor value on the TIIApr17s was estimated to be 7bp. Therefore, the floor value spread was estimated to be about 3.5bp. This positive spread needs to be subtracted from the roll because, all else equal, investors should be willing to pay this as a premium to own the issue with the more valuable floor. See the separate section in this Guide on Par Floors for further consideration on how floors are valued.

FIGURE 1

Fair value estimate of TIIApr16/TIIApr17 roll

Five-year TIPS Forward Roll	
Announcement Date	4/12/2012
Settlement Date	4/30/2012
Expected Issue Size	16
Yield of Current Benchmark (TIIApril16)	-1.297%
Financing Rate from 04/13 to 04/30/12	0.20%
Total Financing Days	17
Net Carry (bp)	4.5
Yield Curve (bp)	17.5
Bad Days (bp, net)	0.0
Liquidity Premium (bp)	0.0
Floor Value Spread (April16-April17)	-3.5
Seasonality Premium (bp)	0.0
Fair Value Forward Roll (bp)	**18.5**

Source: Barclays Research

We then need to put all these parts together to come up with an estimated roll. We found the fair value of the roll versus April16s on this new issue to be about 17bp-18.5bp. Assuming 20bp repo from April 13 settle to April 30, 2012, the carry on April16s is about +4.5bp. The floor on the new issue is worth about +7bp (in running terms) while the April16 floor is worth about +3.5bp, and so the relative difference is about -3.5bp. Using the Jul16 and Jul17 real curve difference of about +17.5bp (these securities have a fairly similar coupon, which should give a decent estimate of the curve), we get the total roll of 18.5bp (4.5bp + 17.5bp – 3.5bp). As it turns out, initial indications on the roll just after the announcement was an 18/18.5bp market so the market seemed to agree with our estimate.

Estimating new issue valuations in Europe

In the US, the roll typically starts trading soon after the initial size and coupon of the new issue is announced. In Europe, WI trading is typically less active for initial auctions, in part because the roll is much less well defined, and very rare if bonds are brought via syndication. While the elements already discussed for TIPS pricing are applicable for calculating fair value estimates for European inflation-linked bonds, there are additional complications. In particular, unlike in the US, the concept of on-the-run bonds is not typically seen in linkers, with non-standard initial maturities and regular reopenings of most bonds. Hence, to the extent that WI trading occurs on a roll basis, rather than in absolute yield or breakeven, it is typically to the nearest issue, which can be shorter or longer than the auction stock. For example, ahead of the OAT€i18 launch in April 2012, what limited WI quotes there were referenced the OAT€i20. Even with this consideration, typically the gap on the curve is notably greater than the one year or six months in the US. This significantly increases the uncertainty about pricing such that, for instance, the DBR€i23 spread to the DBR€i20 traded in a range of more than 10bp prior to the initial auction in March 2012.

The methodology for calculating the fair value on real yield curves is fundamentally similar to the US but with some notable differences. Not only are the yield curve gaps larger when considering fair value for European issues than for those in the US, but there are rarely enough bonds to provide a yield curve estimate that does not consider the value of the bond from which the roll is quoted, creating the risk of double counting of relative value distortions. The fact that nearby issues are often much older than the new bond can also create significant coupon differences, such that, for instance, in estimating the fair value ahead of the sale of the OAT€i18 on a simple yield curve basis produced an estimate 14bp lower than a duration-weighted calculation. As a result of the greater uncertainty, other metrics are more commonly used as valuation cross checks than for new TIPS issues. In particular, breakeven and relative z-spread asset swap metrics are often referenced given that nominal bond curves and inflation swaps are more completely defined than bond real yield curves.

Another contrast between new issues in Europe and those in the US is that new issues are normally less liquid than their neighbours until their size has been built up via reopenings. More frequent European new issue auctions but for much smaller sizes than in the US gives relatively little incentive for investors to switch into brand new issues at initial auctions. Hence, in the euro area it is normal for new issues to be launched at a discount rather than a premium, with rolling out of old stocks typically limited. Having relatively old neighbours can also make the relative value of the implied floor of new issues more pronounced; though in France and Sweden new issues are typically issued with index ratios above 1 as accretion starts from a full year before the initial coupon, limiting the floor value somewhat. However, lower liquidity also means the floor value of new issues is rarely fully priced unless asset swap investors are the marginal buyers of the paper (in which case the floor element can be extracted), as investors with an interest in allocating into new inflation-linked bonds are unlikely to assign a high probability to a deflation shock.

In the past, new €is issues sometimes referenced issuance from other European countries when there were large gaps in the domestic curve, but given the sharp increase in volatility between countries since 2011, this has not been a common methodology over the past few years. That said, when the DBR€i30 was launched in April 2014, the longest existing point was the DBR€i23. Given that the launch of the DBR€i30 was an extension of the current German curve, any analysis that relied on valuation metrics related to existing German issues was heavily biased by the extrapolation assumption used. Such an approach was inappropriate given that the German linker curve contained only four issues. We turned to the OAT€i curve for guidance but the absolute measures (ie, real yield and asset swap) there were not useful either, as there was a marked difference there between French and German linkers. On the other hand, we found that the DBR€i20 and DBR€i23 were more or less in line with the OAT€i curve in terms of incremental forward breakevens and seasonally adjusted breakevens. There was also a more fundamental reason why the OAT€i breakeven curve could serve as a useful reference, apart from the fact that it was more or less consistent with the two longest DBR€is: while real yields and asset swaps are driven by the specific credit dynamics of the two issuers, the breakeven metric references a variable that is common to both. In practice, this does not mean that breakevens of two €i issuers should be the same, but in that particular case, it did appear that French and German linkers are relatively consistent on that metric. Therefore, we used the OAT€i breakeven curve as the basis for the fair value calculation of the DBR€i30.

FIGURE 2

Fair value estimate of DBR€i30

Estimate based on 2 April 2014 closes	
Announcement Date	8 April 2014
Settlement Date	10 April 2014
Announced Issue Size	€2bn
OAT€i27 breakeven	1.67%
OAT€i32 breakeven	1.884%
Forward breakeven between OAT€i27 and OAT€i32	2.45%
Breakeven of hypothetical OAT€i30 (using constant forward breakeven)	1.81%
Adjustment for seasonality	0.11%
Seasonality-adjusted breakeven of hypothetical OAT€i30	1.70%
Seasonality component of DBR€i30 at issuance	Negligible
Retained fair value estimate for DBR€i30 breakeven	1.70%
Nominal comparator yield (DBR 6.25% April 2030)	**2.20%**
Corresponding real yield	**0.50%**
Real yield spread to DBR€i23	**+45bp**

Source: Barclays Research

To date, individual countries in the euro area have issued bonds maturing at the same time each year so there is no seasonality to consider when pricing against same-issuer bonds. In Sweden, seasonality has been an element that should have been factored in to the launch of both 2017 and 2022 issues, given their less favourable June maturity date compared to their neighbouring December redeeming bonds. In practice, it appeared to be partly priced, which is not unusual for seasonal factors, though it is hard to split this factor from floor value when there is no observable inflation volatility. In the UK, new-style issues have both November and less favourable March maturity dates, which are a notable relative value consideration even for the relatively long maturities involved. Recently, 10y and shorter benchmarks have tended to be launched via auction, with syndications used for longer-dated bonds. It is notable that the syndication process for new gilt linkers has seen new issues launch very close to their theoretical fair value levels, with any supply concession coming in absolute yield or breakeven ahead of the supply.

INFLATION PRODUCTS

Why should governments issue linkers?

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The number of sovereign issuers of inflation-linked debt continues to grow. We discuss the various reasons why governments might decide to issue.

Why should governments issue linkers?

Exploiting excessive market inflation expectations

A government may have more faith than investors in the institutional arrangements in place to maintain an anti-inflationary bias. This was a major factor in the UK's decision to issue linkers in 1981: aggressive monetary and fiscal tightening had been implemented to bring inflation under control, but investors remained unconvinced that there would be a significant long-term reduction. By issuing inflation-linked bonds, the UK Treasury thus saved billions of pounds when inflation fell sharply and stayed low, ultimately bringing inflationary expectations down as well. Ex post, some were critical about the underperformance of linkers versus conventional bonds in this phase, but such criticism was unjustified. Nominal bonds had enjoyed a windfall gain due to what was, for the market, unexpectedly low inflation.

In most developed economies, this factor is notably less important than it has been in the past. With independent and transparent monetary policies, the gap between market and government expectations of inflation is likely to be small. While there may be times when divergences of expectations encourage issuance, this mismatch is unlikely to be the primary concern. For more recently developing countries with less established monetary and fiscal institutions and capital markets, there may still be occasions when governments perceive that the markets' expectations of price increases are too high, particularly when institutional changes have been made to fight inflation more directly. The substantial increase in issuance in Brazil in 2006 may have been partly motivated by such considerations, as may have the resumption of issuance in Turkey in 2007.

Positive credibility feedback

A closely related benefit of inflation-linked bond issuance is that it can create a positive credibility feedback. If a government really has taken steps to bring down long-term inflation, it is in its interest to issue inflation-linked bonds while inflation expectations remain high. The market may be more willing to believe in the institutional changes made to bring down inflation, if the government is seen to be "putting its money where its mouth is". The more inflation-linked debt a country issues, the less incentive it has to reflate the economy and reduce the real value of the debt stock. The longer the expected lifespan of a particular government or policy regime, the more beneficial the strategy may be. This is another argument that is not particularly relevant for developed economies with totally independent monetary policies. It may be very significant for transitional economies that have undergone periods of high inflation, though; Turkey is a clear example of where this may apply, while it may also have been a factor behind the significant increase in issuance in South Africa in 2009.

Saving a risk premium

A popular early argument for inflation-linked issuance was that if government inflation-linked bonds really were risk-free financial assets, a government could save an inflation risk premium by issuing them in place of nominal debt. If investors are primarily interested in maintaining the future real value of their savings, they should be prepared to pay an insurance premium for the privilege of owning a risk-free inflation hedge. In practice, it is debatable to what extent such a premium has been seen in the major markets, except when there are substantial liabilities linked to inflation, as for instance in the UK. However, this consideration tends to gain increasing emphasis when monetary policy credibility comes under pressure. Early in the development of some of the major markets, there appeared to have been negative inflation risk premia, or at least positive effects were more than offset by negatives, eg, liquidity. Conceptually, the risk premium benefit of inflation-linked issuance is likely to be more pronounced at longer maturities as the inflation protection element becomes more valuable. Empirically, in most markets, forward breakeven spreads between inflation-linked and nominal bonds usually increase at longer maturities, while long-term survey measures of inflation are normally relatively static with respect to maturity, suggesting that risk premia are indeed more favourable for inflation-linked issuance at longer maturities.

The appropriate nature of liabilities

The future expenditures and revenues of a government are almost all essentially real flows. Its major future “asset” is its entitlement to a (real) stream of tax revenues, which will reflect inflation and real economic activity. Having at least a portion of liabilities linked to inflation should offer risk reduction benefits to the government borrower, matching its debt servicing costs with its revenues. The more that revenues tend to grow faster than expenditures as prices rise, the more there is an incentive to issue inflation-linked bonds. While ex-post the costs of inflation-linked bonds may be higher to issuers than nominal bonds would have been if there were higher-than-expected inflation, the government is better placed to cover this cost. This argument is stronger in the event of a higher percentage of taxation from income and consumption taxes, as corporate taxes tend to be less dependent on domestic price levels. The argument is weakened for countries that have significant inflation-linked liabilities, for instance, pension commitments linked to inflation that are liable to grow more quickly than inflation-linked tax revenues.

Cyclical benefits

Issuance of inflation-linked bonds can have significant cyclical, as well as long-term liability benefits for a government. When growth is strong, there is little pressure on public finances, but inflation is likely to be higher. Equally, when growth is weak, prices are unlikely to rise quickly. Servicing linker costs should, thus, tend to be a fiscal stabiliser compared with servicing nominal debt. The fiscal effect of a deflationary downturn on a country with a significant stock of inflation-linked bonds ought to be less severe than a country with only nominal debt. The UK DMO puts particular emphasis on the fact that inflation and the government’s budgetary situation are likely to be highly correlated. Other than a “stagflation” scenario, the main risk to this hypothesis is late in the economic cycle, when after a strong growth period inflationary pressures may continue to grow even when output is already falling away, but the counter-argument is that tax revenue also tends to lag output growth. Conversely, issuing inflation-linked at the start of an economic upswing may be optimum timing, as it is likely that during such a phase inflation risk premia will be high until policy acts to contain inflationary pressures. It is also a time when funding needs are high, so it is advantageous to extend the average life of the debt portfolio.

Risk diversification

Even governments with no natural preference for either real or nominal liabilities should regard it as appropriate to have some inflation-linked liabilities within their debt, unless they assign no probability to inflation being lower than the market expects. A government is better off having a balanced liability portfolio in the face of economic uncertainty, in our view. This diversification benefit can mean that it is in a government’s interest to issue inflation-linked bonds, even when implicit inflation is lower than the government’s inflation expectations. As it is sometimes easier to sell longer-dated real return bonds than nominal issues, a benefit also arises from reducing the exposure to short-term cash flow pressures.

Maximising investor reach

Clearly, there is potential for a government that issues inflation bonds to reach investors who would not buy nominal government bonds, and also to tap new money that would not have been allocated to nominal debt. The largest issuers in recent years, including the US Treasury, have stressed this point. For example, US state and local government pension funds hold less than 5% of their assets in government bonds; however, they are more natural buyers of inflation-linked bonds, as there are relatively few competing sources of inflation-linked supply, while their liabilities are linked to the cost of living. Similarly, in the euro area, where there is particularly high competition between government issuers, the ability to reach an additional set of investors is a highly regarded prize. A broader investor base not only cheapens funding on average, but also reduces the reliance on particular sources of funds, again reducing risk.

Duration and cash flow benefits

A standard inflation-linked bond has smaller nominal cash flows upfront than as the price level rises. An inflation bond is, in nominal terms, being issued at a discount if inflation is expected over the life of the issue. This benefit may be a factor worth considering for transitional countries that have short-term cash constraints but ultimately sound finances. In addition, for a country looking to extend the duration of its debt, issuing inflation-linked bonds can offer an attractive proposition. It is a less important factor in developed countries, where governments are required to account for inflation as it accretes in linkers, while extending average duration via the nominal market is relatively straightforward, if so desired.

In several Latin American countries, long-dated maturities have been issued in inflation-linked before the nominal market was sufficiently developed for long nominal issuance, due to fear of inflation eroding the value of nominal debt. Even when, such as in Mexico, nominal curves have eventually extended to maturities as long as those of inflation-linked bonds, the duration of the long linkers has remained notably longer due to the back-ended nature of linker cash flows. South Africa has undergone a similar extension of its debt since the introduction of inflation-linked bonds.

Social benefits

The existence of inflation-linked bonds may provide benefits to society beyond the funding considerations. The ability to discern markets' inflation expectations easily may be of benefit to policy setters. In particular, there may be considerable benefits if breakeven spreads between inflation-linked and nominal bonds help avoid inflationary monetary and fiscal policy errors. With central banks making no secret that they observe both spot and forward inflation-linked breakevens, relatively stable spreads may also provide a self-reinforcing credibility tool for inflation targeting. After the US FOMC indicated that the main market-based series of inflationary expectations on which it focuses is the breakeven implied by 5y5y forward TIPS, this series stayed in a tight 40bp range until the strong inflation volatility of 2008-09. While it can be difficult for central bankers to ascertain how much of breakevens is true inflationary expectations and how much comes from a risk premium, to the extent that the series itself becomes tied to policy credibility, this differentiation becomes relatively less important. Since the start of the sovereign debt crisis, it is doubtful, though, that much information about genuine inflation expectations can be sustainably extracted from euro area bond breakevens. Breakevens there have, to a large extent, been driven by risk-on/risk-off moves and have been distorted, for instance, by the ECB's excluding BTP€is from its Securities Markets Programme. Being less subject to distortions, inflation swaps have therefore increasingly been seen as more representative of expectations.

To provide a significant benefit to policymakers, an inflation-linked market needs to be seen as relatively representative. One of the major reasons put forward within Japan for an inflation-linked bond programme was that the resultant implied inflation rate would be a useful policy gauge, with this argument also influencing the decision not to offer a deflation floor. However, without a broad acceptance of the asset class by domestic investors, this role failed to gain traction. Experience elsewhere also suggests that it can take several years before there is sufficient liquidity and acceptance of the asset class for the implied inflation to be a reliable enough guide to be a major benefit.

Having a market-based reference of inflation expectations from linkers may also be useful for economic agents in making decisions. The existence of inflation bonds could theoretically reduce inflation uncertainty. This could encourage more savings, either directly into inflation-linked bonds or indirectly into assets for which there is a clearer real value if there are inflation-linked assets for comparison. Putting a price on such benefits is difficult, but as there seem to be few clear differences in behaviour between economic agents in similar countries with and without inflation bond markets, it is unlikely to be very large.

Drawbacks of inflation-linked issuance

In our view, criticism suggesting inflation products are less liquid than their nominal equivalents is fair, with liquidity differences exacerbated following market dislocations in the six months from September 2008. In the euro area, the sovereign debt crisis has also affected the linker market to a greater extent than the nominal one. In the US, however, since the 2008 shock, the liquidity gap has become notably lower than it was prior to the middle of the decade. The reason for the lower relative liquidity of linkers globally has a lot to do with the product matching long-term needs better than nominals. Partly, the lower liquidity is the price of success for meeting specific needs so well, which means that much less day-to-day trading is needed. While liquidity is lower, a less frequent need to trade means that the relative cost of turnover is not that high. Nonetheless, liquidity is a concern that a new government issuer has to overcome in order to sell inflation-linked bonds at attractive levels. In addition, the issuance of inflation-linked bonds should not be viewed in isolation. For a sovereign with a very small debt, which needs to keep a liquid nominal market to help the overall market function and in case circumstances become less favourable, there is an argument for not issuing inflation-linked. This was the situation in Australia, where government supply ceased after 20 years in 2003, despite substantial domestic pension fund demand. In this case, increasingly active quasi- and non-government supply developed along with inflation swaps trading, with government issuance restarting in 2009 as funding needs rose.

One persistent criticism of governments issuing inflation-linked bonds is that any form of inflation indexation can be damaging in the long run. If bonds are linked to inflation, there will be increased pressure for other items to be linked to inflation, too. The danger is that if the cost of inflation is made less painful for individuals by widespread indexation, it may increase until it reaches levels that are once again painful. This line of reasoning was particularly prevalent in Germany, where, after multiple periods of hyper-inflation, it was made illegal during the period of the Deutsche mark for any debt to be indexed. While there is some evidence to support the risks of creeping inflation from widespread indexation, and countries such as Israel and Iceland have tried to wean themselves off indexation as a consequence, this is a long way from saying that it is the fault of inflation-linked bonds. There is no reason why bonds cannot be linked to inflation without general indexation elsewhere. It should be relatively easy for a government to keep financial funding and other price setting at arms' length. If monetary policy is independent and can respond to the inflationary effects of any indexation, the signalling benefit from inflation-linked bonds is likely to partially offset the inflationary bias.

An extension to the dangers of indexation is that if there is a substantial risk premium in inflation-linked bonds and the implied inflation rate in the market is used as a basis for agents' behaviour when setting prices and wages, there may be an inflationary bias created that is a negative social externality. On the other hand, appropriate monetary policy should be able to address this observable element, while the lower fiscal pressure resulting from a government funding with inflation bonds when there is a significant inflation risk premium ought to be deflationary.

Inflation Derivatives Products

INFLATION DERIVATIVES PRODUCTS

Inflation swaps and forwards

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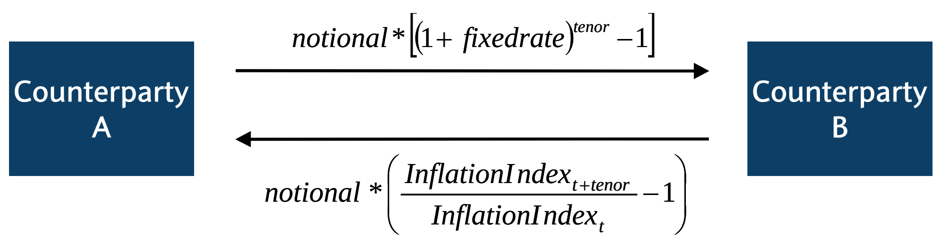
Zero coupon inflation swaps form the building blocks of the inflation derivatives market and are now established products used by an array of market participants. While their cash flow structure is very simple, their valuation is not always trivial. Other types of swaps exist, but they are priced off the more liquid zero coupon instruments.

Zero coupon inflation swaps

A zero coupon (ZC) inflation swap is a pure inflation instrument. Cash flows between the two parties in the transaction occur only at maturity and involve the exchange of a notional adjusted for inflation that has accrued over a specified time period against the notional capitalised with a fixed rate. The fixed rate, agreed at inception, reflects expected future inflation; it is therefore the "price" of expected inflation over the period of the swap and is quoted as an annualised rate. The leg depending on accrued inflation (referred to as the inflation, or the floating, leg) will vary solely on the basis of the final price index reference value at the end of the period of the swap. The cash flow on the fixed leg is predetermined by the quoted swap rate and is effectively a breakeven inflation rate; both parties will breakeven on the trade (ie, the net cash flow at maturity will be nil) only if annualised average inflation over the swap's period is equal to the initial fixed rate.

FIGURE 1

Zero-coupon inflation swap structure



Source: Barclays Research

One issue to be aware of is the potential confusion from the terminology used when inflation swaps are traded. Paying or receiving in inflation swap parlance normally relates to the inflation leg. The receiver/payer in an inflation swap will receive/pay accrued inflation and pay/receive the fixed rate. This is opposite to the convention in the nominal swap market where the receiver/payer is understood to receive/pay the fixed rate. Alternatively, a long/short position in an inflation swap implies receiving/paying inflation (ie, the floating element) versus paying/receiving the fixed leg, which is again the opposite of nominal swap parlance. Stating exactly which leg is being received and paid clears any confusion.

As with inflation-linked bonds, the inflation indexation mechanism in a swap is subject to a lag, although the lagging principles may differ from the bond market. For standard US CPI and FRCPIx (French CPI ex-tobacco) swaps, the price index reference value is calculated on the same three-month lag and interpolated principle as in their corresponding bond markets. For illustration, we consider a 10-year ZC US CPI swap traded on 20 May 2014. The start date from which inflation accrues on the swap is 22 May 2014, as the spot date is the trade date plus two business days. The price index reference value for 22 May 2014 is calculated as an interpolation between the February and March 2014 CPI values, in the exact same way as for US TIPS. The final price index reference date will be 22 May 2024, with the reference calculated as an interpolation between the February and March 2024 CPI values. For standard UK RPI and euro HICPx swaps, the lagging principles are notably different from the cash market as they trade on a non-interpolated basis, with a two-month lag in the UK and a three-month lag in the eurozone. This means a euro HICPx swap traded on any given day of a particular month will have the same starting index reference value, which will be the published index value three months prior. For example, all standard euro HICPx swaps traded during May 2014 pay inflation accruing from February 2014 – referred to as the base month. A 10y swap would therefore pay inflation from February 2014 to February 2024. In June 2014, the base month for all standard euro HICPx swaps shifts one month and changes to March 2014.

FIGURE 2

Illustrative term sheet for a Euro HICPx zero coupon inflation swap

Trade date	20-May-14
Swap start	22-May-14
Swap end	22-May-24
Notional amount (EUR)	EUR10 million
Payer of fixed rate coupon	Counterparty A
Fixed rate zero coupon	$(1+1.65\%)^{10}-1$
Coupon payment date	22 May 2024
Payer of euro HICPx coupon	Counterparty B
Euro HICPx zero coupon	(Euro HICPx Month End / Euro HICPx Month Start)-1
Month end	February 2024
Month start	February 2014
Reference rate	European HICP excluding Tobacco (NON REVISED)
Reference source	First publication by Eurostart as shown on Reuters OATEI01
First fixing	116.28
Coupon payment date	22 May 2024

Source: Barclays Research

The practical advantage of a non-interpolated convention is that a standard swap traded in a particular month can later be unwound and offset with a standard swap if the unwind date is in that same month. This is because the base month would not have changed. The convenience here in the unwind process is the transparency and tight bid-offers that standard screen-quoted swaps usually offer. As a result, the non-interpolated convention makes short-term “in-and-out” trading within the same month relatively easy. In the interpolated case, the fact that the index reference dates change every day implies that standard swaps on two different days will not be perfectly offsetting. The quoted market for non-interpolated swaps remains consistent during a month, which enables an easy reading of how the market is moving over that month. However, when the base month changes, it is important to note there is a discrete jump in quoted swap rates mainly because of seasonality. While there are no discrete jumps in interpolated swaps, the interpolation imposes a drift on quoted rates, which makes the interpretation of data relatively difficult.

The traded price indices in standard inflation swaps are naturally the same as for their corresponding bond markets. On the other hand, settlement dates may be different from bonds, as they are generally in line with nominal swap markets instead. In the UK, a t+0 settlement date is typical, while in the US and euro area, t+2 is standard. The settlement can be especially important when dealing with non-interpolated swaps. In particular, care should be taken when establishing new positions in euro swaps at the end of each month because it is possible that not all market quotes at this time will be on a consistent basis, with some quoting on the basis of a lag to the settlement date and others versus the execution date. Stating exactly which base month is being traded avoids confusion.

FIGURE 3

Conventions across the main zero coupon inflation swap markets

Index	CPI NSA	Euro HICPx	FRCPIx	UKRPI
Currency	USD	EUR	EUR	GBP
Interpolation method	Interpolated	Non-interpolated	Interpolated	Non-interpolated
Lag	2-3 months	3 months	2-3 months	2 months
Spot date	T+2	T+2	T+2	T+0
Calendar	NYB + London	Target	Target	London
Bloomberg Index codes	CPURNSA	CPTFEMU	FRCPXTOB	UKRPI

Source: Barclays Research

Building a CPI curve from zero coupon inflation swaps

Zero coupon inflation swaps provide the building blocks for the construction of a projected CPI curve from which other inflation-linked derivatives can be priced. On each trading day, annual tenor swap quotes effectively provide the projected increase in the price index from a start index reference date and over whole-year periods. However, unlike in nominal swaps, it is not sufficient to interpolate between annual points because interpolation assumes the price index will be growing at a constant rate over a year. This is unlikely given the seasonal behaviour of price indices. The second step therefore consists of an adjustment for the estimated seasonality during each month. We illustrate the calculations involved in constructing a projected CPI curve for Euro HICPx.

- Trade date: 4 May 2012
- Base index reference month: February 2012
- Euro HICPx for February 2012: 113.53
- 10y zero-coupon Euro HICPx swap: 2.12%
- 11y zero-coupon Euro HICPx swap: 2.16%

We want to calculate the projected Euro HICPx value for April 2022.

We first calculate:

Projected Euro HICPx for February 2022: 113.53*(1+2.12%)^10 = 140.02923…

Projected Euro HICPx for February 2023: 113.53*(1+2.16%)^11 = 143.61518…

We can therefore calculate the annual "trend" of inflation between February 2022 and February 2023. "ln" and "exp" below are the natural logarithm and exponential functions.

Trend = ln (143.61518…) – ln (140.02923…)

= 0.025286…

Using this annual trend, we calculate a first-stage projection for the April 2022 index value. We note that there are two months from February 2022 to April 2022.

First-stage projection April 2022 index = Projected index February 2022 * exp (Trend * 2/12)

= 140.02923 * exp (0.025256…*2/12)

= 140.62061…

This first stage approximation assumes the price index grows at a constant rate between February 2022 and February 2023, but this is unlikely to be the case given seasonality in monthly inflation.

We assume that percentage monthly seasonals for Euro HICPx are as below:

January	-0.96%	July	-0.58%
February	0.30%	August	-0.02%
March	0.91%	September	0.12%
April	0.20%	October	0.09%
May	0.01%	November	-0.13%
June	-0.13%	December	0.19%

We can now apply the adjustment for seasonality to the first-stage projection.

Projection for April 2022 euro HICPx = First stage projection * exp (March + April seasonals)

= 140.62061 * exp (0.91% + 0.20%)

= 142.1902….

Using the method above, the future euro HICPx index values can be projected for each month as far as zero coupon swap quotations allow. Once projections for future monthly index values are derived, future daily index references can also be calculated by interpolation in the same way as in bond markets. This is necessary, for instance, in the projection of a linker's future cash flows when performing asset swap calculations.

The detailed computation steps to construct a projected CPI curve are formalised in Figure 4 for a swap market that trades on a non-interpolated basis, as euro HICPx does for instance. For markets that trade on an interpolated basis (eg, FRCPIx and US CPI swaps), the base index reference will not necessarily correspond to a monthly point. In that case, a zero coupon rate will project a specific daily index reference, rather than the index value for a month. For example, on 2 May 2012, the base index reference for zero-coupon FRCPIx swaps corresponds to the daily index reference calculated for 4 May 2012. Therefore, a 10y and an 11y zero-coupon swap will give projections for the daily index reference of 4 May 2022 and 4 May 2023. To calculate projections between those two dates, the same principles as in the non-interpolated case (ie, the determination of an annual inflation trend and the application of a seasonal adjustment) apply, although the calculations steps would differ slightly.

FIGURE 4

Computation steps for constructing a projected CPI curve

We use the following notations:

CPI_0 : CPI index value for start index reference date

$PRCPI_t$: projected CPI for index reference date t years after the start reference date

$PRCPI_t^m$: projected CPI for index reference date t years and m months after the start reference date

ZC_t : quoted annualised ZC swap rate with maturity t years

MS_n : month-on-month seasonality, in %, of the month which is n month(s) after the start reference month

We have: $PRCPI_t = CPI_0 * (1 + ZC_t)^t$

To interpolate between $PRCPI_t$ and $PRCPI_{t+1}$, we can use a piece-wise flat interpolation method, whereby we calculate the annual trend rate of inflation between t and t+1 as:

$$\ln(PRCPI_{t+1}) - \ln(PRCPI_t)$$

We then approximate $PRCPI_t^m$, before applying the seasonality overlay, as:

$$PRCPI_t^m = CPI_0 * \exp\{ [\ln(PRCPI_{t+1}) - \ln(PRCPI_t)] * m / 12 \}$$

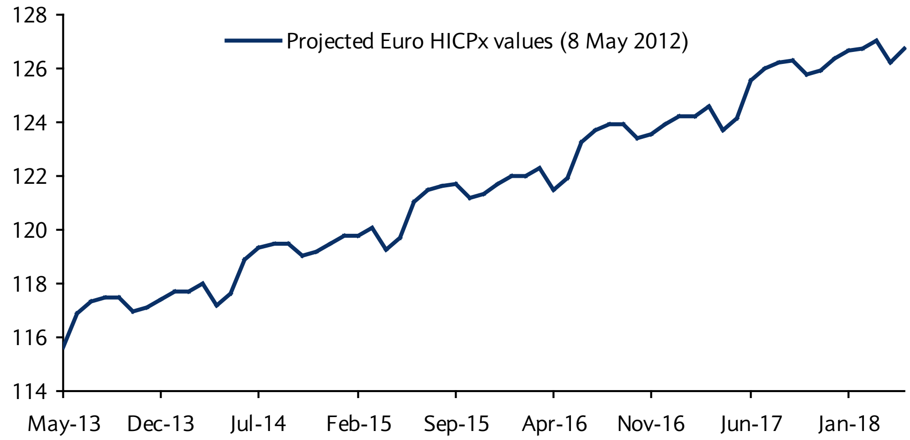
After applying the seasonality overlay, we have:

$$PRCPI_t^m = CPI_0 * \exp\{ [\ln(PRCPI_{t+1}) - \ln(PRCPI_t)] * m / 12 \} * \exp \sum_{n=1}^{m} MS_n$$

Due to the seasonality adjustment, the segments between two annual points on a projected CPI curve will not be straight lines but will have an oscillatory pattern. This is illustrated in Figure 5, where projected annual Euro HICPx values are computed from quoted Euro HICPx swaps on 2 May 2012 and intermediate values calculated via interpolation plus a seasonality overlay. From the projected CPI curve, a complete ZC swaps curve can be built by calculating the annualised rate of growth of the index from the starting reference date to each future reference date. The magnitude of the oscillation due to seasonality on the projected ZC curve will naturally decrease in longer maturities because the ZC rate is expressed as an annualised rate, as in Figure 5.

FIGURE 5

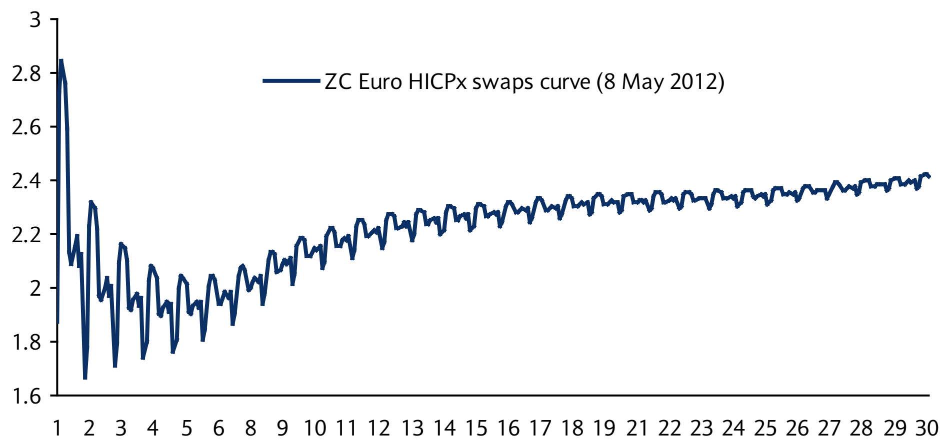
Projected euro HICPx values after interpolation and seasonality overlay



Source: Barclays Research

FIGURE 6

Euro HICPx swaps curve after interpolation and seasonality overlay



Source: Barclays Research

P&L on existing ZC swap positions

In a zero coupon inflation swap, the only unknown among the parameters determining the cash flows is the end index value reference. The unwind value of a zero-coupon inflation swap trade therefore varies essentially on the basis of changes in the projected index value for the final inflation reference date (although changes in the nominal discount factor may also have a small effect if the swap already has value). As an illustration, we assume a 5y ZC UK RPI swap traded in November 2009. This swap will pay inflation accreting from September 2009 to September 2014 versus an annualised fixed rate (breakeven rate). This rate can be used to compute the projected index value for September 2014 at inception date. If the swap is unwound at a later point in time, the new annualised rate corresponding to what the market is then pricing as inflation between September 2009 and September 2014 is needed. If the base month for standard ZC UK RPI swaps has changed, then this rate will not be readily available from market quotations. Therefore, the projected index value for September 2014 may need to be computed using an interpolation plus seasonality overlay method analogous to the one detailed above. The difference between the notional inflated using the new projected index value for September 2014 and using the projection at inception date gives the expected future net cash flow at maturity of the swap. This expected cash flow is then discounted by a zero coupon nominal discount factor to give the current value of the swap position. Figure 7 details the computation steps for the P&L calculation.

FIGURE 7

P& calculation on a seasoned ZC inflation swap position

Trade date: 17 November 2009

Index traded: UK RPI
Tenor: 5y
5y ZC swap rate: 3.15%
Notional: £ 100mln

Base month on standard swaps on trade date: September 2009
Published September 2009 UK RPI value: 215.3

Swap pays inflation accruing from September 2009 to September 2014

Projected index value for September 2014 at trade date = 215.3 * (1.0315^5)
= 251.41 (rounded 2dp)

<u>Trade unwind date: 11 December 2009</u>

At the unwind date, we have:

Base month on standard swaps: October 2009
Published September 2009 UK RPI value: 216

4y ZC swap rate: 3.05%
5y ZC swap rate: 3.13%

Projected index value for October 2013 = 216 * (1.0305^4)
= 243.58 (rounded 2dp)

Projected index value for October 2014 = 216 * (1.0313^5)
= 251.99 (rounded 2dp)

Trend rate of inflation between October 2013 and October 2014 = ln (251.99) – ln (243.58)
= 3.392% (rounded)

We assume the following m/m seasonality vector:

January	-0.574%	July	-0.173%
February	0.080%	August	-0.013%
March	0.094%	September	-0.068%
April	0.594%	October	-0.027%
May	0.279%	November	-0.392%
June	0.116%	December	0.083%

At the trade unwind date, the projected index value for September 2014:

= Projected index value for October 2013 * exp (Trend inflation * 11/12) * exp (November + December +…..+ September m/m seasonal)
= 243.58 * exp (3.392% * 11/12) * exp (-0.392% + 0.083% +….-0.068%)
= 251.34

This is equivalent to working backwards from the projected index value for October 2014:

Projected index value for September 2014 = {Projected index value for October 2014/ exp (Trend inflation/12)} / exp (October m/m seasonal)
= {251.99/exp (3.392%/12)} / exp (-0.027%)
= 251.34

To calculate the P&L on the position, we compare the notional capitalised on the basis of the two projections for the September 2014 index value.

Notional capitalised using projection on trade date = (Projected index value for September 2014 on trade date / September 2009 index value) * Notional
= (251.41/215.3) * £100mn
= £116.774mn

Notional capitalised using projection on unwind date = (Projected index value for September 2014 at unwind date / September 2009 index value) * Notional
= (251.34/215.3) * £100mn
= £116.741mn

The capitalised notionals calculated correspond to the cash flows at maturity on the fixed leg of a swap paying inflation from September 2009 to September 2014.

The difference in the cash flows is -£32922. This has to be discounted to the trade unwind date by the zero coupon discount factor, which is about 0.86. This means that if one goes long inflation on the 5y swap on 17 November 2009 and unwinds it with an equivalent swap, the P&L (excluding transaction costs) would be -£32,922 times 0.86 – ie, -£28,314.

Risk on ZC swap positions

By definition, the fixed rate of a ZC inflation swap is set at inception such that the value of the swap is nil. Hence, at inception, the swap has no sensitivity to the nominal discount factor – ie, zero nominal DV01 (delta value of 1bp). On the other hand, the position will be sensitive to changes in the ZC inflation swap rate; this sensitivity is known as the inflation DV01. We consider the following:

5y ZC euro HICPx swap traded on 2 May 2012, with settlement on 4 May 2012 and a notional of €25mn. We assume it is a long position in the swap – ie, inflation is received.

Fixed rate of swap: of 2.05%.

The cash flows on that transaction will occur on 4 May 2017. We assume the nominal discount factor for a cash flow occurring on that date is 0.95.

At inception, by definition, the projected value of the cash flow on the leg that depends on inflation is equivalent to that of the fixed leg and is given by: $[(1+2.05\%)^5-1]$*€25 million = €2,669,738. Its present value is given by: €2,669,738 * 0.95 = €2536251.

Given that the value of the swap is nil at inception (both projected cash flows are expected to be the same), its value has no sensitivity to the changes in the nominal discount factor. Thus, the nominal DV01 is nil.

We assume the fixed rate on a 5y swap increases 1bp to 2.06% just after the inception of the swap. This means that the market has changed the projected value of the cash flow on the leg that depends on inflation. The new projected value is given by: $[(1+2.06\%)^5-1]$*€25 million = €2,683,298. The cash flow (profit) that is now expected to be received at maturity is no longer nil and is equal to €2,683,298 minus €2,669,738 – ie, €13,560. The present value of that expected profit is €13,560*0.95 = €12,882.

Therefore, the inflation of the position is equal to €12,882; this is the change in the value of the swap if zero-coupon swap rates move by 1bp. The DV01 can also be calculated for a 1bp move lower, in which case the value of the swap would change by -€12,876, with the absolute value very close to the +1bp case. When a swap starts to acquire value, then it is clear that it starts to have some nominal sensitivity. For example, if the nominal discount factor curve is bumped by 1bp, then the €13,560 will be discounted by a different rate such that value of the swap will change.

A seasoned swap trade is likely to have acquired value, for instance because breakevens have changed or because realised inflation levels have been different from the levels implied by the swap at inception. To determine the inflation DV01 on a seasoned trade, the same principle as above is applied. The zero coupon swaps curve is bumped by 1bp. A new end index reference value is projected for the swap, and the value of the swap is calculated under this new projection. For seasoned trades that have acquired significant value, the nominal DV01 may not be negligible, although, in general, this nominal duration is usually a minor second-order consideration.

Zero coupon real rate swaps

While in a ZC inflation swap the cash flow only depends on the traded breakeven level and final inflation print, a real rate swap involves a real, inflation-linked, cash flow versus a floating leg – for example, a compounded Libor rate. In most developed markets, the majority of investors choose to separate decisions on nominal duration and inflation exposure even though most liabilities are in a real format, although real rate swaps do also trade. In most emerging markets, real rate swaps are much more commonly quoted than inflation swaps. Real rate swaps are usually quoted in a zero coupon format in markets in which ZC inflation swaps are established but can also trade in a coupon format in most of these markets.

The effective duration of a ZC real rate swap is relatively long because the appropriate discount factor is real rather than nominal. Generally, investors matching liabilities who trade real rates will mostly trade ZC, but value investors, particularly those concerned about convexity of forward positions, often trade real rate swaps with fixed real rate coupons. In Latin America, almost all single-currency real rate swap activity is in coupon form. The parallel currency format of Latin American linker markets other than Brazil makes this kind of position, a quasi-cross currency swap, relatively straightforward.

Forward zero coupon inflation swaps

Forward inflation swaps, here understood as the forward between two maturities on the curve, can be calculated from spot market levels and are traded in the most liquid markets. Forwards provide a measure of the market's expectations for inflation beyond the short term and are an important element in the analytical framework or the most developed inflation markets. Market-based measures of five-year inflation in five years time are in particular closely watched, having been referenced explicitly by central bankers in the US and the euro area. In the US, the liquidity and definition of the bond breakeven curve make it relatively easy to bootstrap and derive measures of forward inflation. However, maturity gaps in the linker curves of other markets mean that it is less straightforward elsewhere. In the euro area for instance, the existence of several issuers also means that breakevens are not always comparable because their valuations may be biased by the credit rating of the relevant issuers. Thus, measures of forward inflation there are typically analysed in the swaps market. Also, other considerations such as liquidity apart, swaps are a more natural instrument to look at forward inflation pricing than bonds because the commonly traded structure in inflation swaps is a zero coupon one, such that a 'clean' forward rate can be bootstrapped from the curve without any distortion from coupon payments.

The generic formula to calculate an inflation swap rate with a tenor S, at a forward date F is:

$$\sqrt[S]{\frac{(1+Y)^{F+S}}{(1+X)^{F}}}-1$$

Where: Y is the zero-coupon rate for a spot starting swap of tenor F+S

X is the zero-coupon rate for a spot starting swap of tenor F

Alternatively, expressed in terms of CPI Index values, the above formula can be rewritten as:

$$\sqrt[S]{\frac{E(CPI_{F+S})}{E(CPI_{F})}}-1$$

Where: $E(CPI_{F+S})$ is the expected value of the CPI Index in F+S years

$E(CPI_{F})$ is the expected value of the CPI Index in F years

However, the above formula is not equivalent to the strict theoretical computation for a forward rate. If expressed in CPI values, the forward rate is theoretically expressed as:

$$\sqrt[S]{E\left(\frac{CPI_{F+S}}{CPI_{F}}\right)}-1$$

In other words, the theoretical computation of a forward inflation swap rate is related to the expectation of the ratio of future CPI values. The generic formula, on the other hand, computes a ratio of expectations. Mathematically, they are not equivalent given that the future CPI values are not independent variables. A convexity adjustment therefore needs to be applied to the 'naïve' forwards calculated from the generic formula. The need for this adjustment is evident when pricing y/y structures that are effectively portfolios of instruments priced from forward starting swaps. Caps and floors on inflation are such instruments. In their market model for inflation, Belgrade, Benhamou and Koehler provide a convexity adjustment formula when computing the forward value of the CPI ratio.

For an intuitive grasp of the notion of convexity in forward inflation swaps, we look at the dynamic hedging of a forward swap position. We assume a 5y5y forward swap trade in which an end user goes long inflation (ie, pays the compounded quoted fixed rate and receives accrued inflation at maturity). The other counterparty (typically a bank) will hedge the 5y5y forward position through a combination of 5y and 10y zero coupon inflation swaps at the inception of the trade; the hedge will be a long position in 10y and a short position in 5y swaps. By definition, a forward starting swap should have no accretion from realised inflation before the forward date. Therefore, the notional on the 5y and 10y swaps should be equal to immunise the inflation accretion before the forward date. While this may seem straightforward, the delicate element is setting the initial notional on the swaps. Assuming a €100mn notional on the 5y5y trade and positive inflation over the five years preceding the forward start date of the swap, then setting the notionals on the 5y and 10y at €100mn is likely to result in overexposure to the 5y5y forward rate. After five years, the initial 5y swap would have expired, but the initial 10y swap will effectively have a remaining term of five years and its notional will have accrued with actual inflation and risen above the €100mn that needs to be hedged. Hence, if positive inflation is expected over the first five years, the notional on the swaps in the hedge portfolio should be set at less than €100mn. The €100mn notional of the forward swap therefore needs to be discounted with inflation that is expected over the initial 5y forward horizon. In practice, the 5y zero coupon inflation rate at inception serves as the best guess for this expected inflation. However, unless actual inflation proves to be equal to the expected inflation, the notional will still need to be rebalanced if inflation overshoots or undershoots initial expectations. This rebalancing mechanism illustrates the convexity effect at work.

Let us assume that after inception of the hedging strategy, inflation is effectively significantly higher than initially discounted. This would point to a potential over-hedge at the end of the forward horizon. The hedger will therefore need to reduce the notional on the 5y and 10y swaps by effectively unwinding part of the hedge. The likelihood is that the unwind will be done at a profit, excluding transaction costs, given that breakevens tend to rise with higher-than-expected inflation. Assuming a higher breakeven curve, a profit will be made on the partial unwind of the 10y swap, but a loss will be made on the 5y leg. However, given the higher inflation PV01 of the 10y leg, the net effect should be a profit unless the curve flattens significantly and/or the discount factor on the longer swap is significantly lower. On the other hand, if actual inflation undershoots initial expectations, then the notional on the hedge will need to be increased. In this case of lower-than-expected inflation, the breakeven curve will tend to move lower, which implies that the increase in the hedge notional is likely to be done at cheaper than initial levels. In this case, too, this is positive for the hedger. Hence, there is a positive convexity effect in hedging a short position in forward inflation swaps. This effect comes from the likely positive correlation between actual inflation and expected inflation (ie, breakevens). If this convexity is passed on to the buyer of forward inflation, then the quoted forward rate should be lower than what is implied by the 'naïve' forward. Obviously, this convexity effect will work the other way around for a seller of forward inflation.

It is, however, difficult to re-adjust a hedge portfolio frequently to take into account the convexity effect, given that the magnitude of the latter tends to be relatively small compared with bid/offer spreads on swaps. Typically, because of transaction costs, rebalancings due to convexity are rarely done more than once a year.

Although the hedging of a forward swap position may not be straightforward conceptually, taking positions is relatively easy in the developed swaps markets. What is effectively traded is a fixed rate against the inflation measured by the change in the index reference between two dates. The difference relative to a normal spot starting swap is that, in the forward case, the base index reference for the swap is also unknown. Therefore, the mark-to-market value of the forward swap over its life is determined by the projection of two index references. Risk measures are also determined by taking into account the fact that the inflation leg is determined implicitly by two unknown elements. Nevertheless, the mark-to-market or risk calculations principles are similar to the spot case.

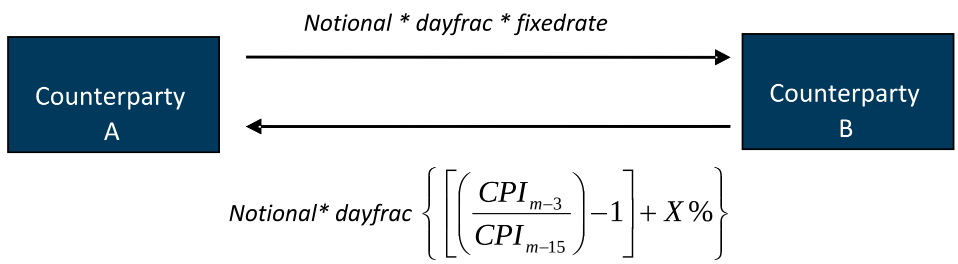
Forward positions are directional ones, with an added exposure to the curve, as in the nominal rates space. This is obvious from the generic forward formula above. Other things being constant, an inflation swap with a tenor of S years, starting in F years, has a positive sensitivity to the spot swap rate with a S+F year tenor. This is the directional element. Although the sensitivity to the curve is less straightforward formulaically, a steepening/flattening curve move will tend to increase/decrease the forward rate. Hence, the best configuration to enter a long/short forward trade is when bullish/bearish expectations are blended with a steepening/flattening view. However, given that the slope of the curve tends to be inversely related to the level of breakevens, the directional element has historically been the strongest driver of forward swaps. Forward strategies therefore seem better suited to fade unjustified relative value distortions on the curve rather than targeting curve slope moves.

Year-on-year inflation swaps

A format of inflation swap that used to be widely quoted in many markets but is now less common is the year-on-year (y/y) structure. This used to be the standard format for swapped corporate inflation-linked bonds sold to investors for whom the back-ended cash flows of government-style issues were not tax efficient and, hence, was more prevalent than the zero structure in the early days of the euro market. The y/y structure involves one counterparty agreeing to receive an annual coupon determined by the y/y rate of inflation in return for paying a fixed rate. The fixed rate is the quoted rate and is analogous to a breakeven inflation, although not in as pure a sense as in a ZC format. The yearly inflation period lags the payment dates in a way similar to the zero structure. In the US, y/y inflation swaps tend to be quoted in the monthly cash flow format, as this is the most tax-friendly structure, whereas in Europe the cash flow frequency is normally annual. Sometimes, the non-inflation leg of the swap will be floating Libor with a spread rather than a fixed rate.

FIGURE 8

Year-on-year inflation swap periodic payments



Source: Barclays Research

Although not quoted nearly as much on dealer screens as the zero-coupon structure, indicative y/y rates are easily derivable from the zeros in the same way as coupon interest rates from zero-coupon interest rates. For longer maturities, convexity distortions can become relatively large, but most structured notes are quite short. The most common use of the y/y swap remains for hedging structured products, both new exposure and unwinds of old bonds that have been sold back to issuing banks. The floating leg of a y/y inflation swap is equivalent to a collection of consecutive forward inflation rates; therefore, the y/y structure can be useful for hedging inflation caps and floors, either on a stand-alone basis or as features within structured products.

INFLATION DERIVATIVES PRODUCTS

Linker asset swaps

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Linker asset swaps are structured in a format similar to conventional bonds, but their valuation is less straightforward. We present a detailed calculation methodology for common asset swap metrics and full worked examples. Discounting is now a significant consideration for asset swap valuation; we present examples of self-discounting and OIS discounting for comparison.

Asset swapping connects inflation-linked bond and swap markets. The appetite for linker asset swaps typically stems from the fact that they often offer a pickup relative to equivalent nominal bonds. An inflation-linked asset swap is a transaction in which the cash flows on the linker are exchanged against Libor-based cash flows. The pricing principles of a linker asset swap are similar to a nominal bond. However, there is an extra step in the calculations for a linker, as the future cash flows, coupon and principal repayment at maturity are inflation-linked and therefore unknown; they need to be projected. As stated in "Inflation swaps and forwards", zero coupon inflation swaps are used to project future values of the CPI and daily index references. This projected curve can then be used to project the linker's future cash flows. The asset swap spread, which is a fixed spread applied to the Libor cash flows, is then determined such that the present value of the whole structure at the start is nil. Linker asset swaps trade in two main formats: par-par and proceeds. The z-spread asset swap is non-tradable but is a better relative value measure than par-par and proceeds.

Par-par asset swap

In a par-par asset swap, the investor implicitly pays par for the bond and pays out all the bond's cash flows to the other party. The floating leg is Libor plus a spread, paid on par, with par also received at maturity. The cash flow components can be broken down as follows:

At inception: The investor buys the bond at a settlement price equal to par (100). This means that the deviation of the market settlement price (inclusive of accrued interest and inflation uplift) P from par has to be factored in. If, for example, P is above 100, it is treated as a positive cash flow for the investor at the start.

Over the life of the bond: The investor receives Libor plus a spread on par and pays out the coupon payments from the bond.

At maturity: The investor pays out the inflation-uplifted principal on the bond and receives par, the notional of the swap.

If the principal at maturity has a deflation floor, it is assumed that the value of the floor is subtracted in the calculations from the price P above.

From the point of view of the investor (and therefore for the counterparty), the total present value of all the cash flows above must sum to zero, and the spread to Libor is adjusted so that this condition is respected. The present values of the different cash flows are:

1. P - Floor value - 100 (at inception)
2. $\sum_i \left(Libor_i + PP\ ASW\right) * DCF_i * df_i$, where $Libor_i$ corresponds to the projected Libor fixings, PP ASW is the par-par asset swap spread, DCF_i is the day-count factor applying to Libor payments and df_i is the discount factor giving the present value of each Libor payment.

3. $-\sum_j C * IR_j * df_j$, where C is the coupon before inflation adjustment and IR_j corresponds to the projected index ratios on coupon payment dates.

4. $-100 * IR_M * df_M$, corresponds to the present value of the projected inflation-adjusted principal paid out at maturity. This can be floored at par.

5. $100 * df_M$ corresponds to the present value of par being received back at maturity.

The frequency of cash flows from the linker will not necessarily be the same as for the swap leg.

PP ASW is then derived from the equation:

P- Floor value - 100 +

$$\sum_i 100 * \left(Libor_i + PP\ ASW\right) * DCF_i * df_i - \sum_j C * IR_j * df_j$$

$$-100 * IR_M * df_M + 100 * df_M = 0$$

In the past, it was very common to use same curve to project Libor-based flows and calculate discount factors (self-discounting). This is usually not the case now, with the discounting assumption usually dependent on the collateral agreement between the two counterparties. Figure 1 illustrates par-par asset swap calculations on the BTP€i24. The value of the floor at maturity is taken into account. We calculate the asset swap under a self-discounting and an OIS-discounting assumption. The par-par asset swap is not a particularly logical calculation to use for inflation-linked bonds, which will tend to deviate from nominal par over their lifetime as they gain inflation accretion, but it is relatively straightforward and became convention in the euro area when most asset swaps were on short maturity bonds with limited history. Implicitly, a par-par asset swap does not consider fully the underlying investment risk on the linker.

FIGURE 1

Par par asset swap calculation for BTP€i24

Bond cash flow dates	Real coupon	Real notional	Projected CPI index from inf swaps	Projected Index ratio	Projected bond flows	Discount factor (6m Euribor)	Discount factor (OIS)	Swap leg dates	Forward 6m par Euribor rate	Day count fraction	Discount factor (6m Euribor)	Discount factor (OIS)
15/09/2014	1.175%		117.17	1.004	1.180%	0.9986	0.9997	15/09/2014	0.47%	0.289	0.9986	0.9997
15/03/2015	1.175%		117.33	1.006	1.182%	0.9971	0.9995	16/03/2015	0.30%	0.506	0.9971	0.9995
15/09/2015	1.175%		118.27	1.014	1.191%	0.9956	0.9993	15/09/2015	0.30%	0.508	0.9956	0.9993
15/03/2016	1.175%		118.40	1.015	1.192%	0.9938	0.9989	15/03/2016	0.37%	0.506	0.9938	0.9989
15/09/2016	1.175%		119.49	1.024	1.203%	0.9913	0.9980	15/09/2016	0.49%	0.511	0.9913	0.9980
15/03/2017	1.175%		119.78	1.027	1.206%	0.9881	0.9963	15/03/2017	0.64%	0.503	0.9881	0.9963
15/09/2017	1.175%		121.11	1.038	1.220%	0.9838	0.9937	15/09/2017	0.85%	0.511	0.9838	0.9937
15/03/2018	1.175%		121.54	1.042	1.224%	0.9786	0.9901	15/03/2018	1.07%	0.503	0.9786	0.9901
15/09/2018	1.175%		123.01	1.054	1.239%	0.9722	0.9855	17/09/2018	1.28%	0.517	0.9722	0.9855
15/03/2019	1.175%		123.49	1.058	1.244%	0.9650	0.9799	15/03/2019	1.49%	0.497	0.9650	0.9799
15/09/2019	1.175%		125.10	1.072	1.260%	0.9568	0.9733	16/09/2019	1.68%	0.514	0.9568	0.9733
15/03/2020	1.175%		125.74	1.078	1.266%	0.9478	0.9658	16/03/2020	1.87%	0.506	0.9478	0.9658
15/09/2020	1.175%		127.38	1.092	1.283%	0.9380	0.9574	15/09/2020	2.05%	0.508	0.9380	0.9574
15/03/2021	1.175%		128.09	1.098	1.290%	0.9276	0.9483	15/03/2021	2.22%	0.503	0.9276	0.9483
15/09/2021	1.175%		129.81	1.113	1.307%	0.9165	0.9384	15/09/2021	2.37%	0.511	0.9165	0.9384
15/03/2022	1.175%		130.71	1.120	1.316%	0.9051	0.9280	15/03/2022	2.50%	0.503	0.9051	0.9280
15/09/2022	1.175%		132.58	1.136	1.335%	0.8932	0.9170	15/09/2022	2.62%	0.511	0.8932	0.9170
15/03/2023	1.175%		133.53	1.145	1.345%	0.8811	0.9058	15/03/2023	2.73%	0.503	0.8811	0.9058
15/09/2023	1.175%		135.62	1.162	1.366%	0.8686	0.8942	15/09/2023	2.81%	0.511	0.8686	0.8942
15/03/2024	1.175%		136.69	1.172	1.377%	0.8562	0.8825	15/03/2024	2.88%	0.506	0.8562	0.8825
15/09/2024	1.175%	100%	138.93	1.191	120.480%	0.8435	0.8704	16/09/2024	2.94%	0.514	0.8435	0.8704

		6m Euribor	OIS
A	PV (bond flows)	125.478%	129.102%
B	PV (swap flows)	15.655%	16.003%
C	PV (par)	84.350%	87.040%
D	ΣDCF.df	9.829	9.993
E	Settlement price , P	106.458%	106.458%
F	Floor value	0.346%	0.346%
(A-B-C-E+F+100)/D	Par Par ASW (bp)	197.0	199.6

Source: Barclays Research

Proceeds asset swap

In a proceeds asset swap, the investor buys the linker at the market settlement price (ie, inclusive of accrued interest and inflation uplift) P, and the notional on the swap is equal to P. Therefore, at inception, there is no deviation from the price P to take into account. The present values of the different cash flows on the transaction are therefore:

1. Floor value (note: UK linkers do not have a deflation floor)
2. $\sum_i P * (Libor_i + PR\,ASW) * DCF_i * df_i$, where $Libor_i$ corresponds to the projected Libor fixings, PR ASW is the proceeds asset swap spread, DCF_i is the day-count factor applying to Libor payments and df_i is the discount factor giving the present value of each Libor payment.
3. $-\sum_j C * IR_j * df_j$, where C is the coupon before inflation adjustment and IR_j corresponds to the projected index ratios on coupon payment dates.
4. $-100 * IR_M * df_M$ corresponds to the present value of the projected inflation-adjusted principal paid out at maturity. This can be floored at par.
5. $P * df_M$ corresponds to the present value of par being received back at maturity.

PR ASW is then derived from the equation:

$$\text{- Floor value} + \sum_i P * (Libor_i + PR\,ASW) * DCF_i * df_i - \sum_j C * IR_j * df_j$$

$$-100 * IR_M * df_M + P * df_M = 0$$

Proceeds asset swap spreads are generated in a similar manner to par-par calculations, with some minor differences. In a proceeds spread, there is no exchange of cash flows upfront, as the swap notional is set to be equal to the bond's dirty price. Therefore, the biggest difference is that the bond premium or discount (P-100) must be discounted from the maturity date, reflecting the fact that the swap notional will be different from 100 at the final maturity of the asset swap. Proceeds asset swaps avoid any issues with historical accretion and, hence, are more appropriate for markets in which bonds have been accreting inflation for years. This was the case for most TIPS when asset swapping became a feature of US inflation markets, particularly in the UK, where many 8m lag issues have been accruing inflation since the 1980s. A par-par asset swap tends to exaggerate the value of the asset swap for a bond trading above par, which bonds with inflation accretion will usually be. For comparison, we consider the proceeds asset swap on the same BTP€i24 below, although this bond would normally trade in a par-par format.

FIGURE 2

Proceeds asset swap calculation for BTP€i24

Bond cash flow dates	Real coupon	Real notional	Projected CPI index from inf swaps	Projected Index ratio	Projected bond flows	Discount factor (6m Euribor)	Discount factor (OIS)	Swap leg dates	Forward 6m par Euribor rate	Day count fraction	Discount factor (6m Euribor)	Discount factor (OIS)
15/09/2014	1.175%		117.17	1.004	1.180%	0.9986	0.9997	15/09/2014	0.47%	0.289	0.9973	0.9992
15/03/2015	1.175%		117.33	1.006	1.182%	0.9971	0.9995	16/03/2015	0.30%	0.506	0.9971	0.9995
15/09/2015	1.175%		118.27	1.014	1.191%	0.9956	0.9993	15/09/2015	0.30%	0.508	0.9956	0.9993
15/03/2016	1.175%		118.40	1.015	1.192%	0.9938	0.9989	15/03/2016	0.37%	0.506	0.9938	0.9989
15/09/2016	1.175%		119.49	1.024	1.203%	0.9913	0.9980	15/09/2016	0.49%	0.511	0.9913	0.9980
15/03/2017	1.175%		119.78	1.027	1.206%	0.9881	0.9963	15/03/2017	0.64%	0.503	0.9881	0.9963
15/09/2017	1.175%		121.11	1.038	1.220%	0.9838	0.9937	15/09/2017	0.85%	0.511	0.9838	0.9937
15/03/2018	1.175%		121.54	1.042	1.224%	0.9786	0.9901	15/03/2018	1.07%	0.503	0.9786	0.9901
15/09/2018	1.175%		123.01	1.054	1.239%	0.9722	0.9855	17/09/2018	1.28%	0.517	0.9721	0.9854
15/03/2019	1.175%		123.49	1.058	1.244%	0.9650	0.9799	15/03/2019	1.49%	0.497	0.9650	0.9799
15/09/2019	1.175%		125.10	1.072	1.260%	0.9568	0.9733	16/09/2019	1.68%	0.514	0.9567	0.9732
15/03/2020	1.175%		125.74	1.078	1.266%	0.9478	0.9658	16/03/2020	1.87%	0.506	0.9478	0.9658
15/09/2020	1.175%		127.38	1.092	1.283%	0.9380	0.9574	15/09/2020	2.05%	0.508	0.9380	0.9574
15/03/2021	1.175%		128.09	1.098	1.290%	0.9276	0.9483	15/03/2021	2.22%	0.503	0.9276	0.9483
15/09/2021	1.175%		129.81	1.113	1.307%	0.9165	0.9384	15/09/2021	2.37%	0.511	0.9165	0.9384
15/03/2022	1.175%		130.71	1.120	1.316%	0.9051	0.9280	15/03/2022	2.50%	0.503	0.9051	0.9280
15/09/2022	1.175%		132.58	1.136	1.335%	0.8932	0.9170	15/09/2022	2.62%	0.511	0.8932	0.9170
15/03/2023	1.175%		133.53	1.145	1.345%	0.8811	0.9058	15/03/2023	2.73%	0.503	0.8811	0.9058
15/09/2023	1.175%		135.62	1.162	1.366%	0.8686	0.8942	15/09/2023	2.81%	0.511	0.8686	0.8942
15/03/2024	1.175%		136.69	1.172	1.377%	0.8562	0.8825	15/03/2024	2.88%	0.506	0.8562	0.8825
15/09/2024	1.175%	100%	138.93	1.191	120.480%	0.8435	0.8704	16/09/2024	2.94%	0.514	0.8434	0.8703

		6m Euribor	OIS
A	PV (bond flows)	125.478%	129.102%
B	PV (swap flows)	15.655%	16.003%
C	PV (proceeds)	89.798%	92.661%
D	ΣDCF.df.P	10.464	10.638
E	Settlement price, P	106.458%	106.458%
F	Floor value	0.346%	0.346%
(A-(B*E)-C+F)/D	Proceeds ASW (bp)	181.7	182.7

Source: Barclays Research

Z-spread asset swap

Neither par-par nor proceeds asset swaps are an ideal valuation measure to compare inflation swaps with bonds. The back-ended cash flows of inflation-linked bonds mean that the value of a floating basis point now is less than that of an inflation-linked bond discounted on its own real yield curve. Hence, a 1bp change in real yield moves the linker asset swap by more than a basis point in either of these methodologies. Deviations of asset swap levels away from Libor flat will tend to become more distorted the longer the maturity of the linker. In an extreme case, a 50y bond may have an expected average principal in present value terms about twice its current level; hence, a 1bp move in the real yield of the bond with no move in the inflation swap curve would move the asset swap about 2bp. It is, thus, relatively difficult to compare asset swap levels across inflation-linked bonds and particularly difficult to compare them with asset swap levels of nominal bonds. For this reason, we prefer to use a z-spread asset swap methodology for assessing relative value.

Z-spread asset swaps are a widely used analytical tool within nominal bonds to smooth out micro distortions and compare relative value, but they are more important for linkers because the distortions are notably larger. The calculation of the z-spread asset swap is done so that, by construction, a 1bp change in the real yield of the bond will move the asset swap 1bp as well. A z-spread asset swap spread between a nominal and an inflation-linked bond thus provides a consistent measure to the richness of bond versus swap breakevens at that maturity. The calculation involves taking the cash flows of a linker in a similar way to a proceeds asset swap and calculating their present value. The next step is to adjust the uplift factor affecting the bond cash flows iteratively in a parallel fashion until the present value matches that of the same cash flows priced from the swap leg. The amount that the swap curve has to be changed to match the value of the bond cash flows is the z-spread asset swap. It will be narrower than asset swaps calculated by the other methods, substantially so in the case of long maturity bonds. An example of a z-spread calculation is trivial to construct in Excel using the solver function to equalise the value of the discounted bond flows with the settlement price of the bond. However, the results of this method can be biased by rounding errors; as such, the discounted value of the bond cash flows may not match the dirty price exactly.

FIGURE 3

Z-spread asset swap calculation for BTP€i24

Bond cash flow dates	Real coupon	Real notional	Projected CPI index from inf swaps	Projected Index ratio	Projected bond flows	Discount factor (6m Euribor)	Discount factor (OIS)	Discount factor from bumped curve (6m EUR)	Discount factor from bumped curve (OIS)
15/09/2014	1.175%		117.17	1.004	1.180%	0.9986	0.9997	0.9936	0.9938
15/03/2015	1.175%		117.33	1.006	1.182%	0.9971	0.9995	0.9835	0.9833
15/09/2015	1.175%		118.27	1.014	1.191%	0.9956	0.9993	0.9732	0.9729
15/03/2016	1.175%		118.40	1.015	1.192%	0.9938	0.9989	0.9628	0.9624
15/09/2016	1.175%		119.49	1.024	1.203%	0.9913	0.9980	0.9519	0.9515
15/03/2017	1.175%		119.78	1.027	1.206%	0.9881	0.9963	0.9405	0.9401
15/09/2017	1.175%		121.11	1.038	1.220%	0.9838	0.9937	0.9282	0.9279
15/03/2018	1.175%		121.54	1.042	1.224%	0.9785	0.9901	0.9151	0.9150
15/09/2018	1.175%		123.01	1.054	1.239%	0.9722	0.9855	0.9011	0.9012
15/03/2019	1.175%		123.49	1.058	1.244%	0.9649	0.9799	0.8865	0.8869
15/09/2019	1.175%		125.10	1.072	1.260%	0.9567	0.9733	0.8712	0.8717
15/03/2020	1.175%		125.74	1.078	1.266%	0.9477	0.9658	0.8554	0.8561
15/09/2020	1.175%		127.38	1.092	1.283%	0.9379	0.9574	0.8390	0.8397
15/03/2021	1.175%		128.09	1.098	1.290%	0.9274	0.9483	0.8224	0.8232
15/09/2021	1.175%		129.81	1.113	1.307%	0.9163	0.9384	0.8053	0.8061
15/03/2022	1.175%		130.71	1.120	1.316%	0.9048	0.9280	0.7882	0.7890
15/09/2022	1.175%		132.58	1.136	1.335%	0.8928	0.9170	0.7708	0.7715
15/03/2023	1.175%		133.53	1.145	1.345%	0.8806	0.9058	0.7537	0.7542
15/09/2023	1.175%		135.62	1.162	1.366%	0.8681	0.8942	0.7364	0.7367
15/03/2024	1.175%		136.69	1.172	1.377%	0.8555	0.8824	0.7194	0.7195
15/09/2024	1.175%	100%	138.93	1.191	120.480%	0.8428	0.8704	0.7023	0.7023

PV	125.389%	129.100%	
Settlement price	106.458%	106.458%	
Calculated z-spread	177.1	208.5	bp
PV (bumped curve)	106.458%	106.458%	

Source: Barclays Research

Calculating carry and roll-down on a proceeds ASWs position

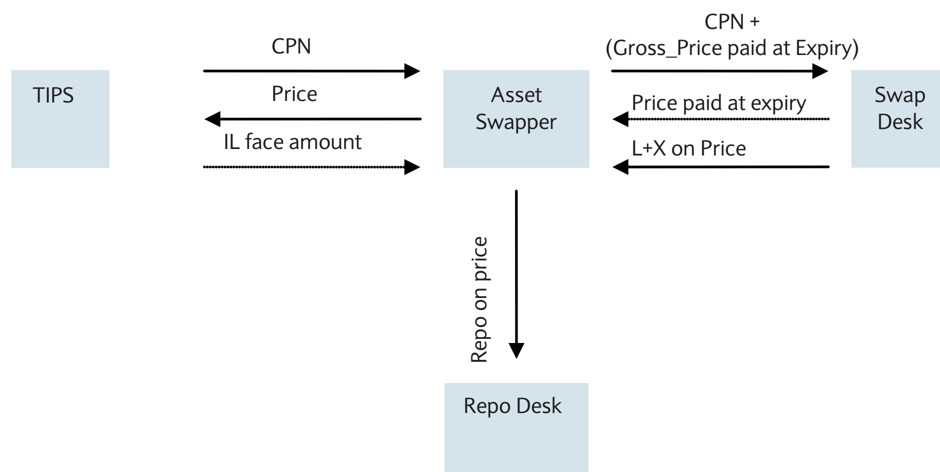
In Figure 4, we provide an example of calculating effective carry on a TIPS proceeds ASW position. Carry on a position is the benefit less the cost of holding the position. To understand the carry/roll-down implications for any given period, one needs to observe the relative flows from an asset swapper's perspective (also see Figure 4).

From the perspective of proceeds asset swapper:

1. Buy an inflation-linked bond
2. Finance at the funding cost (account for repo, collateral agreement)
3. Pay the TIPS (inflation-linked) cash flows to a dealer/swap desk
4. Receive L + spread from the swap desk on the dirty price of the bond.

The spread to Libor is calculated as shown in Figure 2. With the aid of Figure 4, we explain how to calculate carry on a proceeds position

FIGURE 4
TIPS Proceeds ASWS Transaction Diagram



Note: Price is the dirty price of the bond at inception. Source: Barclays Research

10y proceeds ASWs 3m carry

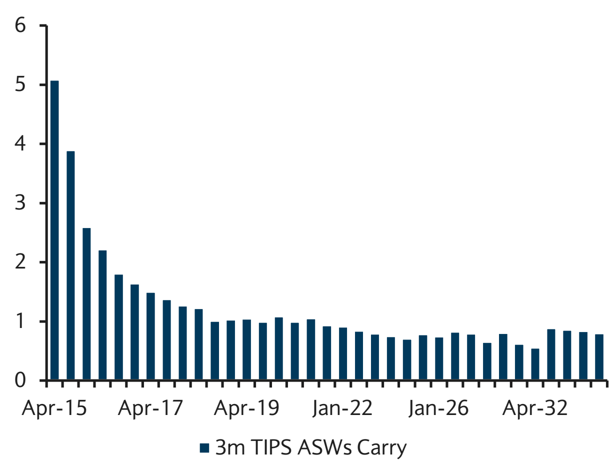
- 3m TIPS ASWs carry = (3mLibor + Spread – Funding Cost) * DCF/ TIPSPV01; here, DCF is about 0.25
- For example, 10y TIPS ASWs (TIIJan24s) were trading at 3m Libor + 13bp as of June 3, 2014
- Assuming a 3m funding cost of 6bp (an investor can assign a CSA-based funding cost in this calculation)
- Assuming 3m Libor of 23bp
- TII Jan 24s PV01: 9.7
- 3m TIIJan24s ASWs Carry = (23bp + 13bp – 6bp)*0.25/9.7 = 0.77bp carry

Figure 5 shows TIPS ASW carry across the curve based on this methodology.

To calculate the roll-down, an investor assumes that the ASW curve remains static; that is, how much marked-to-market position change P&L one would get if the ASW curve did not change and the position shortened in maturity. There are multiple ways to do this. One approach is to build a z-spread ASW valuation (for each bond) shortened by 1y holding period. Then, look at spot z-spread ASWs minus a 1y shorter ASWs and divide by 4 to estimate a 3m ASW roll-down. Looking at a 1y shorter ASWs allows investors to avoid any seasonality issues as y/y seasonality sums to zero. Another approach is to look at bonds 1y shorter in maturity and to use that to calculate the roll-down (3m roll-down = 0.25 *(Spot z-Spread – 1y shorter z-spread)). This would be an approximate market-based 1y roll-down. One can divide these numbers by 4 to arrive at a 3m roll-down. In the market-based approach (Figure 6), relative distortions (rich vs cheap) of 1y-apart securities being rich/cheap will show up. For example, Jul18s roll-down is negative because the security is trading rich relative to Jul17s.

FIGURE 5

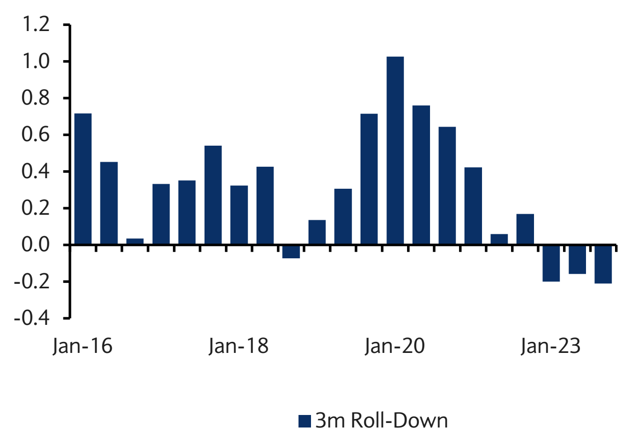
TIPS ASWs carry (3mL+spread-funding)*DCF/PV01



Source: Barclays Research

FIGURE 6

Market based 3m TIPS roll-down



Source: Barclays Research

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Bond breakevens versus inflation swaps

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Market participants had been used to seeing a close relationship between bond breakevens and inflation swaps. However, recent crises have shown that cash and swap markets can diverge significantly, with each market driven by its specific dynamics such as funding costs in the US. Asset swapping activity should theoretically hold the two markets together, but such activity is usually not sufficient to offset diverging forces in stressed market conditions.

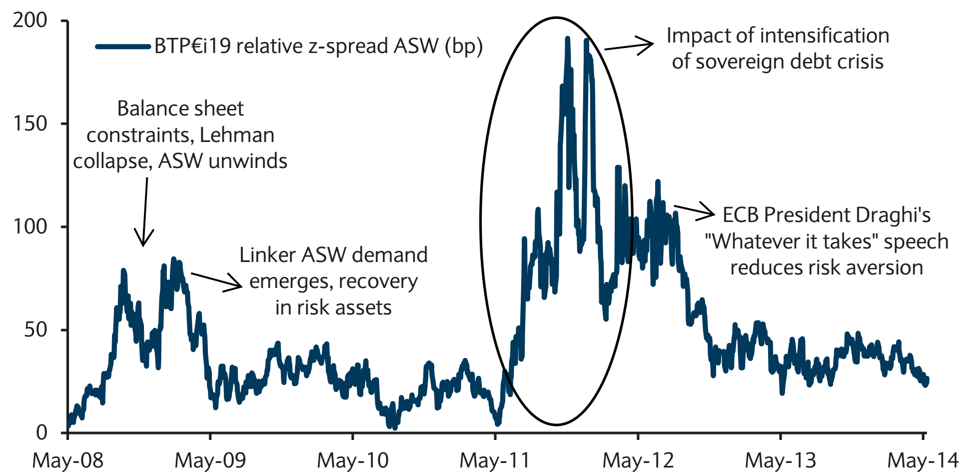
Inflation swaps and bond breakevens, in essence, measure the same economic variable. Although they vary in technical detail – one product is based on a coupon-bearing instrument while the other is in zero-coupon format – both should be driven mainly by markets' expectations of future inflation. However, inflation swaps and inflation-linked bonds make up two distinct markets with different participants. The mechanism that effectively holds the inflation swaps and cash markets together is asset swapping (Linkers ASWs minus Nominal ASWs), so if asset swaps do not trade in sufficient volume, then the tendency for swaps and cash breakevens to trade close to each other may not be strong. Furthermore, one market may be subject to stresses that do not necessarily have a major effect on the other, and again valuations may diverge. As we explain in "Linker asset swaps", we use the relative z-spread asset swap between a linker and its nominal comparator as an analytical measure of the richness/cheapness of a linker's breakevens versus the inflation swaps curve.

Relatively recent history illustrates how the cash and swaps markets can be disconnected. Before the crisis in 2008, differentials were small and evolved within a relatively tight range. In summer 2008, though, the market started focussing on disinflation risks. This led many market participants to exit long breakeven positions, but this coincided with a period when balance sheets constraints were increasing. In September 2008, the collapse of Lehman Brothers triggered a wave of linker asset swap unwinds. Those unwinds essentially meant that the market was no longer receiving inflation in swap format; this effectively led to a massive richening in inflation swaps versus bond breakevens. That said, over that period, both bond and swap breakevens dropped massively. There were common drivers pushing them lower: the economic outlook was bleak, focus had turned to deflation and dealers were scrambling to delta-hedge short positions in floors. At the same time, tactical investors continued to exit long breakeven positions at a time when banks' balance sheets could not accommodate such exposures. Those balance sheet constraints meant that linkers were initially affected to a much greater extent. In the euro area, when banks' delta hedging of short floor exposures became the dominant factor, specific cheapening pressures intensified on swaps and bond breakevens staged a sharp correction of their prior relative cheapening. However, they gave back much of this correction in the first two months of 2009 and it was not until asset swap demand for linkers emerged in March 2009 that bond breakevens corrected and stabilised versus swaps.

The sovereign debt crisis in the euro area provides another example of how linker and inflation swap markets may diverge. From a general perspective, the crisis has had a notably different effect on cash breakevens relative to swaps. Indeed, typical real money investors in the linker market tend to be more risk averse than those in the nominal market. With the extreme volatility in sovereign spreads during the sovereign debt crisis, real money activity in European linkers fell significantly, even when valuations relative to the nominal market stood out as economically very attractive. To a large extent, the individual European linker markets became more volatile versions of their respective nominal markets. Breakevens cheapened on risk-off periods but even at attractive levels, failed to attract demand in sufficient size. The situation can be interpreted as one where the linker and nominal markets each have their separate dynamics; in some way, the differential between them is no longer viewed as a meaningful measure that should reflect inflation expectations. Euro HICPx swaps, on the other hand, are not directly affected by stresses in peripheral debt market and have been relatively well-behaved over that period. The crisis also had more "mechanical" effects on relative valuations. For instance, unwinds linked to Greek linker asset swap positions were very supportive for swaps while the positive effect on the cash market was marginal. Also, the ECB, within its Securities Market Programme, was buying nominal BTPs but not BTP€is. This created a strong (mechanical) cheapening bias which affected mainly BTP€is, and this compounded with the underlying threat that BTP€is would fall out of Barclays' main indices at some point. As a result, and unsurprisingly, relative z-spread asset swaps in most BTP€is cheapened significantly. President Draghi's "Whatever it takes" speech in July 2012 thereafter initiated a gradual compression in peripheral spreads. BTP€i relative z-spreads came down alongside the tightening in absolute spreads.

FIGURE 1

Bond breakevens versus swap valuations are no longer stable



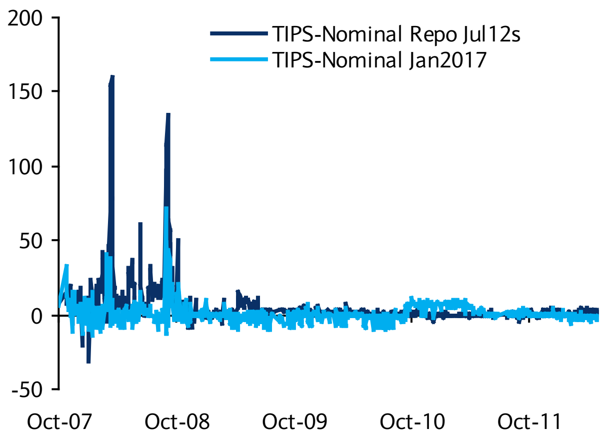
Source: Barclays Research

In the US, we believe the gap between inflation swaps and bond breakevens can be explained primarily by funding costs embedded in a CPI swap, whereas cash breakevens are quoted pre-funding costs and are driven, in part, by the lack of payers in the derivatives market. Since most end-user investors using CPI swaps want to receive inflation, dealers hedge their risk using an offsetting leveraged breakeven position in the repo markets. The dealer is then exposed to the repo bid/offer, repo rate differential risk, and balance sheet charges (including relative liquidity and haircuts). While most of the time repo rate differentials are relatively insignificant, dealers need to price in the potential for the differential to widen. This was evident in 2008 in the US market when TIPS repo rates increased significantly relative to nominal Treasuries (Figure 2). These costs are then embedded in the inflation swap rate, making it higher than the corresponding bond breakeven, other things being equal. Figure 2 shows that during the height of the crisis in 2008, 4y TIPS and 10y TIPS repo differential widened to 150bp and 75bp, respectively. One can price this as a risk-premium/option on top of a breakeven position as there is uncertainty over how long this type of condition may persist. A 10y CPI swap hedged with 10y breakevens (assumption: held to maturity) has more time to experience this type of funding differential relative to a 1y CPI swap hedged with 1y breakevens. Therefore one would expect the difference between CPI swaps and cash-breakevens to be wider as you go further out in the curve.

In terms of the balance sheet cost, one can see that TIPS ASWs trade cheaper than nominal ASWs. This is another way to show the balance sheet cost of holding TIPS versus nominals.

FIGURE 2

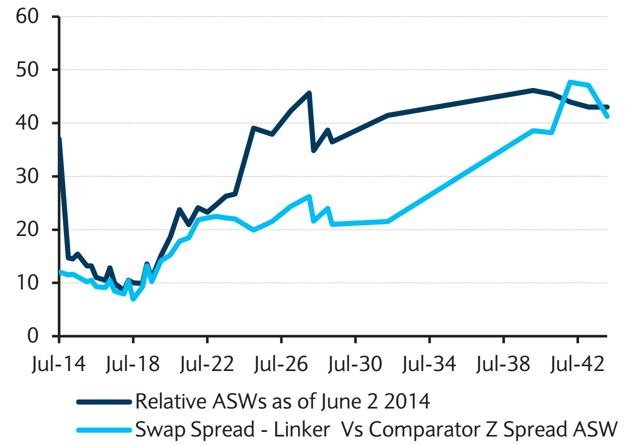
Repo differential TIPS and nominals



Source: Barclays Research

FIGURE 3

TIPS minus nominal ASWs roughly equal to CPI swaps minus cash BEs



Source: Barclays Research

Figure 3 shows that the relative ASWs differential, that is TIPS ASWs – Nominal ASWs, are roughly equivalent to CPI Swaps minus cash breakeven at every point. To summarize this means that when TIPS breakevens are adjusted for floors and the relative ASWs differential is added, a synthetic CPI swaps position is created

TIPS Breakevens (adjusted for floors) = TIPS breakevens + Short par floor.

CPI Swap ~ TIPS Breakevens (adjusted for floors) + TIPS ASWs – Nominal ASWs.

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Par floors in linkers

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Par floors embedded in linkers had been, for a long time, of little relevance from a valuation perspective. However, when the market started pricing deflation, especially in the US, it became crucial to understand how they affect the valuation of different bonds.

Canadian-style linkers usually contain an embedded deflation floor at maturity such that the principal reimbursed cannot be below par. In short, at maturity, the investor gets the greater of par or the inflation-adjusted principal. The floor on a linker usually applies only to the principal at maturity; coupon payments can be and have been paid off an inflation-adjusted principal. Since the inflation-adjusted principal is the par amount times the index ratio (of the reference CPI to the base CPI), this is another way of saying that at maturity, the index ratio is floored at 1 as it is applied to the principal. The payoff on the principal amount at maturity can be written as:

Par Deflation Floor Payoff at Maturity: Max {Par, Par X IndexRatio}

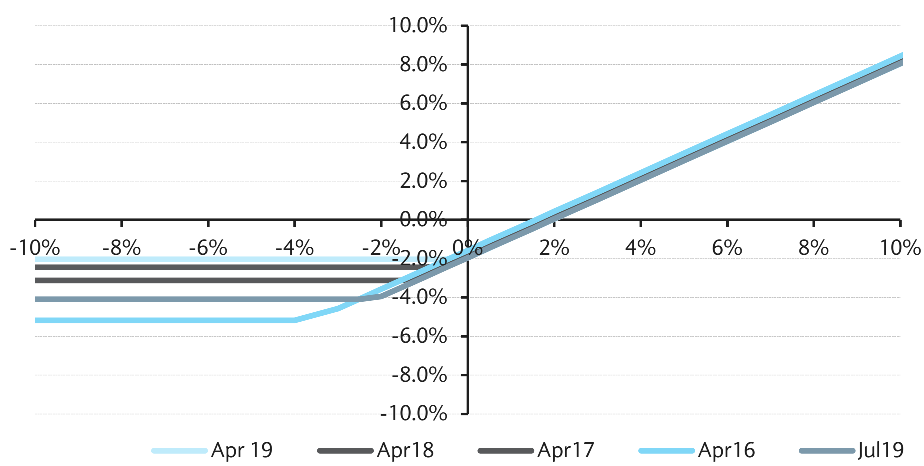
Four factors affecting the floor value of a linker are:

1. **Accrued inflation (and the strike for the deflation floor):** One can think of the deflation floor on a linker breakeven position as a protective put on a stock option. The more inflation a bond has accrued, the further out of the money the protective put is relative to the current stock price. Thus, the bonds that have accrued the least amount of inflation are closest to ATM. Bonds that have accrued significant inflation have more downside, as their deflation floor strike (or protective put) is very OTM. Naturally, any newly issued linkers have the least amount of accrued inflation. Hence, for instance, the newly issued 5y, 10y and 30y TIPS would be closest to ATM. Figure 1 shows that the newly issued 5y issues protect the most against deflation, or need the least deflation (about 3bp annualized deflation) to maturity, for the floor to kick in.

   On June 4, 2014, the TIIApril19 index ratio was about 1.00886 (accrued inflation 0.9%), while the Jul19 index ratio was 1.1071 (accrued inflation 10.7%); thus, relative to Jul19s, April19s are close to being ATM par floor. This is why as of June 4, 2014, the April19 par floor was worth about 2.5bp, while the Jul16 par floor was worth about 0.4bp.

FIGURE 1

April19s floor protection kicks in before older issues



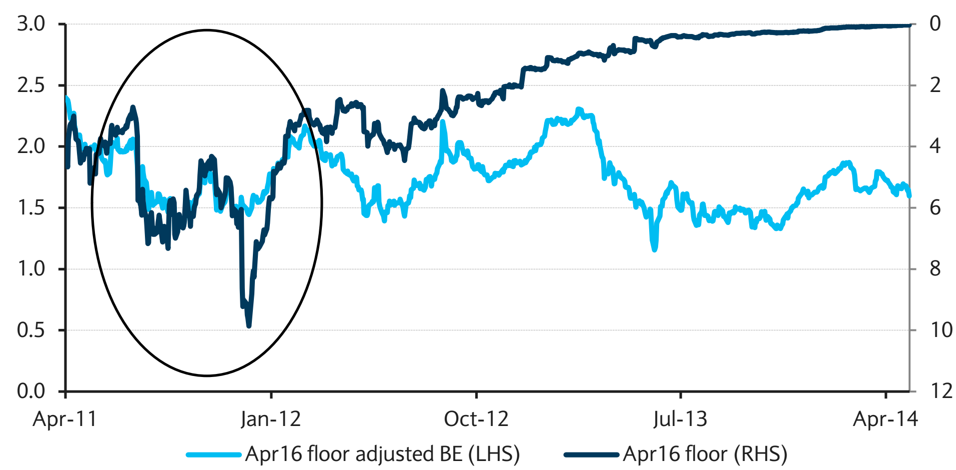
Source: Barclays Research

2. **Remaining time to maturity of the bond:** Bonds with a longer maturity are more likely to be OTM at maturity. This can be due to the fact that central banks usually have an implicit or explicit inflation target. For example, over the medium term, the Fed has a 2% inflation target, while the ECB has a similar target on euro HICP. Over the longer term, it is therefore reasonable to expect the Fed and ECB to do everything in their power to avoid a deflationary spiral. This is why in 2008 near-term floors richened significantly relative to longer-term floors. With this precedent, we would expect the newly issued 5s (TIIApr19s, TIIApr18s and TIIApr17s) to be the target for par deflation floor premium-led bids relative to the 10y or 30y floors.

3. **The level of breakevens:** This determines the extent to which the floor is considered in the money. Figure 2 shows that when breakeven levels decline, the floor value picks up. A fall in the bond's breakeven brings the implied maturity index ratio closer to par, and its theoretical value can increase substantially. Along with implied vols, this is the most significant driver of the option value. Also, implied vols are directional with the decline in breakevens. That is, when breakevens are lower, implied vols are typically higher (Figure 3). In this sense, it is better to buy floors when breakevens are high.

FIGURE 2

Apr16 floor moves with the changes in Apr16 BE



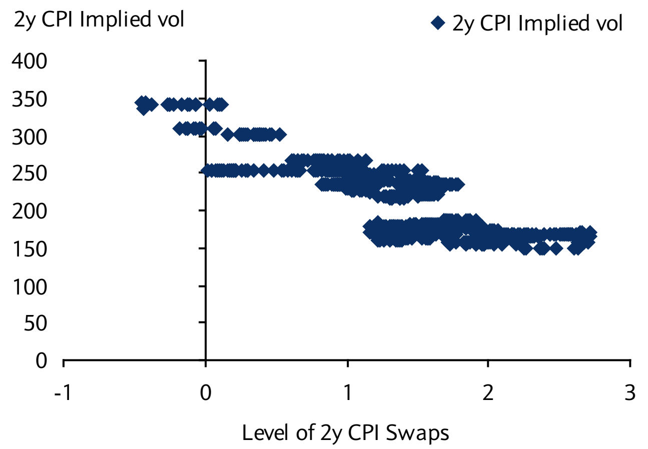
Source: Barclays Research

4. **Implied volatility of breakevens:** In our experience, implied vols are similar to equity markets, inversely related to the level of breakevens (Figure 3). That is, when breakevens are low, implied vols tend to be higher. And as with all options, an increase in the implied volatility of the underlying forward CPI expectations increases the probability of the option's being in the money. In the most recent crisis (Figure 4), implied vols increased, as did the corresponding deflation floor option values.

Going into the 2008 financial crisis, broker/dealers were likely still short deflation floors through structured notes A typical inflation-linked structured note has an embedded deflation floor, struck at 0% inflation to maturity. Thus, dealers become short when they issue these notes. In the US, one of the ways broker/dealers hedge their short optionality is via long floor rich TIPS issues (eg, TIIApr16s or TIIApr17s) versus nearby issues whose floor is deeply OTM (an alternative to shorting CPI swaps). This sort of hedging is what exacerbated the bid for TIIApril13s in September-October 2008 (Figure 4). An increase in realized vol would likely increase implied vols in these structures, making dealers more sensitive/exposed to the underlying optionality, thus further increasing a relative bid to the ATM TIIApr16s versus TIIJan16s.

FIGURE 3

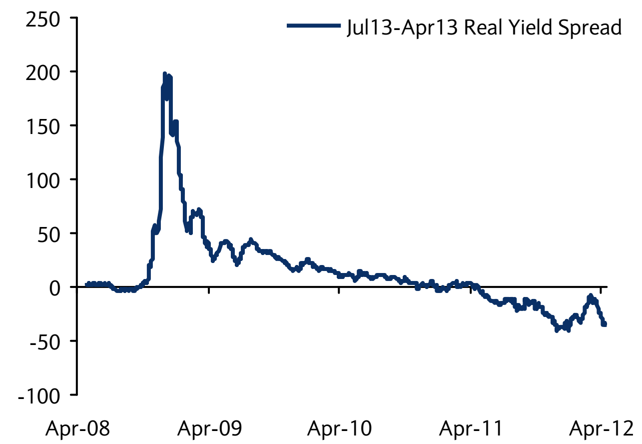
Level of implied vol higher when CPI swaps are lower



Source: Barclays Research

FIGURE 4

2008 financial crisis richened April13s to Jul13s about 200bp as the 5y deflation floor became more valuable



Source: Barclays Research

Estimating deflation floor premium from the market

One way to value a deflation floor premium is to look at the CPI options market. Given that these options markets are not yet very liquid, investors can also compare the traded proceeds ASWs (quoted by the broker/dealers and which include the floor premium on a security) on linkers with their own calculated proceeds ASWs. This is particularly true in the US TIPS market. For example, at the height of the 2008 financial crisis, April13s (Figure 4) traded rich. Thus, when an investor calculated proceeds ASWs, it showed up as rich. In the quoted proceeds ASWs market, the dealer would take into account all of the TIPS cash flows, including the floor premium, to arrive at a price. Thus, the difference between the traded versus calculated proceeds ASWs should include an estimate about the floor premium value:

TIPS Floor Premium ~ Market-based Proceeds ASWs - Calculated Proceeds ASWs

Assumption: Market-based proceeds ASWs include the trader's valuation of the floor premium on any given security.

Additionally, as we have done in Figure 4, to estimate the value of a 5y floor, one can take a relative yield spread of the newly issued 5s versus old security in the sector (ie, Apr16-Jul16, Apr17-Jul17, April19-Jul19 etc.).

As noted in the implied volatility primer, we primarily use the Black log-normal model on the forward index ratio to price floors. The implied vol estimates are input directly from the CPI options market.

Calculating the deflation probability

Prior to the announcement of QE 2, Fed Chairman Ben Bernanke cited that the probability of deflation had increased to about 30% and that to avoid a deflationary spiral and stimulate aggregate demand, it was necessary to engage in quantitative easing. Specifically, he cited floor premiums in the TIPS market as a gauge for the deflationary probability. Below, we estimate CPI floor values via estimation from the TIPS market and/or direct inputs from the CPI options, using options math to back out the implied probability of exercise. In the case of 0% CPI floors, this translates into deflation probability through the maturity of the option.

Specifically, we use a Black log-normal model on forward index ratios to calculate the probabilities of a CPI option being exercised. We assume a log-normal distribution for index ratios as the index ratios cannot go below zero. To calculate forward index ratios, we use zero coupon CPI swap rates to the maturity of the options. In general, in the CPI options market, the zero coupon CPI swap rate is used as the underlying because from an option sellers perspective, the CPI swap is used as the underlying for pricing.

The Black formula is akin to the Black-Scholes formula for pricing stock options, except that the forward price is used instead of the spot price. Below, we summarize the equation for calculating the put option on forward index ratios and the probability of exercise.

Inflation Index Ratio-Based Put Option Premium = D (T) * [K * N (-d2) – F * N (-d1)]

$$d1= \frac{\ln(F/K)+(\sigma^2/2)*T}{\sigma\sqrt{T}}$$

$$d2 = d_1 - \sigma * \sqrt{T}$$

N () is the cumulative distribution function of the normal distribution

T = Time to maturity

D (T) = Discount rate to maturity, we use the nominal swap curve

F = Spot Index Ratio pushed forward by the zero coupon CPI swap rate of the respective maturity,

$$F = \text{Spot Index Ratio} * (1 + \text{ZC\_CPI\_Swap})^T$$

K = Strike, is the expected inflation index ratio at maturity

σ = Volatility of the inflation index ratios

For a put option, the probability of exercise is N (-d2) or (1 – N (d2)). For the intuition behind this probability, one can look at the derivation of the Black or Black-Scholes formula for a digital option (the payoff is 1 if the option expires in the money and 0 if it expires out of the money) using a statistical approach.

For a digital put option, the premium is equal to D (T) * N (-d2), in other words, to the discounted expected value of the maturity pay-off. For a digital, since the expected value at maturity is either 1 or 0, N (-d2) is just the probability of the option's expiring in the money. Here, it would mean the probability of the forward index ratio being below the strike index ratio.

Thus, the probability of the inflation index's being in the money (for a put option) is N (-d2). Figure 5 shows that the deflation probability though maturity is implied by 1y, 5y and 10y cumulative CPI deflation floors (where the forward index ratio strike is 1).

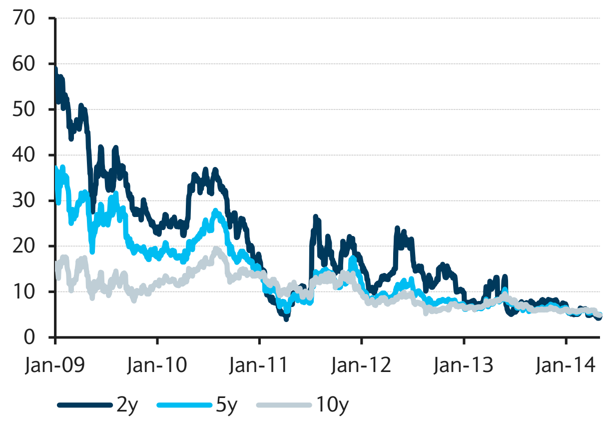
For a digital call option, the premium is equal to D (T) * N (d2), in other words, to the discounted expected value of the maturity pay-off. For a digital, the expected value at maturity is just the probability of option expiring in the money (if it does, the pay-off is 1, else it is 0; the expected value is 1 * Pr (F > K) – 0 * Pr (F < K). Here, it means the probability of the forward index ratio being above the strike index ratio.

Thus, the probability of the inflation index's being in the money (for a call option) is N (d2).

In terms of exact calculations, we look at the market premiums for all inflation options, back out the flat volatility and then calculate the probability of option exercise. Figure 6 shows the probability of exercise for all 5y expected inflation ranges as of June 4, 2014.

FIGURE 5

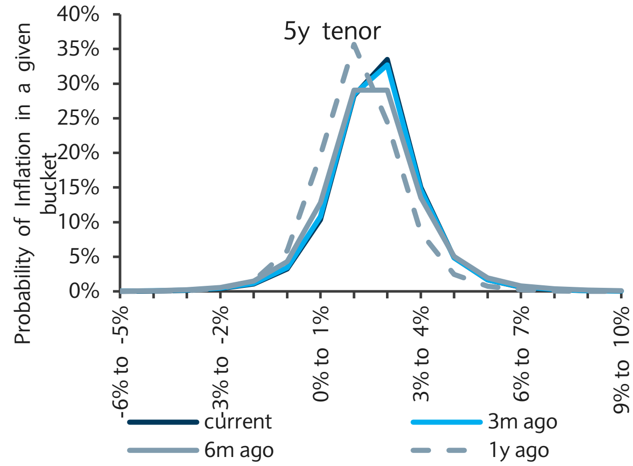
Probability of deflation as implied by the CPI options market



Source: Barclays Research

FIGURE 6

Implied inflation distribution from the CPI options market



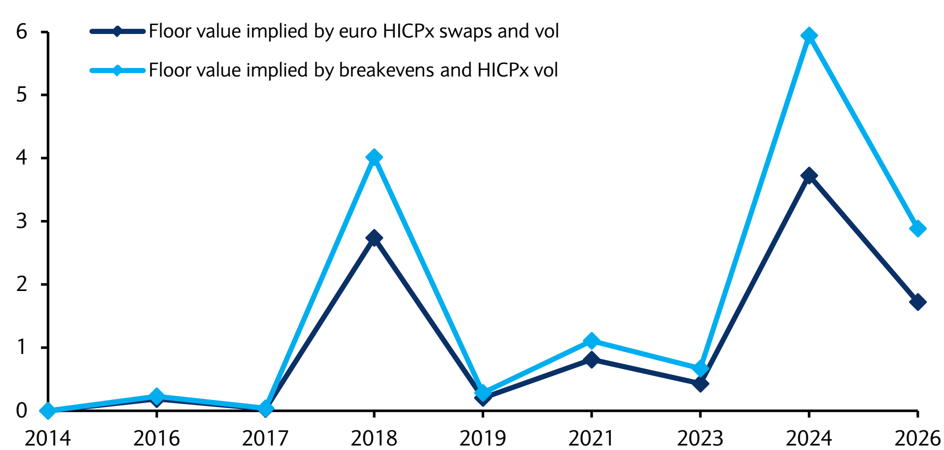
Source: Barclays Research

The effect of wide relative z-spread asset saps on par floor values

When valuing the floor embedded in a bond, the degree to which it is in or out of the money is typically determined by the inflation swaps curve; ie, the ATM strike for any maturity is determined by what the swap market is quoting. To some extent, this makes sense, as the implied vol input would also be based on floors for which the traded underlying would be inflation swaps. However, one can easily realise that determining the moneyness of a par floor on a linker with respect to the inflation swaps curve is acceptable only if the breakeven on the linker is not significantly different to what the swaps curve is implying. In other words, if the absolute value of the relative z-spread on a bond is very high, determining the value of the embedded floor using the inflation swaps market as the underlying would create an internal inconsistency with the bond's pricing. We illustrate this with BTP€is. Breakevens in BTP€is dropped to very low levels amid the sovereign debt crisis, below zero on some issues. Euro HICPx, on the other hand, stood at much higher levels. For a BTP€i with a breakeven that is significantly below euro HICPx swaps, using swaps as the underlying would make its par floor appear far more out of the money than if its own breakeven were used as the ATM strike.

FIGURE 7

BTP€is floors notably more valuable if ATM is determined by bond breakevens



Source: Barclays Research (calculations as of 3 June 2014)

INFLATION DERIVATIVES PRODUCTS

Zero-coupon CPI caps and floors

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A market for zero-coupon CPI caps/floors exists in the US and the euro area, although activity and liquidity are generally lower in caps than in floors. Given the extreme level of monetary stimulus globally, interest for the instrument may develop if the focus on inflationary risks posed by current policies increases.

CPI cap/floor basics

A zero-coupon CPI cap/floor is essentially a call/put option on the inflation index or, more precisely, on the change in the inflation index over the tenor of the contract. Its underlying for pricing is therefore a zero-coupon inflation swap, making it very different from y/y caps/floors. The market for zero-coupon CPI caps grew alongside the zero coupon floor market, although the latter is significantly more active because liquidity benefits, to some extent, from the existence of par floors in linkers. That said, it is relatively straightforward now to get quotes for caps on US CPI and euro HICPx.

We use the US market to illustrate the mechanics of a zero coupon CPI cap and floor, although the principles would also be directly applicable for the European market. Typically, in US CPI caps/floors, the underlying CPI NSA is 3m lagged and progresses via stepwise interpolation (unlike CPI swaps and/or cash TIPS, in which the CPI interpolation method is linear for daily accrual). On the other hand, in euro HICPx caps/floors, the underlying follows the same convention as standard swaps. The zero-coupon CPI cap pays the difference between realized CPI at maturity and a pre-specified CPI strike if that difference is greater than zero, and nothing otherwise. The latter is typically quoted in annualized inflation terms from the 3m-ago CPI print. The zero-coupon CPI floor pays the difference between a pre-specified CPI strike and realized CPI at maturity if that difference is greater than zero, and nothing otherwise. Figure 1 and Figure 2 outline typical structures.

FIGURE 1

A term sheet for 5y CPI NSA-based zero-coupon CPI cap (struck @ ATM)

Notional: $100mn
Underlying index: US CPI Urban Consumers NSA (non-seasonally adjusted headline CPI, BBG ticker: CPURNSA)
Source: US Bureau of Labor Statistics
CPI lag: 3m
CPI interpolation: Stepwise or Non-Interpolated
Start date: May 9, 2012
End date: May 9, 2017
First CPI fixing: 227.663 (February 2012 CPI)
Time to maturity (T): 5 years (as CPI is 3m lagged)
ATM: Current CPI swap rate to maturity, in this case it is about 2.33%
Buyer's maturity payoff: $Notional * \max\left(\frac{CPINSA(Feb.2017)}{CPINSA(Feb.2012)} - (1+ATM\%)^T, 0\right)$

Seller: upfront premium, 3.0% of notional as of May 9, 2012 for an ATM CPI cap

Source: Barclays Research

FIGURE 2

A term sheet for 5y CPI NSA-based zero-coupon CPI floor (struck @ ATM)

Notional: $100mn
Underlying index: US CPI Urban Consumers NSA (non-seasonally adjusted headline CPI, BBG ticker: CPURNSA)
Source: US Bureau of Labor Statistics
CPI lag: 3m
CPI interpolation: Stepwise or Non-Interpolated
Start date: May 9, 2012
End date: May 9, 2017
First CPI fixing: 227.663 (February 2012 CPI)
Time to maturity (T): 5 years (as CPI is 3m lagged)
ATM: Current CPI swap rate to maturity, in this case it is about 2.33%
Buyer's maturity payoff: $Notional * \max\left((1+ATM\,\%)^T - \frac{CPINSA(Feb.2017)}{CPINSA(Feb.2012)}, 0 \right)$

Seller: upfront premium, 3.0% of Notional as of May 9, 2012 for an ATM CPI floor

Source: Barclays Research

Pricing

As we have done for the pricing of CPI floors (in the par floors), we employ a Black Model in valuing CPI caps as a starting point. The index ratio at the option maturity can be viewed as a random variable with a log-normal distribution. For the above example, we value a 5y ATM CPI cap option (assuming ATM 5y CPI swap rate of 2.33%).

At the current (as of June 3, 2014) CPI swap rate of 2.19%, the 5y forward index ratio (assuming spot index ratio of 1) is about 1.115. 5y implied CPI vol is about 104.6bp/annum, or 6.6bp/day.

C = D(T) * [K*N(d_1) – F*N(d_2)]

P = D(T) * [K* N(-d_2)- F*N(-d_1)]

$$D_1 = \frac{\ln(F/K) + (\sigma^2/2)*T}{\sigma * sqrt(T)}$$

$$D_2 = \frac{\ln(F/K) - (\sigma^2/2)*T}{\sigma * sqrt(T)}$$

The tau, or time to expiry, for this option is ~5. The vol supplied in this formula would be (6.6bp/day*sqrt(252*T)/10000), or approximately 2.32%. The discount factor we measure for this maturity is roughly 0.92. With these values, we arrive at a 5y cumulative CPI cap (on a $10k notional) of roughly $211, or roughly 2.11% of notional. As far as pricing is concerned, typical variables for options pricing matter, such as volatility, time to maturity, relative skew, etc. The same can be applied to calculating the floor/value. Figure 3 shows valuations as of June 3, 2014.

Applications and uses of zero-coupon CPI caps/floors

Hedging

- CPI caps and floors are well suited as hedging instruments for partial indexation schemes.
- A payer/receiver of inflation on an inflation swap can limit the uncertain inflation payoff by buying a cap/floor. One would pay a premium to buy this cap/floor, but would receive a guarantee that the exposure is not above/below a certain pre-agreed strike.

Investing/trading

- As with all options, CPI caps and floors can be used to leverage a view on headline CPI.
- An investor can combine selling an OTM CPI cap with a cash-breakeven or zero coupon CPI swap position for a long covered cap or covered breakeven to gain a better entry point into a long inflation position (while capping gains beyond a certain inflation strike). A protective floor can be used to protect the downside of a cpi CPI swap/breakeven.

For reference, an inflation cap-floor parity should be satisfied at any time in this market.

Zero coupon CPI cap (strike: X) – Zero coupon CPI floor (strike: X) = Payer inflation swap.

FIGURE 3

Pricing (as of June 3, 2014) of various US caps/floors in the market

Tenor	CPI Swap Rate, %	Caps, % of notional				Floors, % of notional			
		ATM	ATM +50bp	ATM +100bp	ATM +150bp	ATM	ATM -50bp	ATM -100bp	ATM -150bp
1y	1.85%	0.4%	0.2%	0.1%	0.0%	0.4%	0.2%	0.1%	0.0%
2y	1.94%	0.8%	0.4%	0.2%	0.1%	0.8%	0.4%	0.2%	0.1%
3y	2.03%	1.2%	0.6%	0.3%	0.2%	1.2%	0.6%	0.3%	0.1%
4y	2.11%	1.6%	0.9%	0.4%	0.2%	1.6%	0.8%	0.4%	0.2%
5y	2.19%	2.1%	1.1%	0.6%	0.3%	2.1%	1.1%	0.6%	0.3%
7y	2.33%	3.2%	1.8%	1.1%	0.6%	3.2%	1.8%	0.9%	0.5%
10y	2.49%	4.5%	2.7%	1.6%	0.9%	4.5%	2.5%	1.3%	0.7%
15y	2.62%	6.9%	4.3%	2.6%	1.5%	6.9%	3.9%	2.1%	1.0%
20y	2.68%	9.0%	5.9%	3.7%	2.2%	9.0%	5.2%	2.8%	1.4%
25y	2.70%	10.6%	7.0%	4.4%	2.8%	10.6%	6.0%	3.2%	1.6%
30y	2.70%	11.8%	7.8%	5.0%	3.2%	11.8%	6.6%	3.4%	1.7%

Source: Barclays Research

Figure 4 shows quotes from Barclays' BISW9 Bloomberg page for Euro HICPx zero-coupon caps as of June 3, 2014. The premiums are expressed as a percentage of the notional traded on different strikes.

FIGURE 4

Indicative premiums on euro HICPx zero coupon caps/floors (as of June 3, 2014)

			Floors % of notional				Caps % of notional			
Tenor	Euro HICPx swap rate, %	ATM	-1%	-0.5%	0%	0.5%	2.5%	3%	3.5%	4%
2y	0.89%	0.5%	0.02%	0.04%	0.09%	0.24%	0.03%	0.02%	0.01%	0.01%
5y	1.24%	1.6%	0.03%	0.07%	0.17%	0.42%	0.20%	0.10%	0.05%	0.03%
7y	1.41%	2.7%	0.05%	0.12%	0.27%	0.64%	0.58%	0.29%	0.16%	0.09%
10y	1.66%	4.4%	0.06%	0.14%	0.35%	0.82%	1.64%	0.87%	0.47%	0.26%
15y	1.91%	6.9%	0.06%	0.17%	0.43%	0.97%	3.73%	2.14%	1.23%	0.73%
20y	2.01%	9.0%	0.06%	0.19%	0.49%	1.12%	5.42%	3.12%	1.81%	1.08%
30y	2.12%	12.3%	0.08%	0.22%	0.53%	1.19%	8.07%	4.40%	2.41%	1.37%

Source: Barclays Research

INFLATION DERIVATIVES PRODUCTS

Y/y inflation caps and floors

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Activity in y/y caps and floors developed due to structured note issuance, well before trading in zero coupon options started. Liquidity in the y/y volatility market has nevertheless remained relatively subdued, limiting the involvement of tactical investors.

Product characteristics

The y/y inflation cap and floor market is most active in euro HICPx, having gravitated to structured note activity in Europe. A cap/floor is a series of caplets/floorlets on y/y inflation. A 10-year y/y cap/floor, for instance, will be a structure of 10 caplets/floorlets with a pre-determined strike rate. Each year, the caplet/floorlet will pay a cash flow if year-on-year inflation is above/below the strike rate, with the cash flow equal to the notional times the difference between the realised y/y and the strike rate. For standard euro HICPx y/y caps and floors traded in the broker market, the index reference date conventions are the same as the underlying swap market: for example, trading on ZC euro HICPx swaps in July occurs with an April base month. This means that euro HICPx caps traded in July will have cash flows determined by April y/y inflation rates over the life of the cap. It is notable that the US y/y cap/floor market also trades in terms of base months, similar to euro HICPx, even though the US CPI swaps market trades on an interpolated daily index reference. One element to highlight is that unlike in nominal caps/floors, the cash flow on the first inflation caplet/floorlet is not known in advance at the trade inception date. Below are illustrative term sheets for a 5y y/y cap and floor on euro HICPx.

FIGURE 1

Illustrative term sheet for 5y y/y euro HICPx cap

Trade date	02 May 2012
Maturity date	04 May 2012
Notional	€25 million
Strike rate	2%
Premium rate	4.10%
Premium	€1,025,000
Index	European HICP excluding Tobacco (NON REVISED)
Counterparty A pays	Premium at the effective date
Counterparty B receives	Every 04/May/n, Notional Amount * Max[{(Index February year n/Index February year n-1)-1}-2%, 0%]
Frequency	Yearly
Day convention	30/360 Modified Following
Holiday calendar	Target

Source: Barclays Research

FIGURE 2

Illustrative term sheet for 5y y/y euro HICPx floor

Trade date	02 May 2012
Maturity date	04 May 2012
Notional	€25 million
Strike rate	0%
Premium rate	1.8%
Premium	€450,000
Index	European HICP excluding Tobacco (NON REVISED)
Counterparty A pays	Premium at the effective date
Counterparty B receives	Every 04/May/n, Notional Amount * Max [0%-{(Index February year n/Index February year n-1)-1}, 0%]
Frequency	Yearly
Day convention	30/360 Modified Following
Holiday calendar	Target

Source: Barclays Research

Quotations for y/y caps and floors are typically in premium terms. In the US, traders are accustomed to quoting y/y CPI caps and floors for monthly resets of y/y CPI, but they also quote yearly resets of y/y CPI. Figure 3 shows the current indicative levels of annual reset y/y CPI caps/floors quoted in upfront premium notional terms.

FIGURE 3

Y/y US CPI NSA caps and floor prices (as of 3 June 2014)

Tenor	Y/Y CPI Swap Rate	Y/Y CPI Caps, % of Notional				Y/Y CPI Floors, % of Notional			
		ATM	ATM+50 bp	ATM+100 bp	ATM+150 bp	ATM	ATM-50bp	ATM-100bp	ATM-150bp
1	1.85%	0.4%	0.2%	0.1%	0.0%	0.4%	0.2%	0.1%	0.0%
2	1.94%	0.9%	0.5%	0.2%	0.1%	0.9%	0.5%	0.3%	0.2%
3	2.03%	1.4%	0.8%	0.4%	0.3%	1.5%	0.9%	0.6%	0.4%
4	2.11%	2.1%	1.2%	0.7%	0.4%	2.1%	1.3%	0.9%	0.6%
5	2.19%	2.7%	1.7%	1.0%	0.7%	2.7%	1.8%	1.2%	0.8%
7	2.33%	4.1%	2.7%	1.8%	1.2%	4.2%	2.9%	2.0%	1.4%
10	2.49%	6.3%	4.4%	3.1%	2.2%	6.6%	4.7%	3.4%	2.5%
15	2.62%	9.8%	7.2%	5.3%	4.0%	10.4%	7.7%	5.8%	4.5%
20	2.68%	12.8%	9.6%	7.2%	5.6%	13.6%	10.3%	7.9%	6.3%
25	2.70%	14.8%	11.1%	8.4%	6.6%	15.8%	12.0%	9.3%	7.4%
30	2.70%	16.5%	12.4%	9.4%	7.4%	17.4%	13.3%	10.4%	8.3%

Source: Barclays Research

Outside the US, particularly in Europe, these structures have annual payments, which means the y/y inflation caps/floors are typically quoted in annual forms in Europe. Given that the cumulative seasonality over a year is zero, the annual reset form of quoting removes a lot of the idiosyncrasies in quoting m/m seasonality in inflation.

Y/y euro HICPx caps and floors are most commonly quoted at strikes with increments of 50bp (ie, 0.0%, 0.5% etc). The development of the range accrual market in particular has helped better define the cap/floor vol smile, as the strikes on these notes occurred at a varied range, usually at 1-1.75% on the floors and 2.5-3.25% on the caps. It has become common also for quotes in the euro HICPx cap/floor market to be expressed in running premium terms.

FIGURE 4
Indicative Euro HICPx y/y cap and floor prices, running premium (as of 3 June 2014)

Y/Y Floors	-1.00%	-0.50%	0.00%	0.50%	1.00%	1.50%	2.00%
2y	0.03%	0.05%	0.09%	0.19%	0.40%	0.75%	1.19%
5y	0.10%	0.13%	0.17%	0.25%	0.41%	0.67%	1.03%
7y	0.13%	0.16%	0.21%	0.28%	0.42%	0.64%	0.96%
10y	0.15%	0.18%	0.23%	0.29%	0.41%	0.59%	0.86%
15y	0.16%	0.20%	0.24%	0.30%	0.39%	0.55%	0.77%
20y	0.17%	0.20%	0.24%	0.30%	0.39%	0.52%	0.72%
30y	0.18%	0.22%	0.26%	0.31%	0.38%	0.50%	0.68%
Y/Y Caps	**2.00%**	**2.50%**	**3.00%**	**3.50%**	**4.00%**	**4.50%**	**5.00%**
2y	0.08%	0.05%	0.04%	0.03%	0.02%	0.02%	0.02%
5y	0.28%	0.20%	0.16%	0.13%	0.11%	0.10%	0.09%
7y	0.38%	0.28%	0.22%	0.18%	0.16%	0.14%	0.13%
10y	0.52%	0.37%	0.29%	0.24%	0.21%	0.19%	0.17%
15y	0.65%	0.46%	0.35%	0.29%	0.25%	0.23%	0.21%
20y	0.69%	0.48%	0.36%	0.30%	0.27%	0.24%	0.22%
30y	0.75%	0.52%	0.39%	0.32%	0.29%	0.26%	0.24%

Source: Barclays Research

Limited Price Indexation (LPI) swaps

LPI swaps are effectively a combination of a standard inflation swap with a series of caplets and floorlets. This structure is common in the UK, where historically the largest stock of defined benefit pension liabilities have been indexed to the Retail Prices Index (RPI) capped at 5% and floored at 0%. Paying fixed and receiving LPI can be thought of as receiving RPI (i.e. paying fixed on the inflation swap) combined with a short position in a cap and long position in a floor. LPI is calculated as an index, on which a swap can then be written, in a similar format to RPI swaps. The usual format is for LPI to be traded as a zero coupon swap with appropriate collateralisation, though a 'pay as you go' format is also feasible.

We model LPI recursively to provide an estimate of market valuations:

$$LPI_t = LPI_{t-1}.[1 + RPIYoY_{t-1}^t - Caplet_{t-1}^t + Floorlet_{t-1}^t]$$

Where $LPI_0 = RPI_0$, RPIYoY is the y/y RPI rate priced by the swap market for the period of interest, and caplet and floorlet prices are expressed in future value and % notional terms. As LPI is a path-dependent swap, this simple model is an approximation to the actual structure as it fails to account for correlation between the RPI swap forwards. Usual market practice is to apply a convexity adjustment to account for this, though there is no clear consensus as to how best to price this. Modelling LPI can be challenging for many market participants given the need for extensive cap and floor prices and RPI forwards, many of which may not trade frequently in the market in isolation. Indeed, historically, it has been more common for LPI swaps to trade in the broker market (typically quoted as a basis point spread to zero coupon standard RPI swaps) than for the underlying caplets or floorlets to trade in isolation. We publish indicative LPI market levels derived using our simple model and inputs from Barclays inflation trading systems in our regular *Inflation Volatility Digest* publication and are able to produce time series data on request.

FIGURE 5

Illustrative LPI swap levels and spread to zero coupon RPI swaps

	LPI [0,5] y/y					LPI premium versus zero-cpn RPI swap (bp)				
	03-Jun-14	-1m	-3m	-6m	-12m	03-Jun-14	-1m	-3m	-6m	-12m
10y	3.25%	3.27%	3.16%	3.25%	3.26%	-3	1	5	6	20
15y	3.43%	3.44%	3.37%	3.47%	3.48%	-4	-1	3	1	12
20y	3.56%	3.56%	3.52%	3.61%	3.60%	-3	-1	2	0	10
30y	3.66%	3.67%	3.65%	3.72%	3.72%	2	3	6	3	9

Source: Barclays Research. Note: levels reflect Barclays Research calculations and assume no convexity adjustment

LPI swaps are usually of interest to those who require a very precise hedge for specific inflation liabilities. UK linkers do not have an embedded principal deflation floor unlike their US and euro counterparts, so there is no related supply of inflation floors to the RPI market from asset swapping activity. This means that 0% strike floors have in the past tended to trade rich on the vol surface, and this remains the case though the skew is less extreme than it has been. We estimate that for a 30y LPI[0,5] swap struck on 3 June 2014, if the implied vols on the 0% floorlet are set equal to the 5% caplet then the headline LPI swap rate would be over 30bp cheaper than our implied market valuation. Given theoretical demand for LPI vastly exceeds supply, there is little reason to think that the skew on the RPI vol surface is liable to correct soon, which coupled with the capital intensiveness of LPI swaps will therefore likely keep this a fairly niche market.

Development of the market

Caps and floors related to structured notes issuance have traditionally been the most important flows. In Europe, activity in structured inflation notes took off in 2003, with coupon typically set as a fixed rate X% plus year-on-year inflation rate. Coupons were usually floored at zero, but floors set at the fixed rate X% were not uncommon either. 2004 saw the emergence of leveraged notes, which typically paid a multiple of y/y inflation or a fixed rate plus a multiple. The leverage factor amplified not only the effect in swaps space but also the implicit notional on any embedded floors. By 2007, the market started to reach a point at which flows unrelated to underlying product were becoming almost as important, especially in the euro area. In 2006-07, inflation-range accruals took centre stage in inflation-linked structured note issuance. Those structures typically aimed for the y/y inflation to remain in a tight range around the ECB's target of inflation close to but below 2%. Range accrual notes helped push down cap/floor vol in the euro area significantly, but investors in these bonds suffered when actual inflation started to move well above the upper end of the ranges offered towards the end of 2007. With realised inflation pushing towards 3% in 2007, cap/floor implied volatility drifted higher as some assumptions in pricing models were changed but also because of some unwinding of the loss-making range accrual notes.

In 2008, the fear of high inflation boosted demand for inflation-linked structured notes from retail investors. Products paying inflation with leverage once again became widespread. Many of these notes were structured with higher leverage than before and with floors above zero. Issuance also thrived in the first half of the year as banks in particular took advantage of expensive credit/funding for financials. Even though implied vols and swaps surged to unprecedented levels, the high funding levels meant that sufficiently attractive pay-offs could easily be structured to cater for the retail investor base. After the 2008 summer, issuance dried out as focus turned to deflation, while a surge in volatility made the cost of floors embedded within most structures extremely expensive. Issuance started to recover in Q2 09 after global central banks had engaged in quantitative easing strategies, which increased inflation fears significantly despite negative realised inflation, but leveraged notes were scarce. Since then, activity has picked up but with relatively simple structures.

In the euro area, the y/y vol market has reached a degree of maturity at which activity is sometimes independent of structured note issuance. However, even then, it is difficult to know if occasional bouts of activity are not in fact related to a dealer reshuffling exposures to risk that was previously warehoused on the back of issuance. Tactical investors are sometimes involved in speculative trades, and with expansionary monetary policies currently being carried out on a massive scale, there had been occasional interest in high strike caps. During the more recent disinflationary trend in the euro area, interest to take positions in floors also increased. Popular vanilla structures included zero cost and premium-intake ones that offered protection against low inflation and mild levels of deflation but with a negative payoff in extreme deflation scenarios.

Some pricing considerations for y/y caps and floors

Following the Fisher equation, an analogy with the foreign exchange market seems to be an obvious starting point when in inflation models: the nominal yield corresponds to the domestic currency, the real yield is analogous to the foreign currency, and CPI is the exchange rate between the nominal and real yields. This analogy is the starting point of the model developed by Jarrow and Yildrim.

The model consists of a three-factor framework comprising the nominal, real, and inflation rates. The nominal and real interest rates are assumed to follow an HJM diffusion process. The CPI is driven by an instantaneous inflation rate defined as the difference between the nominal and the real interest rates. The Jarrow-Yildrim model provides arbitrage-free conditions between the three components. In their paper, the authors obtain the nominal and real rate term structures by applying standard stripping techniques to nominal US Treasuries and TIPS. Volatility parameters for the nominal and real forward rates are computed from historical data on TIPS and nominal US Treasuries, while the volatility of the inflation rate is derived from the CPI time series. Finally, estimates of the correlation parameters between the three components are calculated through sample moments using historical inflation, real, and nominal interest rate data.

Advantages of this model are its simplicity and intuitiveness and the fact that its framework is easy to implement. Also, in the particular case where the CPI process is linked to an instantaneous inflation rate, it provides closed form solutions for inflation swaps and Black-Scholes formulas to evaluate inflation options, whether they have a zero coupon or a y/y format. However, its main drawback is that it is particularly suited to markets in which calibration is necessary for data on the bond market. This is especially problematic for the euro area inflation options market, where the more natural curve for data calibration would be the inflation swap curve. To this end, other models that fall under the 'market models' category have emerged as more suitable candidates.

One such approach has been developed by Belgrade, Benhamou and Koehler. They link the zero-coupon and the y/y inflation derivatives in the European inflation swap and options markets through a market model. Forward values of the CPI are modelled. The authors provide a convexity adjustment formula when computing the forward value of the CPI ratio, where the forward value of the ratio is what effectively determines the expected value of a caplet/floorlet. They show that the forward value of the ratio is the respective forward CPI multiplied by an adjustment that is an explicit function of the forward CPIs, the forward zero coupon bond and the correlations between them. Unlike in the Jarrow-Yildrim framework, the availability of the CPI forward is considered to be sufficient such that real rates are not used as an input. As for the nominal curve, an HJM-type diffusion is assumed. The calibration to market data is done using money market and swap prices for the nominal zero coupon term structure. Traded optional instruments are used to define the nominal volatility structure. The authors give closed formulas for the valuation of breakeven swaptions and numerical integration for options on real yields.

Sophisticated models are needed to cater for the complexity in volatility products. For example, a very common but complex (in terms of pricing) product is the LPI swap, which is an interest rate product dependent on the path of inflation. Hence, to value the product, a simulation of annual inflation rates is needed up to the maturity of the swap. The simulation needs to be carried out within an inflation model. The simulation of nominal rates can be implemented through a usual HJM framework.

In the euro inflation market, traders build the inflation volatility term structure (vol as a function of expiry) for individual ATM caplets/floorlets (not quoted in the market) so that they can match ATM cap/floor straddles (quoted in the market). The SABR (stochastic volatility) model seems to be a natural choice as a calibration tool for inflation smiles. Inflation can become deflation and drop below 0% (as happened in several countries in 2009); therefore, the SABR parameter beta is set close to zero (ie, assuming the normal-like distribution for inflation rates). Inflation volatilities implied from option prices are then calibrated in the SABR model, in which the correlation (an inflation rate versus its volatility) and the vol-of-vol (volatility of inflation volatility) parameters determine the “skewness” (asymmetry) and the “smileness” (curvature) of vol smiles. Typically, the correlation parameter tends to be negative up to the 10y expiry. When inflation goes down, there is more demand for low-strike, shorter-dated floors as a protection/hedge; hence, inflation volatility is supported and goes up. On the other hand, positive correlations make sense for longer-dated options (10y and above). When inflation increases, pension funds should be natural buyers of high-strike, long-dated caps to hedge their liabilities.

Cumulative CPI options delta-hedging

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We review CPI options pricing and outline the steps/considerations involved in delta-hedging these options with CPI swaps (the underlying of CPI options) or breakevens. In practice, because CPI swaps are less liquid than cash breakevens, the latter are often used to delta-hedge CPI options. We go through several examples of delta hedging CPI options with cash breakevens. Specifically, we try to understand the nuances of the offsetting transactions involved using TIPS breakevens to replicate a CPI options payoff.

In pricing CPI options from a hedging perspective, the volatility of breakevens and/or CPI swaps (the implied forward CPI print) matters more than realized CPI print volatility. CPI swaps or breakevens or implied forward CPI prints are used to replicate the CPI options payoff. Thus, one should compare CPI swaps or the approximate breakeven volatility with the implied volatility of a CPI option, not m/m realized CPI print volatility. In addition, one needs to keep in mind the differential between cash breakevens and CPI swaps, ie, the relative ASWs (TIPS minus nominals), when delta-hedging CPI options using cash breakevens.

CPI options pricing and the underlying hedging instrument

With the still relatively nascent CPI options market in the US but a growing TIPS market (which has embedded par floor optionality), we think it makes sense to review a delta-hedging/option replication perspective for CPI options. We hope the exercise will shed more light on the applicability of CPI options in any given portfolio.

In the US inflation-derivatives market, the most liquid CPI options are the cumulative caps and floors. The cash inflation-linked instruments, TIPS, have an embedded cumulative floor on the original issue face amount. This is one source of supply for floors. The term sheets below describe the structure of a cumulative floor at 0% (deflation floor) and a cumulative cap struck at 2%. We will build on these examples throughout this report for pricing, delta-hedging, etc. Cumulative CPI options tend to be stepwise in interpolation (3m lagged), versus the linear interpolation methods used in the cash market with a 2m-3m lag.

FIGURE 1
A term sheet for CPI NSA-based zero coupon CPI floor struck at 0%

- Notional: $100mn
- Underlying index: US CPI Urban Consumers NSA (non-seasonally adjusted headline CPI, BBG ticker: CPURNSA Index)
- CPI lag: 3m
- CPI interpolation: stepwise or non-interpolated
- Start date: April 17, 2009 (underlying reference CPI: 211.143, January 2009)
- End date: January 15, 2012
- Time to maturity (T): 2.74y
- First CPI fixing: 211.143 (3m lagged January 2009 CPI print)
- Buyer maturity payoff: $Notional * \max\left((1+0\%)^T - \frac{CPINSA(Oct.2011)}{CPINSA(Jan.2009)}, 0\right)$
- Seller: upfront premium, $2mn

Source: BLS, Barclays Research

FIGURE 2

A term sheet for CPI NSA-based zero coupon CPI cap struck at 2%

- Notional: $100mn
- Underlying index: US CPI Urban Consumers NSA (non-seasonally adjusted headline CPI, BBG ticker: CPURNSA Index)
- CPI lag: 3m versus current trade date
- CPI interpolation: stepwise or non-interpolated
- Start date: April 17, 2009 (underlying reference CPI: 211.143, January 2009)
- End date: January 15, 2012
- Time to maturity (T): 2.74y
- First CPI fixing: 211.143 (3m lagged January 2009 CPI print)
- Buyer maturity payoff: $Notional * \max\left(\frac{CPINSA(Oct.2011)}{CPINSA(Jan.2009)} - (1+2\%)^T, 0\right)$
- Seller: upfront premium, $2mn

Source: BLS, Barclays Research

CPI options can be priced using a Black log-normal model. The forward index ratio, F, (expected inflation accretion to maturity) can be thought of as a random variable with a log-normal distribution, akin to a forward stock price in the Black log-normal model. In the above term sheet, the forward index ratio is $\left(\frac{CPINSA(Oct.2011)}{CPINSA(Jan.2009)}\right)$. Typically, the seller of CPI options will price the optionality with respect to the CPI swaps based forward index ratio.

Floor Price = D (T) * [K*N(-d_2) – F*N(-d_1)]

$$d_1 = \left(\frac{\ln(F/K) + (\sigma^2/2)*T}{\sigma*\sqrt{T}}\right)$$

$$d_2 = \left(\frac{\ln(F/K) - (\sigma^2/2)*T}{\sigma*\sqrt{T}}\right)$$

In Figure 1, for the 0% CPI floor starting in April 17, 2009 (maturing on January 15, 2012), the starting CPI swap rate is 0.93% (annualized), so the forward index ratio is about $(1+0.93\%)^{2.74}$, which is about 1.02566. The strike index ratio (deflation floor index ratio) is 1, as the anticipated strike inflation is 0%. The tau, or time to expiry, is about 2.74y. The implied vol in the market for this maturity and strike on April 15, 2009, was about 19.1bp/day (on the high side, as we had just emerged from the 2008 financial crisis, with inflation expectations running well below the Fed's mandate), or through maturity about 5% (19.1bp/day * sqrt(252*2.74y)/10000). With these inputs, a $100mn 2.74y deflation floor starting on April 17, 2009, has a premium of about $2mn.

CPI caps/floors are priced versus a CPI swaps curve, rather than breakevens, as the broker/dealer will take into account the balance sheet cost required in delta-hedging a CPI cap/floor position. CPI swaps generally trade richer than breakevens because to establish long CPI swaps (receive inflation) synthetically, the dealer must put on a breakeven position and lock in the relative ASWs (TIPS minus nominals). TIPS ASWs trade cheap to nominal ASWs; therefore, the synthetic CPI swap position comes out richer than cash breakevens. At the 10y point, the current relative spread is 30-35bp; that is, CPI swaps trade 30-35bp richer than cash breakevens. If the dealer does not lock in the relative ASWs position and only hedges with breakevens, when delta-hedging versus a CPI option, he/she is exposed to the spread between CPI swaps and cash breakevens.

Ideally, a dealer trading CPI options would prefer to hedge using the closest offsetting CPI options position, but given that the inflation derivatives market is not as liquid yet, the most likely scenario is that the dealer ends up delta-hedging directional risk.

Underlying hedging choice: Breakevens or CPI swaps? Answer: Breakevens, but beware of relative ASWs risks

If a dealer/investor sold a 0% strike floor (deflation floor) to a counterparty, the choices of underlying instrument to delta-hedge this are primarily a matched-maturity CPI swap and cash breakevens (TIPS versus matched-maturity nominals). In this case, the dealer will want either to pay inflation or to short breakevens (short TIPS, long matched-maturity nominals). Matched-maturity CPI swap and cash breakevens are essentially a forward on the market-implied CPI NSA at maturity. The CPI swap implied maturity CPI NSA will be at a higher level than a cash breakeven implied maturity CPI NSA, given the positive relative ASWs differential between the two.

The decision to choose a CPI swap or breakeven as a hedging instrument comes down to a few factors: balance sheet, liquidity and one's view on relative ASWs (TIPS minus nominals). A CPI swap does not require a balance sheet, while a breakeven position will. Additionally, a TIPS breakeven position is more liquid/transaction efficient (less cost) than a CPI swaps position. At the 10y point, a round trip on a CPI swap would be roughly +2bp (conservative estimate), while for breakevens it would be about 1bp. Given that delta-hedging requires frequent rebalancing, liquidity and transaction cost will be of the highest importance. In this situation, the investor will most likely choose cash breakevens as the hedge. On the last factor, because CPI caps/floors are based on CPI swaps, while the delta hedge is performed using cash breakevens, the trader has essentially expressed a view on relative ASWs (TIPS versus nominal ASWs). In a delta hedge, if investors are long TIPS breakevens versus a sold CPI cap position, they benefit if the relative ASWs compress (ie, TIPS liquidity improves relative to nominals), while if they are short TIPS breakevens versus a sold CPI floor, they benefit if the relative ASWs widen. The first effect of relative ASWs compression is demonstrated in the second delta-hedging example below.

Which breakeven security to delta hedge a CPI options position?

The first step is to start with the closest matched-maturity breakeven position to minimize the stub risk. If a perfect matched maturity is not available, we would prefer a slightly longer security to cover the entire inflation period. One thing to keep in mind is that CPI caps/floors are typically off a non-interpolated CPI every month, while breakevens (or the underlying long TIPS) are based off linearly interpolated CPI prints.

To hedge with near-ATM deflation floor TIPS or not?

Additionally, if a dealer sold a floor, he/she could avoid some sold gap/gamma risks by first being long the relative floors in the cash TIPS market; for example (as of April 4, 2012), one could be long April16 versus Jan16s versus a sold 4y floor. Assuming the dealer has hedged some of the delta by being long TIPS relative floors via this construction, one can calculate a net delta of the position and then hedge the rest of the delta away by being short breakevens on April16s or any nearby breakeven closest to maturity.

Obviously, all hedging considerations noted above are neutral of specific market views. The investor may decide a deflation floor should not have any value in the context of the Fed's reaction function and, thus, may choose not to hedge the gap/gamma risk on an OTM trade.

Two delta-hedging examples

1. A sold deflation floor on April 2009, expiring on January 15, 2012 (see Figure 1 for the specification): delta hedged by being short TIIJan12 breakevens.

2. A sold CPI cap @ 2% strike on April 2009, expiring on January 15, 2012 (see Figure 2 for the specification): delta hedged by being long TIIJan12 breakevens.

To do this exercise more efficiently, we constructed a breakeven return index for TIIJan12 (Figure 5). Appendix A shows how to construct such an index.

In a brief review of delta-hedging, in the continuous time Black log-normal model, an investor can replicate an aggregate pay-off (including the premium cost and maturity payoff) of any option position (assuming some constant volatility) by continuously maintaining a delta-hedged position (delta calculated with respect to assumed volatility) using the underlying forward, assuming a frictionless world and the underlying returns are normally distributed:

- Under Black assumptions, when implied vols equal realized vols
- Option Premium + Delta-Hedge P&L ~ Options Maturity Payoff

In practice, an option seller would follow a similar approach to offset a sold options position but delta-hedge in discrete times. At the inception of the trade (when selling an option to a counterparty), the seller will have to make some assumption about the realized volatility (which will affect the delta hedge P&L) in the underlying. If the starting volatility assumption is correct, the net P&L of the premium intake minus the aggregate P&L of the discrete delta hedge versus option payoff should be negligible. If the assumption (implied volatility on the option) is higher than realized volatility, the net P&L of premium intake minus the aggregate P&L of the discrete delta hedge should be positive versus the option payoff, on average, and vice versa.

Example 1: A sold deflation floor on April, 2009, expiring on January 15, 2012, hedged by being short TIIJan12 BE

Given the above parameters, the options price is about $2mn. In retrospect, we know the realized volatility of the forward CPI index implied by breakevens at each discrete monthly interval over the 2.74y period: 14.26bp/day. With this assumption, the 2.7y deflation floor price is about $1.3mn. With the benefit of hindsight, assuming a TIIJan12 BE-based discrete monthly delta hedge, we know the option is overpriced relative to the anticipated delta-hedge P&L by about $700K ($2mn-1.3mn). We are assuming breakeven returns are normally distributed.

On April 15, 2009, we sell a 0% floor, collect the $2mn premium and simultaneously begin delta-hedging the sold optionality (Figure 3). On the first day, the delta on the position is about 0.35, as we are OTM with respect to the CPI swap level of 0.93%. So we short $35mn in breakevens to offset the delta on our $100mn sold floor. One nuance is that had CPI options been based on cash breakevens (which traded at 10bp versus 93bp on CPI swaps), the floor delta would have been higher. As maturity approaches, CPI swaps and breakevens converge due to no-arbitrage. Hence, the CPI swap-based delta would be closer to the cash breakeven-based one.

Next month (May 15, 2009), due to a positive breakeven return of 0.34%, our delta hedge (short Jan12 BE) loses $0.118mn. The option delta is still 0.35. On June 15, 2009, BEs and CPI swaps widen sharply, the delta is reduced to 0.21 and BE returns 2.37%. We take another $0.82mn loss on a $35mn short breakeven position and then reduce the position by $14mn, to $21mn, in accordance with the model delta. Our net delta-hedging P&L is now -$0.948mn. From June 15, 2009, forward, Figure 3 records the delta hedges through the maturity of the option on a monthly basis and notes the cumulative delta-hedging loss of $1.28mn. We collect about $2mn in premium; netting it with the delta-hedging loss, we end up with about $700k P&L. The deflation floor expired out of the money at the end of the holding period, as the Fed embarked on several quantitative easing programs to avoid a deflationary outcome.

Hence, we do not return a payoff to the buyer of the option. In total, the position aggregate P&L added up to the difference between the option valued at implied vol of 19.1bp/day versus the option valued at realized vol of 14.26bp/day. Clearly, transacting in breakevens will require bid-ask costs, which will subtract from the P&L. In the example below, the option expires on January 15, 2012, but its delta goes to zero almost a year before the option expiry. CPI option sellers can choose to delta-hedge according to their view or in a systematic manner with respect to the change in delta, rather than on monthly prints. This exercise reaffirms the fact that in valuing options under the Black framework, it is the volatility of the hedging instrument (breakevens or forward CPI expectations) that matters, not the volatility of the m/m CPI prints, from now until the forward CPI date.

FIGURE 3

Delta-hedging (using Jan12 breakevens) for a sold deflation floor (maturing January 15, 2012) on April 15, 2009

Date	Option premium	BE	CPI swap	BE return	Delta	Delta hedge P&L	Cumulative hedge (P&L)	Delta hedge	Change position	New position
4/15/2009	$2.08	0.11%	0.93%		-0.35		$0.00	(35.00)	$0.00	-$35.00
5/15/2009	$1.66	0.09%	0.58%	0.34%	-0.35	-$0.118	-$0.118	(35.12)	-$0.12	-$35.00
6/15/2009	$0.82	0.97%	1.52%	2.37%	-0.21	-$0.829	-$0.948	(35.83)	-$14.83	-$21.00
7/15/2009	$1.12	0.32%	0.89%	-1.34%	-0.28	$0.282	-$0.665	(20.72)	$7.28	-$28.00
8/17/2009	$1.15	0.17%	0.91%	0.24%	-0.27	-$0.066	-$0.731	(28.07)	-$1.07	-$27.00
9/17/2009	$0.78	0.60%	1.01%	1.27%	-0.21	-$0.343	-$1.074	(27.34)	-$6.34	-$21.00
10/19/2009	$0.48	0.85%	1.33%	0.52%	-0.16	-$0.109	-$1.183	(21.11)	-$5.11	-$16.00
11/19/2009	$0.29	0.95%	1.38%	0.28%	-0.12	-$0.045	-$1.228	(16.05)	-$4.05	-$12.00
12/21/2009	$0.31	1.06%	1.46%	0.21%	-0.13	-$0.026	-$1.254	(12.03)	$0.97	-$13.00
1/21/2010	$0.22	1.38%	1.71%	0.59%	-0.10	-$0.077	-$1.331	(13.08)	-$3.08	-$10.00
2/22/2010	$0.18	1.48%	1.63%	-0.05%	-0.09	$0.005	-$1.326	(10.00)	-$1.00	-$9.00
3/22/2010	$0.14	1.47%	1.76%	0.05%	-0.08	-$0.004	-$1.331	(9.00)	-$1.00	-$8.00
4/22/2010	$0.11	1.60%	1.74%	0.22%	-0.07	-$0.018	-$1.349	(8.02)	-$1.02	-$7.00
5/24/2010	$0.15	0.79%	1.27%	-1.06%	-0.09	$0.075	-$1.274	(6.93)	$2.07	-$9.00
6/24/2010	$0.13	0.63%	0.96%	-0.06%	-0.08	$0.005	-$1.269	(8.99)	-$0.99	-$8.00
7/26/2010	$0.11	0.55%	0.76%	-0.06%	-0.08	$0.000	-$1.269	(8.00)	$0.00	-$8.00
8/26/2010	$0.09	0.52%	0.65%	-0.15%	-0.07	$0.017	-$1.252	(7.98)	-$0.98	-$7.00
9/27/2010	$0.05	0.59%	0.84%	0.04%	-0.05	-$0.003	-$1.255	(7.00)	-$2.00	-$5.00
10/27/2010	$0.02	0.93%	1.12%	0.47%	-0.02	-$0.023	-$1.278	(5.02)	-$3.02	-$2.00
11/29/2010	$0.01	0.74%	1.00%	-0.21%	-0.01	$0.004	-$1.274	(2.00)	-$1.00	-$1.00
12/29/2010	$0.00	1.42%	1.50%	0.72%	0.00	-$0.007	-$1.281	(1.01)	-$1.01	$0.00
1/31/2011	$0.00	1.80%	1.92%	0.27%	0.00	$0.000	-$1.281	-	$0.00	$0.00
2/28/2011	$0.00	2.43%	2.57%	0.56%	0.00	$0.000	-$1.281	-	$0.00	$0.00

Source: Barclays Research

Example 2: A sold CPI cap at 2% strike on April 2009, expiring on January 15, 2012, hedged by being long TIIJan12 BE

Here, we go through the exact same exercise but hedge a sold 2% CPI cap with long Jan12 breakevens. The option premium intake assuming implied 19.1bp/day volatility is about $2mn. Realized breakeven forward CPI volatility through the hedging period is about 14.3bp/day, giving a fair value of the option at about $1.3mn, the net difference of about +$700k. Thus, we expect about +$700k P&L from our delta-hedging exercise (Figure 4).

With discrete delta-hedging on a monthly basis, we collect the $2mn premium and start the delta hedge with a long 0.36 units of Jan12 breakevens. Once again, because CPI swaps are the underlying for CPI options and are richer than our hedging instrument of cash breakevens, the starting delta is higher. In this sense, as liquidity improves in the TIPS market and breakevens converge with CPI swaps, we would expect further positive P&L. As economic conditions improve starting in 2009, breakevens widen and the hedge gains, but our delta exposure gradually increases until we are long $100mn of TIIJan12 breakevens to hedge \$100mn 2% CPI caps. The delta hedge in this case made about +\$2.6mn (Figure 4). On the offsetting side, the realized inflation through the holding period turned out to be greater than 2% (strike), at roughly 2.75%; thus, we had to pay the option buyer about \$2mn as a terminal payoff, essentially wiping out the premium intake. So the question remains: why did the breakeven delta hedge make \$2.6mn versus our expected gain of +700K, OptionVal (impliedVol)- OptionVal (realizedVol)? The answer lies in the difference between CPI swaps and cash breakevens; Jan12 cash breakevens traded 75-80bp cheaper to CPI swaps. Our delta hedge was calculated with respect to CPI swaps, but we hedged with cash breakevens. As the maturity of the option approached, the relative ASWs spread compressed as TIPS liquidity improved. The 75-80bp compression over 2.7y tau implied an additional breakeven gain versus the CPI swap of about \$1.90mn. Thus, our P&L net of CPI swap versus cash breakeven compression is +700k. Therefore, depending on one's view of the relative ASWs, when hedging a sold CPI cap, one should account for the relative ASWs (CPI swaps versus breakevens) and the relative delta difference it may cause.

FIGURE 4

Delta hedging (using Jan12 breakevens) for a sold 2% CPI cap (maturing January 15, 2012) on April 15, 2009

Date	Option premium	BE	CPI swap	BE return	Delta	Delta hedge P&L	Cumulative hedge (P&L)	Delta hedge	Change position	New position
4/15/2009	\$2.00	0.11%	0.93%	0.000%	0.36	0	\$0.00	\$36.00	\$0.00	\$36.00
5/15/2009	\$1.23	0.09%	0.58%	0.338%	0.30	\$0.12	\$0.12	\$36.12	\$6.12	\$30.00
6/15/2009	\$2.13	0.97%	1.52%	2.370%	0.44	\$0.71	\$0.83	\$30.71	-\$13.29	\$44.00
7/15/2009	\$1.46	0.32%	0.89%	-1.344%	0.35	-\$0.59	\$0.24	\$43.41	\$8.41	\$35.00
8/17/2009	\$1.67	0.17%	0.91%	0.235%	0.38	\$0.08	\$0.32	\$35.08	-\$2.92	\$38.00
9/17/2009	\$1.94	0.60%	1.01%	1.269%	0.43	\$0.48	\$0.81	\$38.48	-\$4.52	\$43.00
10/19/2009	\$1.85	0.85%	1.33%	0.521%	0.46	\$0.22	\$1.03	\$43.22	-\$2.78	\$46.00
11/19/2009	\$1.70	0.95%	1.38%	0.282%	0.47	\$0.13	\$1.16	\$46.13	-\$0.87	\$47.00
12/21/2009	\$1.82	1.06%	1.46%	0.214%	0.48	\$0.10	\$1.26	\$47.10	-\$0.90	\$48.00
1/21/2010	\$1.95	1.38%	1.71%	0.594%	0.52	\$0.29	\$1.55	\$48.29	-\$3.71	\$52.00
2/22/2010	\$1.70	1.48%	1.63%	-0.049%	0.50	-\$0.03	\$1.52	\$51.97	\$1.97	\$50.00
3/22/2010	\$1.58	1.47%	1.76%	0.050%	0.50	\$0.02	\$1.54	\$50.02	\$0.02	\$50.00
4/22/2010	\$1.61	1.60%	1.74%	0.220%	0.51	\$0.11	\$1.65	\$50.11	-\$0.89	\$51.00
5/24/2010	\$1.12	0.79%	1.27%	-1.065%	0.42	-\$0.54	\$1.11	\$50.46	\$8.46	\$42.00
6/24/2010	\$0.96	0.63%	0.96%	-0.060%	0.40	-\$0.03	\$1.09	\$41.97	\$1.97	\$40.00
7/26/2010	\$0.80	0.55%	0.76%	-0.058%	0.37	-\$0.02	\$1.06	\$39.98	\$2.98	\$37.00
8/26/2010	\$0.66	0.52%	0.65%	-0.149%	0.34	-\$0.06	\$1.01	\$36.94	\$2.94	\$34.00
9/27/2010	\$0.60	0.59%	0.84%	0.039%	0.34	\$0.01	\$1.02	\$34.01	\$0.01	\$34.00
10/27/2010	\$0.57	0.93%	1.12%	0.467%	0.36	\$0.16	\$1.18	\$34.16	-\$1.84	\$36.00
11/29/2010	\$0.35	0.74%	1.00%	-0.206%	0.31	-\$0.07	\$1.11	\$35.93	\$4.93	\$31.00
12/29/2010	\$0.47	1.42%	1.50%	0.718%	0.39	\$0.22	\$1.33	\$31.22	-\$7.78	\$39.00
1/31/2011	\$0.61	1.80%	1.92%	0.267%	0.49	\$0.10	\$1.43	\$39.10	-\$9.90	\$49.00
2/28/2011	\$0.86	2.43%	2.57%	0.564%	0.64	\$0.28	\$1.71	\$49.28	-\$14.72	\$64.00
3/28/2011	\$1.22	2.99%	3.52%	0.661%	0.79	\$0.42	\$2.13	\$64.42	-\$14.58	\$79.00
4/28/2011	\$1.44	3.32%	3.13%	0.488%	0.97	\$0.39	\$2.52	\$79.39	-\$17.61	\$97.00
5/31/2011	\$1.37	1.81%	1.83%	-0.180%	0.97	-\$0.17	\$2.34	\$96.83	-\$0.17	\$97.00
6/30/2011	\$1.34	0.86%	0.87%	0.038%	0.99	\$0.04	\$2.38	\$97.04	-\$1.96	\$99.00
8/1/2011	\$1.57	0.62%	0.52%	0.326%	1.00	\$0.32	\$2.70	\$99.32	-\$0.68	\$100.00
9/1/2011	\$1.36	0.31%	0.34%	-0.262%	1.00	-\$0.26	\$2.44	\$99.74	-\$0.26	\$100.00
10/3/2011	\$1.90	-0.15%	2.09%	-0.037%	1.00	-\$0.04	\$2.40	\$99.96	-\$0.04	\$100.00
11/3/2011	\$1.60	-0.29%	0.01%	0.256%	1.00	\$0.26	\$2.66	\$100.26	\$0.26	\$100.00

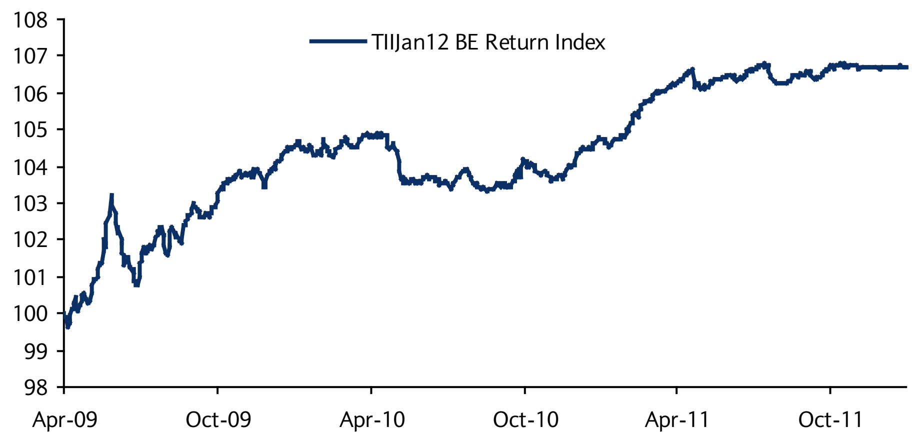
Source: Barclays Research

Appendix A: Some investors have asked how to calculate returns on breakevens. While conceptually it is clear that a long breakeven position is essentially a contract on a forward CPI index, and on a held-to-maturity basis investors will gain or lose by the amount that realized CPI comes in above or below the market-implied CPI, it is still useful to understand how to approximate returns on a marked-to-market breakeven position. Such a position is constructed by being long TIPS versus a short comparable nominal position, DV01 weighted (to see how relative weight is set up, please see *the forwards article from January 14, 2010*). Thus, a breakeven return is equal to:

BE Return = TIPSReturn – (TIPSStartingDuration/ComparatorStartingDuration)*
ComparatorReturn

Figure 5 shows the TIIJan12 BE return index starting from April 15, 2009. At the beginning of the period, the market was priced for annualized inflation of about 0.11%, or 0.29% total through the holding period. Cumulative inflation turned out to be close to 7%. Hence, the TIIJan12 breakeven return index climbed to 106.70.

FIGURE 5
TIIJan12 BE return index starting from April 15, 2009



Source: Bloomberg, Barclays Research

In calculating approximate breakeven returns, we first calculate TIPS returns for any holding period. For example, we can calculate TIIJan2012 TIPS returns from April 15, 2009, to May 15, 2009, by calculating the price return and coupon returns in the following manner:

- On April 15, 2009, $100 face value TIIJan12 (coupon: 3.375%) price is 106.5625, with an index ratio of 1.19187 (modified duration: 2.75).
- On May 15, 2009, $100 face value TIIJan12 (coupon: 3.375%) price is 106.219, with an index ratio of 1.19633.
- Inflation-adjusted price return: May15Idx_Ratio *May15Price – Apr15Idx_Ratio*Apr15 Price: 1.19633*106.219-1.191865*106.525 = $0.065.
- Earned coupon through the holding period: May15Idx_Ratio * 3.375 * (30/365): $0.332.
- Total $ return: 0.40.
- Total % TIPS return: 0.40/(106.5625*1.19633) = 0.31%.

During the same period, the total comparable nominal return (using T 4.25 January 2012 issue, starting modified duration: 2.62) was about -0.03%. Using the formula above, we approximate the BE return through the holding period to be:

0.31% - (2.75/2.62)*-0.03% = 0.34%.

Total Return Swaps

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We examine the basics of a total return swaps (TRS) as they apply to inflation products. We discuss their applications and the dealers' valuation perspective, as well as the risks in such transactions.

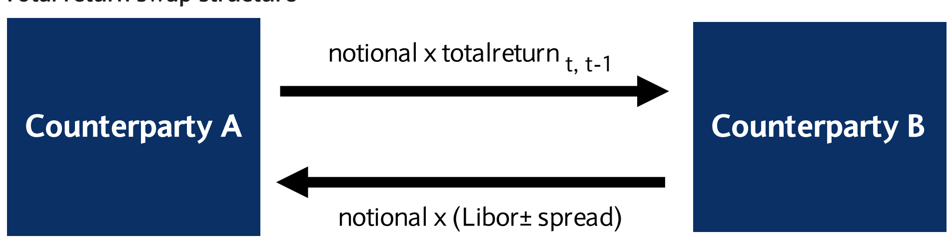
One way for investors who are interested in getting real returns without taking on inflation-linked securities on their balance sheets is to execute an over-the-counter inflation-linked based total return swap (TRS) with a dealer.

Total return swap: What is it?

A TRS is an over-the-counter transaction in which an investor (asset total return receiver) receives all cash flows (including coupons and market value changes) related to a referenced asset (for example, a TIPS index or particular TIPS security) in return for paying a floating leg (typically Libor) plus/minus a fixed spread in a periodic fashion (Figure 1). In other words, the investor does not own the underlying asset on its balance sheet but receives returns associated with the asset by paying a fee. The notionals and maturities (term or maturity of the swap) are set at the inception of the trade. Typically, the maturity can be set as long as one year. The underlying asset can be any instrument(s) (a single bond, a portfolio of bonds, index, etc). Investors can take a long or a short position with respect to the reference asset in such a transaction.

The spread applied to the floating side of the swap is required to compensate the dealer for the balance sheet cost of holding the asset or assets underlying the agreement. The credit rating of the institution offering the swap can also have a bearing on the pricing, with those with a lower rating potentially requiring less spread to hold the assets. While there is a counterparty credit risk involved in a total return swap, this can be mitigated by ISDA plus CSA agreements or frequent resets of the swap.

FIGURE 1
Total return swap structure



Source: Barclays Research

Structure and hypothetical example

- To conduct a TRS trade, ISDA and CSA are required.
- Tenor: Flexible; Can be as long as one year. 1m to 1y generally.
- Resets: Flexible; Typically monthly or quarterly, with semi-annual also possible.
- Price: Typically quoted as Libor + X (basis point spread, includes funding and replication costs.
- Early termination/notional adjustment: Possible, usually subject to early unwind charges, and notional adjustments are subject to negotiations.

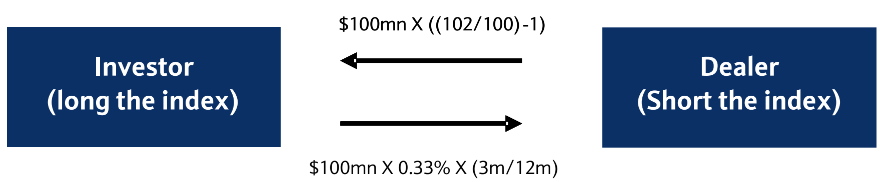
The hypothetical example in Figure 2 shows the mechanics of a 6m maturity TRS at each point. The underlying reference asset is the US TIPS index.

FIGURE 2
Mechanics and cash flows of a TRS, as of June 6, 2014

Parameter	Value
Inception	June 6, 2014
Reference Index	US TIPS Index
Initial Notional	$100mn
TRS Tenor	6m
TRS Reset	Quarterly
Initial TIPS Total Return Index Fixing	100
Initial 3m Libor Fixing	0.23%
Spread over 3m Libor (bp)	10

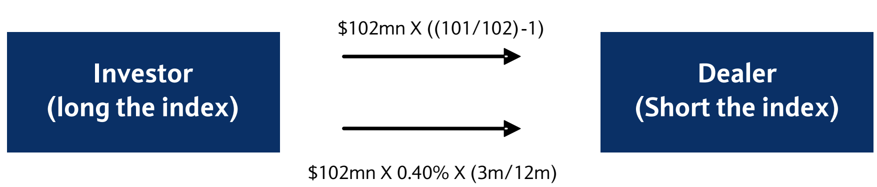
Source: Barclays Research

- Inception TIPS TR Index value: 100
- TIPS TR Index at the end of 3m: 102
- Libor reset plus 10bp spread from previous date: 0.23% + 0.10% = 0.33%
- Investor receives index return of 2% and pays 8.25bp of quarter period Libor on a $100mn notional.



At maturity:

- Previous TIPS TR Index value: 102
- Current Index value: 101
- Libor reset plus 10bp spread from previous date: 0.30% + 0.10% = 0.40%
- Investor pays index return of 0.98% to the dealer and pays 10bp of quarter period Libor on a $102mn notional.



Range of TRS usage in inflation product

Total return swaps do not have to be linked to a particular security. Indeed, swaps on indices are typically more common than on individual bonds in the inflation-linked space, often of specific maturity subsets, rather than whole market indices. TRS are actively used for individual bonds and indices in US TIPS and UK linkers and for euro area inflation-linked, including country and maturity, sub indices. They can also be used as a means to access less liquid inflation markets, with bond-specific and broad index allocations. Note that the floating rate referenced in a TRS need not necessarily be in the same currency as the underlying asset. Indeed, total return swaps can be based on index returns spanning a number of different markets, for instance, global inflation-linked indices such as the Barclays Emerging Market Tradable Inflation-linked Bond Index (EMTIL). Another way in which TRS are used is to gain exposure to the performance of an inflation-linked bond in asset swap without having to own the underlying bond, though usually the TRS on the bond and the real rate cash flows are considered separately in such positions.

Valuation perspective

TRS valuations versus Libor tend to reflect the funding value of the underlying assets plus a spread embedding transaction expenses and the cost of using the balance sheet of the counterparty. As of June 6, 2014, the US TIPS index-based TRS was trading at indicative levels of Libor + 10bp for a one-year period. It is worth noting that balance sheet costs have been increasing. In essence, a total return payer can hedge the inflation-linked TRS by buying the underlying security and funding it on balance sheet and selling it at the swap maturity. The funding cost for the total return payer will drive the spread for the TRS. When a TRS is made with a portfolio of bonds or an inflation linked index, the payer will have to buy the underlying index. However, the bid-offer will typically be lower than replicating individual bonds because the TRS dealer would aggregate positions across his/her portfolio, thereby reducing the relative hedging costs. The index swap dealer is also likely more comfortable taking on outright market risks and basis risks than an investor who is trying to outperform/match a benchmark.

Uses of a TRS: Portable alpha, leverage, exposure …

- One of the attractions of a TRS is leveraging a dealer's balance sheet. For example, a buyer can be long $100mn worth of TRS without having to buy the assets for that money, just by paying a fee on the notional. It also enables investors to obtain off-balance-sheet exposure to assets in which they might not be able to invest directly.

- Buying and selling index swaps may be cheaper than individually trading in and out of an asset class operationally and in terms of bid/offers.

- In terms of trading, TRS allow a payer to short an asset without actually selling it. This may be useful for someone who is managing a portfolio against an index but expects near-term underperformance. Also, customization in terms of maturity and underlying security selection allows for a better synthetic structure.

- Investors can also benchmark their portfolios to standard inflation indices and reduce tracking error.

- Most important, using TRS to source a benchmark "beta" return frees up capital to pursue alpha opportunities. For example, receiving TIPS index returns in a TRS has the potential for outperformance, so long as the investor can earn better than the financing rate he/she pays on the Libor leg of the transaction.

Users of TRS

Typical users of a TRS would be pension funds, asset managers, insurers, hedge funds, foundations/endowments, and index tracker funds/ETFs. The reasons for usage vary significantly, even within the same type of investor, with the flexibility that they offer attractive to most that are able to trade them. Typically pension funds, endowments, and ETF managers are focused on getting exposure to benchmark indices in an efficient manner. In Europe in particular, pension funds often focus on the effective leverage that can be added through TRS, particularly when the underlying assets have low expected returns but improve liability matching. Asset managers and insurers tend to focus on achieving beta returns in a single off-balance-sheet transaction, to allow them to focus on active management for alpha generation. TRS provide the flexibility for them to create products using asset classes away from their core competencies. Hedge funds tend to focus on accessing markets that are otherwise inaccessible, saving costs on custodial accounts and the flexibility that TRS offer in terms of maturity, payout currency, and leverage.

Risks of TRS

- In an unfunded format, a TRS allows for significant portfolio leverage, which could be risky for overall asset management.
- A total return swap is an OTC contract and exposes the investor to the credit risk of the counterparty dealer. To some extent, this can be mitigated by monthly resets and collateralization of the NPV, in line with the CSA agreement between the investor and the dealer.
- Last, the investor is exposed to resets on floating leg spreads. This becomes important if one wants to get a long-term exposure to an asset class.

Inflation Markets

INFLATION MARKETS

US

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The US Treasury began issuing inflation-linked bonds, most commonly known as TIPS, in 1997. By 2000, TIPS had overtaken the UK inflation-linked market to become the largest market of its type, reaching a total market value of $1trn by April 2014. As of May 2014, TIPS make up about 45% of the Barclays World Government Inflation Bond Index. The Treasury has varied its issuance pattern over time and currently issues at 5y, 10y and 30y maturities in monthly auctions. At the end of 2013, TIPS made up about 8.2% of outstanding marketable Treasury debt, and we estimate they will make up about 11% of net Treasury coupon issuance in 2014. Despite the depth of the TIPS market and the commitment from the Treasury, there is not much corporate issuance, and inflation derivative activity is relatively limited, although the use of swaps and asset swaps continues to increase.

The Inflation Index – CPI-U

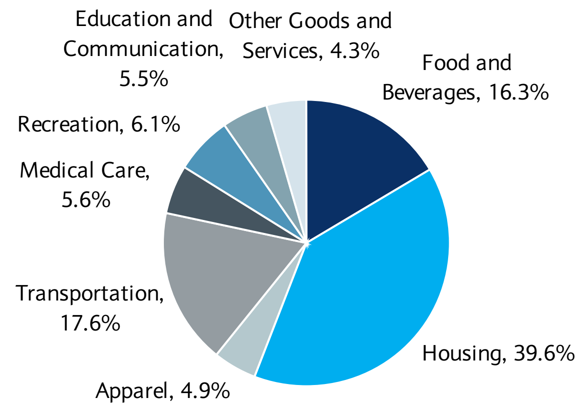
The Inflation Index used for TIPS is the not seasonally adjusted US City Average All Items Consumer Price Index for all Urban Consumers (CPI-U), which measures price changes for urban consumers of a fixed basket of goods and services of constant quality and quantity. Prices are collected from 85 urban areas, which include 21,000 retail and service establishments. Rents data are gathered from 40,000 landlords and tenants. Prices are collected for over 200 categories, which are classified under eight major groups.

Breakdown of CPI-U components

The basket of goods and services and the item weights are determined from the Consumer Expenditure Survey (CEX). Since the CPI is a fixed-weight index, the implicit weights remain the same from month to month. A related concept is the relative importance of an item. This means, in essence, that if the price of a particular item rises more than the average price increase of items in the basket, the relative importance of that item increases. To illustrate, the price of crude oil, as measured by the WTI, rose from about $20 per barrel in January 2002 to near $140 per barrel in June 2008. One result is that the relative importance of energy rose from 6.2% to 12% during the same period, and then fell to 7.6% at the end of 2008 as energy prices declined. Figures 1 and 2 highlight the change in the relative importance of the eight major categories from 1997 to those in 2014. Annual relative importances are typically released in mid-February for the previous year.

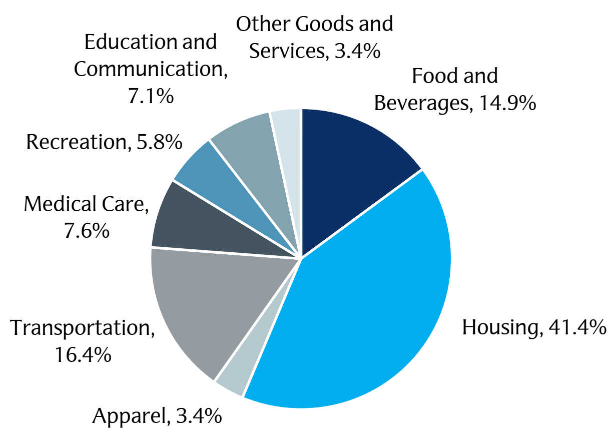
As can be seen from Figure 2, one of the most significant categories in terms of weights is housing, over half of which is an imputed measure called "Owners' equivalent rent of primary residence" (OER), which attempts to capture price changes if those consumers who own their home were to rent instead. BLS measures the change in implicit rents over time by matching owner units to renter units with similar characteristics. The characteristics include location; structure type; and other general traits such as age, number of rooms and type of air conditioning. As owners pay for utilities separately, BLS calculates the 'pure' rent of the matched renters by removing the value of any landlord-provided utilities and furniture. As utility prices tend to fluctuate more than actual rents, imputed pure rents tend to be negatively correlated with utility prices, primarily natural gas prices. Before 1983, the BLS used an asset price approach in computing the shelter component of CPI; because this method was driven by interest rates and house prices, it was much more volatile than the current method, and core CPI volatility has declined since.

FIGURE 1
1997 CPI-U relative importances



Source: Haver Analytics, Barclays Research

FIGURE 2
2014 CPI-U relative importances



Source: Haver Analytics, Barclays Research

Energy prices can also have a significant effect on m/m CPI prints and are historically responsible for more than 50% of the volatility there. Energy currently makes up about 9% of the total CPI basket. This weight has grown since TIPS were first issued, so energy is even more important to inflation-linked investors now than in prior years. While the BLS only publishes the relative importance for each December, the weightings do change from month to month. As seasonal factors affecting Energy CPI are at their worst in December, the BLS relative importance data understate the average weight of energy. Gasoline (Motor Fuel) is the most important component of Energy CPI, because its weight is higher and because it tends to be more volatile than the other components: electricity, home fuel oil and utility gas service (natural gas).

TIPS market history

While officially called Treasury Inflation-Indexed Securities (TIIS), the more common name used by market participants (including the Treasury) is Treasury Inflation-Protected Securities (TIPS). In this article, we use the latter, given that it is the market convention. The US Treasury first issued inflation-protected securities in 1997, in order to broaden its investor base, diversify and potentially reduce its debt service costs and create liabilities that were more closely aligned with the government's main asset – tax revenues. Initial issuance was in 5y, 10y and 30y securities, and after many changes to the calendar, the Treasury has come full circle and has been issuing at those maturity points since 2010. TIPS are structured such that they pay a fixed coupon on a principal amount, which is adjusted for inflation. The inflation index used is the not seasonally adjusted headline CPI. There is a par floor on the principal at maturity, so the investor is protected from deflation from issue date to maturity, but not in between. A historical synopsis of the TIPS program is presented in Figure 3.

FIGURE 3

TIPS program historical milestones

Date	Event
5/16/1996	Treasury Secretary Rubin announces the intention to issue Treasury inflation-indexed securities (http://www.treas.gov/press/releases/rr1073.htm)
9/25/1996	President Clinton and Treasury Secretary Rubin announced the terms and conditions of the first Treasury inflation-indexed security
1/29/1997	First 10y TIPS auction
4/9/1997	First 5y TIPS auction
4/8/1998	First 30y TIPS auction
6/30/1998	Final rules on fungible inflation-indexed STRIPS were published
9/1/1998	Treasury begins selling series-I savings bonds
9/29/1998	Treasury announces regular quarterly schedule for TIPS and discontinues 5y TIPS
1999	Fed conducts first TIPS pass
11/30/2000	TIPS are stripped for the first time
10/31/2001	Treasury eliminates 30y TIPS because of lower borrowing needs
7/15/2002	First 5y TIPS matures
4/18/2002	Treasury conducts TIPS buyback
4/30/2003	Treasury expands 10y TIPS auctions to four per year with two new issues per year
2/8/2004	CPI futures begin trading at CME
5/5/2004	Treasury announces the introduction of 20y TIPS and reintroduction of 5y TIPS
7/27/2004	First 20y TIPS auction
10/26/2004	First reintroduced 5y TIPS auction
1/15/2007	First 10y TIPS matures
1/22/2008	TIPS index market value hits $500bn
2/29/2008	5y real yield goes negative for the first time
11/20/2008	10y breakevens touch zero during financial crisis
1/18/2009	Fed includes TIPS in "QE1"
2/22/2010	First reintroduced 30y TIPS auction
11/3/2010	Fed includes TIPS in "QE2"
2011	Treasury moves to monthly TIPS auctions
9/21/2011	Fed includes TIPS in "Operation Twist"
4/30/2012	Treasury provides data on foreign ownership of TIPS in its annual TIC holdings report
12/12/2012	Fed includes TIPS in 'QE3'
4/11/2013	FRBNY begins to break out TIPS trading volume and primary dealer positions by maturity
May/June 2013	Fed 'taper-talk' causes a 100+bp rise in 10y real yields
4/11/2014	TIPS index market value hits $1trn

Source: US Treasury, Barclays Research

There was limited initial support for TIPS, as investors used them primarily as a tactical trading vehicle. The small number of participants resulted in low trading volumes and a low beta to nominal yields. Breakevens were generally the main catalyst for investment decisions. In November 2000, the iSTRIPS market was launched when the TII08s became the first TIPS to be stripped. iSTRIPS allow investors to trade the TIPS coupon and principal components separately, where the principal component carries the floor, although to date there has been only scarce interest in iSTRIPS. While iSTRIPS have not been a success, it was important that the Treasury encourage stripping activity as a sign of its commitment to the TIPS program when many market observers were questioning the durability of the asset class. Despite this commitment, the Treasury reduced TIPS issuance commensurate with reductions in the nominal calendar until only an annual 10y note, with just one re-opening auction, existed in 2001 (Figure 4).

With five years of history and the 5y TIPS issued in 1997 having matured in 2002, the TIPS market finally started to gain broader acceptance. Consultants began recommending TIPS in earnest, and due diligence and approval processes were introduced. There was also increased interest in real return mutual funds and other funds tied to the TIPS Index as investors began to make diversification allocations into TIPS as a new "asset class."

Increasing demand led to significant growth in 2004, as the Treasury issued nearly as many TIPS that year as it did in the previous three. It also announced a major expansion of the program to include two 5y auctions and two 20y auctions per year, in addition to the existing quarterly 10y note auction cycle. Alongside growth in the cash market was a developing inflation derivatives market. CPI futures began trading at the CME in early 2004, and volume in the CPI swaps market increased significantly along with issuance in inflation-linked corporate notes. The US inflation market continued to develop in 2005, particularly on the derivative and structured note side.

From 2005 to mid-2008, average daily trading volume leveled off because of an increase in demand from structural investors such as pension funds and insurance companies, where investments tend to be passive in nature. Related to this demand was significant growth in Inflation-Linked Total Return Swaps activity from investors looking to receive the return of the TIPS Index or a Global Inflation-Linked Index in a passive way.

There was a significant shift in the investor base beginning in the second half of 2008. After making up about 50% of TIPS market flows in 2007, hedge funds largely exited the asset class during the financial crisis. After the market cheapened significantly following this deleveraging process, real money investors began to increase structural allocations significantly. Foreign central banks began to buy because of diversification benefits and as a *de facto* currency hedge. As of June 2013, foreign official institutions held about 24% of the TIPS market. Domestic real money increased structural allocations in part because of medium-term inflation risks associated with stimulative fiscal and monetary policy and because of a realization by many that the right allocation to TIPS within a well diversified portfolio is not zero. However, retail fund flows began to turn negative in the fall of 2012 and this trend accelerated when real yields sold off sharply following talk, in May and June 2013, from Fed officials that it was likely to taper its QE3 asset purchases. The Fed has been buying (and selling) TIPS as part of its Treasury open market operations known as QE1, QE2, Operation Twist and QE3, though it appears that those purchases will end in either October or December of 2014. The Treasury has responded to rising structural investor demand by increasing gross issuance from $58bn in 2009 to a projected $155bn in 2014. With this growth, the market value of the TIPS index breached $1trn in April 2014.

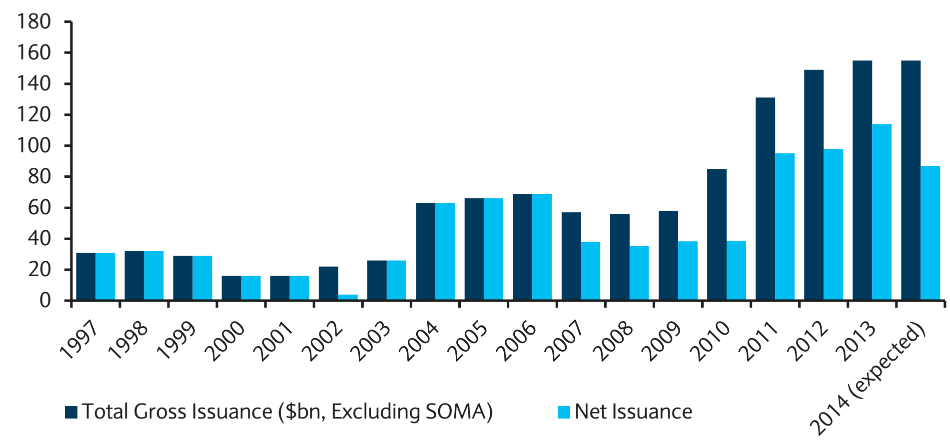
TIPS issuance summary

Figure 4 shows annual TIPS issuance since 1997. While issuance in the first three years of the program was just above $30bn per year, it declined to only $16bn in 2000 and 2001. The reduction, however, was not a reflection on the TIPS program but rather on the effect of budget surpluses, as all Treasury issuance was being reduced. With the return to deficits in 2002, issuance began to grow and the $63bn issued in 2004 was equal to all TIPS issuance in the prior three years. TIPS issuance grew only modestly, by $6bn, from 2004 to 2005, but other Treasury issuance was being reduced, so the TIPS market grew on a relative basis (Figure 5).

The figure also shows that TIPS issuance has been generally increasing relative to other coupon-bearing Treasury issuance, particularly since 2003. After picking up in 2006, TIPS issuance slowed in 2007 on an outright basis and relative to nominal coupon issuance as the Treasury became proactive in slowing the growth rate of the program as it matured. It held TIPS issuance steady at $56-58bn gross and $35-38bn net during 2007-09, even as it increased nominal issuance significantly and the percentage of Treasury debt represented by TIPS fell from a peak of 10.6% in late 2008 to less than 8% by the end of 2009. After recommitting to the asset class and aiming to improve the liquidity of the program, the Treasury increased gross TIPS issuance to $85bn in 2010, $131bn in 2011, and $149bn in 2012. It then slowed the pace of increase in 2013, when gross issuance was $155bn, and has guided the market to expect unchanged issuance in 2014. Because of these increases, TIPS as a percentage of outstanding Treasury debt has increased from 6.9% in February 2011 to 8.2% in April 2014, though this is still down from its peak of 10.7% in July 2008 (Figure 6).

FIGURE 4

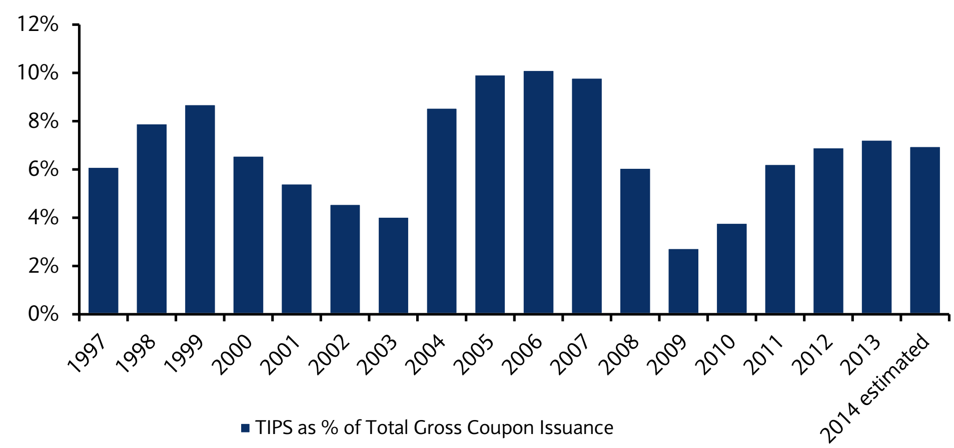
Annual TIPS issuance ($bn)



Source: US Treasury, Barclays Research

FIGURE 5

TIPS issuance as a % of all Treasury note and bond issuance

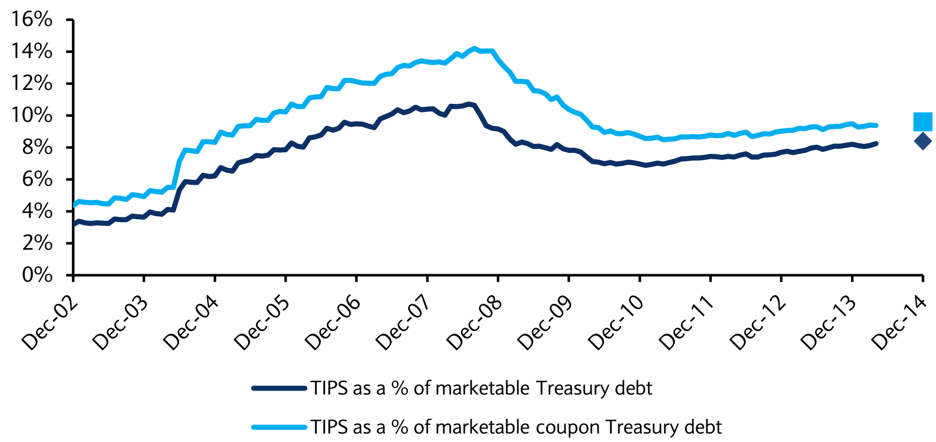


Source: US Treasury, Barclays Research

Increased issuance has driven an improvement in liquidity as well. In the initial years of market development, trading volumes tended to spike only around auction weeks, as they were seen as liquidity events in an otherwise low-volume product. While auction periods are still seen as liquidity events, this pattern has changed and trading volumes are more consistent, particularly now that there is a TIPS auction every month, whereas before 2010 the Treasury held TIPS auctions in at most four months of the year. While trading volume increased only slightly over 2000-02, when it averaged $1.87bn per day, it was $3.73bn in 2003, and average daily trading volume increased significantly in late 2004; it was $5.95bn in 2004 and took a sizable jump up to $8.77bn in 2005 (Figure 7). Trading volume then levelled off at $8-10bn/day until the financial crisis. From late 2008 to mid-2010, average daily trading volume declined to a trend near $4.5-5bn. This is because of the structural shift from hedge funds to real money investors, who typically take more of a buy-and-hold approach to investing so tend to trade less. Volume has been increasing since mid-2010, likely because of increased issuance and market size, and has averaged just less than $12bn since the start of 2012.

FIGURE 6

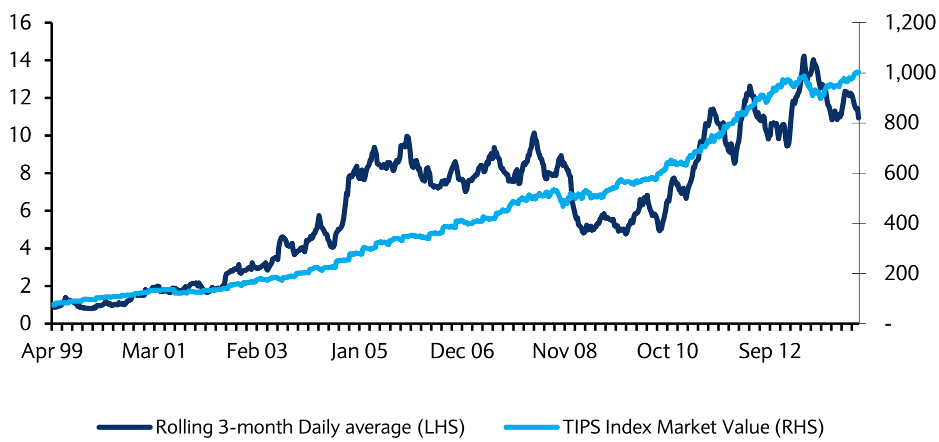
TIPS as a % of Treasury debt



Source: US Treasury, Barclays Research

FIGURE 7

TIPS market value and average daily volume ($bn)



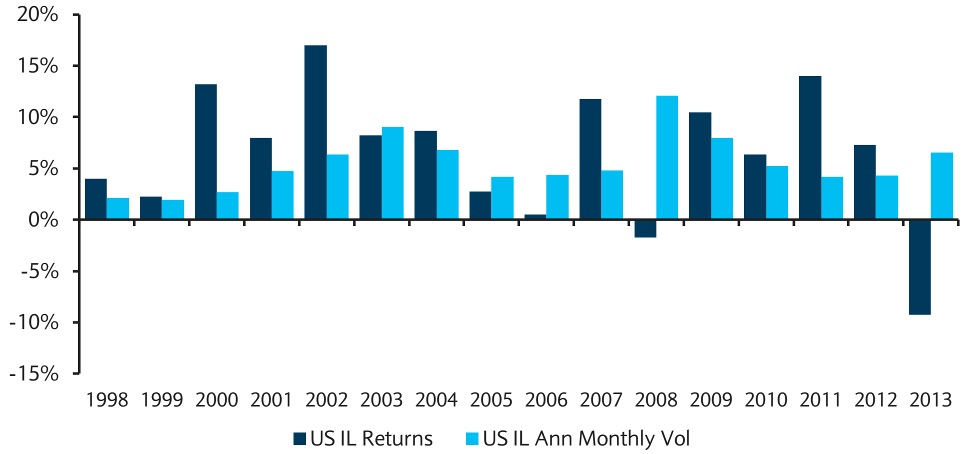
Source: Bloomberg, Federal Reserve, Barclays Research

Returns

Through 2013, TIPS have had an annualized return since inception of 6.07%. This compares with the 6.13% annualized return on a basket of comparable maturity nominal Treasuries. The greatest annual return for TIPS was 17% in 2002, and the worst was -9.26% in 2013; the only other year that the TIPS Index had a negative return was in 2008. Relative to the nominal comparator Index, the biggest underperformance was -18.4% in 2008, but that was followed by the largest outperformance of 16.2% in 2009.

FIGURE 8

TIPS historical performance and risk



Source: Barclays Research

TIPS structure

Along with most major inflation-linked bond markets except the majority of issues in the UK, TIPS follow the Canadian model, in which the security pays a fixed coupon on the inflation-adjusted principal. The principal is adjusted on a daily basis using an index ratio that quantifies the rate of growth in inflation or deflation between the issue date and settlement date. The index is lagged three months from the settlement date; for example, for 1 January 2014, the CPI-U for October 2013 applies. We compute the index ratio as follows:

Index Ratio = Reference Index/Base CPI Index; where the Base CPI Index is the Reference Index at issue date and,

Reference Index = CPIm-3 + (t-1)/Dm x (CPIm-2 – CPIm-3)

where:

CPIm-2 = is the price index for month m-2

CPIm-3 = is the price index for month m-3

Dm = is the number of days in month m

m = is the month in which settlement takes place

t = is the day of the month on which settlement takes place.

For settlement amounts, real accrued interest is calculated as for ordinary Treasuries. The clean price, which is the trading price and does not include either the inflation or coupon accrual, and accrued are each multiplied by the Index Ratio to arrive at a cash settlement amount. For coupons paid, the (real) semi-annual coupon rate is multiplied by the Index Ratio, likewise for the par redemption amount (with the cash value subject to the par floor).

Floor

In addition, TIPS have an embedded floor such that at maturity, the investor gets the greater of par or the inflation-adjusted principal. Since the latter is the par amount times the index ratio (which is the ratio of the reference CPI to the base CPI), this is another way of saying that, at maturity, the index ratio is floored at 1 as it is applied to the principal. The pay-off on the principal amount at maturity can be written as:

$$Max\{Par,\ Par \times IndexRatio\}$$

The floor applies only to the principal amount at maturity – coupon payments can be and have been paid off an inflation-adjusted principal amount less than par. For example, the first coupon payment on the TIIJul16s was paid off an index ratio of 0.99858. The fact that there is not a floor on the coupon payments does complicate the calculation profile of TIPS somewhat, but the deflation effect on coupons becomes significant only in severe deflation environments. The effect on the coupon can vary somewhat across issues with different coupons in significant deflation.

It is important to remember that the "strike" on the floor is at par, or an index ratio of 1, not where the index ratio is at the time of purchase. For this reason, the floor of newer bonds tends to be more valuable because the index ratio is typically lower than seasoned TIPS. For example, for a trade that settles on May 20, 2014, the TIIApr18 Index ratio is 1.01967. This means that there has been 1.97% cumulative inflation accrued since issuance in April 2013 when the bond was issued. The floor would kick in if the index ratio fell below 1, so the inflation accrued since issuance would first need to be fully reversed out in a period of deflation. With about four years left, there needs to be about 0.5% annualized deflation to maturity for the floor to be at the money at maturity.

Before September 2008, the market put very little value on this embedded option. However, during the financial crises, when breakevens out to the 9y turned negative and investors were increasingly risk averse, the value increased significantly: for example, at one point, the real yield spread between TIIApr13s and TIIJul13s was 200bp, with most of this difference explained by the floor. The non-linear inflation market began quoting cumulative caps and floors around early 2009, and the value of the embedded option could then be priced separately from TIPS.

Tax

On August 25, 1999, the Internal Revenue Service published final regulations covering the tax treatment of inflation-indexed instruments. Investors should consider the entire document, but a key paragraph is detailed below:

"The final regulations provide rules for the treatment of certain debt instruments that are indexed for inflation and deflation, including Treasury Inflation-Indexed Securities. The final regulations generally require holders and issuers of inflation-indexed debt instruments to account for interest and original issue discount (OID) using constant yield principles. In addition, the final regulations generally require holders and issuers of inflation-indexed debt instruments to account for inflation and deflation by making current adjustments to their OID accruals."

Thus, the inflation escalation of principal in the US is taxable as income annually, even though the Treasury will be making the inflation payment at maturity. This creates a phantom inflation tax, which for non tax-exempt investors such as insurance companies and individual investors may make ownership of TIPS unattractive. To ameliorate this problem, in 1998 the Treasury issued a Series I Savings Bond program targeted at individual investors. These bonds are tax exempt for 30 years.

Owing to this phantom tax issue, many retail or other taxable investors view nominal Treasuries and corporate inflation-linked notes as more tax efficient. While it is true that TIPS are disadvantaged from a cash flow perspective, they are not necessarily penalized on the expected after-tax total return versus nominal Treasuries. Other inflation-linked structures pay out the inflation on a monthly coupon, rather than accreting on the principal, so the investor is taxed on income actually received. However, as state taxes are typically paid on these bonds as well, the advantage is not as clear cut as many perceive.

Rules and regulations governing the tax treatment of TIPS can be found at the following link: *ftp://ftp.publicdebt.treas.gov/gsrintax.pdf*.

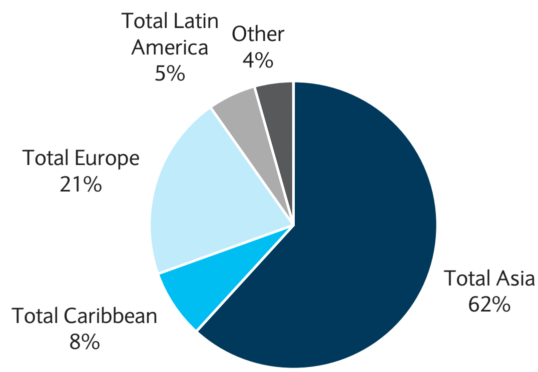
Major holders of US inflation-linked bonds

A broad range of investors have been involved in the TIPS market. The majority continue to own them as diversification from core positions, although this has been changing, and we continue to see strong demand from long-term structural accounts such as pension funds and insurance companies, and more recently foreign official institutions. Mutual funds were the heaviest early buyers of TIPS and remain the largest managers of the asset class, albeit with an increasing amount directly mandated from pension funds and endowments. Core and core plus-type total return funds and bond funds now commonly hold TIPS within their portfolios, while there are an increasing number of real return funds for whom TIPS are the core asset. Endowments and lottery funds have also proved natural buyers. The insurance sector is notably less important than in Europe, mainly because inflation-linked life policies are much rarer, although inflation-linked structured issuance by insurance companies has become more common over the past two years. Real return balanced funds that own, for example, equities, commodities, and real estate, with TIPS as their fixed income position, had held significant structural positions in long maturity TIPS but have generally been averse to holding long real yields below 1%.

One of the main reasons the Treasury reintroduced 5y TIPS issuance in 2004 was to encourage central bank buying. Foreign official institutions have become an increasingly important feature of the market, but until 2009 their position remained relatively small compared with their nominal Treasury holdings. At the start of 2009, structural investments in TIPS from foreign central banks and sovereign wealth funds began because of diversification benefits and as a *de facto* currency hedge. We expect official institutions to move to at least market weight over time. The Treasury's TIC data showed that as of June 2011 foreign official institutions held $136bn in TIPS out of total Treasury holdings of $3.5trn. TIC data released in April 2014 show that as of June 2013, foreign investors owned $342bn TIPS with $236bn of this held by foreign official institutions and 62% held by Asian investors (Figure 9). We expect foreign demand to continue because, at 5.9% of total Treasury holdings, this investor base is still underweight versus a market weight and, because TIPS offer a currency hedge relative to nominal Treasuries, we believe that foreign official institutions should be overweight versus a market-weighted portfolio.

FIGURE 9

Regional distribution of foreign ownership of TIPS as of June 30 2013



Source: US Treasury, Barclays Research

Pension reform could encourage more buying of TIPS by private defined-benefit pension schemes, but since most private funds do not have explicit cost-of-living adjustments (COLAs), allocations to TIPS would be mainly for diversification purposes. The absolute scale of private-defined benefit assets is considerably smaller than the more than $2trn state and local government sector, though. More importantly, state and local government pension scheme liabilities have relatively more explicit price indexation rather than wage indexation and much more frequently have indexation commitments beyond the period when a member of the pension scheme is an active contributor. State and local government schemes are already the largest pension fund buyers of TIPS, and their liabilities mean the potential for increased buying is substantial. On the other hand, federal pension reform is unlikely to affect the state sector significantly, so the relative importance of the private sector defined-benefit sector may increase. As in other countries, few TIPS have been bought to date for defined-contribution pension schemes, which remain skewed heavily towards equities.

iSTRIPS

Over the years, the US Treasury has developed the inflation-indexed security market in a similar fashion to the nominal Treasury market. Hence, the development of a full yield curve has led to increased issuance, increased investor demand and a deep and liquid market. Allowing TIPS notes and bonds to be stripped into zero coupon instruments is another step in this process. STRIPS is an acronym for Separate Trading of Registered Interest and Principal Securities. A TIPS security can be divided into its two components – coupon and principal. Each coupon cash flow, along with the principal payment, is made into a real zero-coupon instrument, or iSTRIP. All TIPS issues are now eligible for stripping, although to date, there has been only scarce interest in iSTRIPS. As of April 2014, there was less than $39mn of TIPS held in stripped form, and most of this was concentrated in TIIApr29s. Most trades have been in lieu of structured products or derivatives.

The US Federal Register sets forth basic conventions for the stripping and future settlement prices of zero-coupon inflation instruments. The complete formulas may be found at the following link for CFR 356.36 Appendix B:

http://www.access.gpo.gov/nara/cfr/waisidx_02/31cfr356_02.html.

Principal component

There is only one principal component (corpus) per TIPS issue. The par amount is the original face value of the bond to be stripped in $1,000 increments. The principal component retains one of the key attractions to TIPS. The embedded floor in TIPS only applies to the principal component, so holders of the principal at maturity receive the inflation-adjusted principal value or the par amount, whichever is greater.

FIGURE 10

Example of principal inflation strip (SIIP)

TIPS 1.625% 1/15/15
P = $1,000,000 par amount
Base CPI on issue date = 190.94516

Source: Barclays Research

If, on January 15, 2015, the reference CPI is equal to 239 (near where we expect it to be), an owner of the principal component will receive:

(Reference CPI at maturity/base CPI) * par value

(240/188.49677) * 1,000,000 = $1,251,668

If, however, the reference CPI at maturity of the bond were somehow less than the base CPI, resulting in an index ratio of less than 1.0, the inflation-adjusted principal would be less than par and the investor would, accordingly, receive the $1,000,000 face value.

The principal component trades at a discount to par when real yields are positive and a premium when they are negative. It will settle in the intervening period using the same methodology as above, substituting the current reference CPI into the equation. So, for example, on a settle date of May 20, 2014, the reference CPI was 235.7077. Therefore, if the January 2015 principal iSTRIP was priced at a real price of 102.25 (a real yield around -1.73%), for that settle date the market value would be calculated as:

(235.7077/188.49677) * 1,000,000 * 1.0225 = $1,262,201

Interest component

The US Treasury faced a hurdle in the initial formation of the strips program, as each TIPS issue having its own base CPI would have a different inflation accrual index. To make issues fungible with each other, the Treasury had to create a two-step process: remove the inflation indexation to allow for stripping and then re-adjust the zero coupons for their inflation accrual. The embedded deflation floor in the TIPS security stays with the principal component, making the coupon component a true real rate security; the development of the inflation derivative market allows buyers of coupon iSTRIPS to purchase inflation floors. Hence, a buyer of coupon iSTRIPS can effectively create "P" if necessary.

The interest component (coupon) from a particular TIPS issue is transferred at an adjusted value initially, which is established using the CPI reference value for its original issue (dated) date. The adjusted value represents the reset of the inflation accrual to 100, with an inflation adjustment made to an investor at maturity. In this way, coupons with the same maturity from different TIPS are now fungible and the coupon strip would be inflation adjusted at the same rate. All such components with the same maturity date have the same CUSIP number, regardless of the underlying security from which the interest payments were stripped.

The US Treasury, in the Federal Register, sets the stripped interest component and its adjusted payment valuation. It established that the adjusted valuation (AV) calculation would be as follows:

FIGURE 11

Example of coupon inflation strip (SII) adjusted valuation

TIPS 1.625 % 1/15/15
C = quoted coupon
P = $1,000,000 par amount
CPI = 190.94516 base CPI on issue (dated) date
AV = adjusted value
AV = ((C/2) *P) *(100/CPI))
or ((0.01625/2) * 1000000) * (100/190.94516) = $4255.15

Source: Barclays Research

In this example, with a $1,000,000 notional stripped, 4.26 of $1,000 bonds are created. Bundled with other issues, there could be sufficient liquidity created to generate round lots of bonds. Prior to maturity, a buyer/seller of a coupon would settle a trade as follows:

Par x (Reference CPI U/100).

Using the example, assume that the January 2015 interest strip is purchased with a settlement date of May 20, 2014, and a reference CPI of 235.7077. If we assume the price is 102.25 (real yield of about -1.73%), the coupon would settle at:

Par x (Reference CPI-U/100) x market price or

$1,000,000 x (235.7077/100) x (1.0225) = $2,410,111

At maturity, the amount payable on a coupon strip is made via the following formula:

FIGURE 12

Amount payable on coupon inflation strip

AP = amount payable at maturity
RVCPI = reference value for CPI at maturity date
AP = AV *(RVCPI/100)

Source: Barclays Research

Following on our example for the principal strip, assume that in January 2015 the reference CPI (at maturity) is 239; final payment would thus be $1,000,000 * (239/100) = $2,390,000.00.

US inflation derivatives

US zero-coupon CPI swaps, the most traded US inflation derivative, have adopted an interpolated base index format, in the same way as the French CPIx market. This more closely aligns the swaps market methodology with the bond market, which also features an interpolated daily reference index. This serves to smooth out the discontinuities in swap breakevens at month-end that occurred while the market found its feet using the HICPx-style format. The index used is the CPI-U not seasonally adjusted index with a three-month lag, the same as that for TIPS. The Bloomberg ticker for the index is CPURNSA <Index>. Barclays's indicative CPI-U zero-coupon swap Bloomberg page is BCAP3.

While zero coupon-style swaps are the most active structure traded on the inter-broker market and with institutional accounts looking to get exposure to cumulative inflation, y/y structures are most commonly demanded by the US retail sector. A primary driver of US swap activity in 2004-07 was hedging related to inflation-linked MTN deals, although issuance in this sector has been extremely limited since 2008. Typically, these corporate deals pay y/y inflation on a monthly basis plus a fixed spread (with a floor usually set at zero on the sum of inflation plus the fixed coupon). Paying out the inflation uplift, rather than accreting the principal as with TIPS, is done primarily to provide higher current income and avoid the phantom income tax problem associated with TIPS. Options on CPI swaps, TIPS and breakevens, along with other non-linear inflation products, such as caps and floors, have traded in the US, but only in limited fashion thus far. Over the past several years, CPI swap activity has been driven more by institutional investors looking for an overlay hedge on their portfolios, particularly nominal fixed income ones, against a sharp rise in inflation.

Linking the cash TIPS and CPI swaps markets are asset swaps. Trading in these in the US has tended to occur as structural carry trades or on a tactical basis when valuations appear at the edge of a range. The general lack of payers in the inflation swap market thus far in the US means that CPI swaps breakevens and bond breakevens are more loosely connected than, say, in the euro area. The gap between cash breakevens and CPI can be explained by the funding costs of a cash breakeven position, including expected repo differentials and balance sheet costs. As liquidity in the TIPS market has improved along with market growth and trading volumes, the relative liquidity premium between TIPS and nominals has come down and, thus, so have relative asset swaps.

CPI futures were introduced in the US in February 2004. However, the initial contract specifications did not prove useful, and it is no longer traded. While it is not likely soon, we do see some scope for reintroducing an inflation contract based on either monthly NSA CPI settings or monthly contracts on the y/y format, similar to the HICPx future in Europe, because it would be more useful for risk management and relative value trading.

The total rate of return swaps market took off beginning in 2006. TRS provides an alternative to cash as a way to gain long or short exposure to cash instruments, particularly by investors looking to match index returns. Many use inflation-linked TRS to gain beta exposure to the asset class while generating alpha returns in some other product.

Trading in the inflation volatility market remains limited but indicative inflation volatility surfaces are developed enough that we created an Inflation Volatility packet. Cumulative caps and floors are used by real money investors to hedge tail inflation risk and some hedge funds and active managers to express structural views. Hedging of corporate inflation-linked notes also provides interest in y/y floors, though as mentioned above, issuance has been quite limited over the past several years. The inflation volatility market can also be used to value the par floor embedded in TIPS. If the economy recovers more, we would expect investors to look to use inflation caps to hedge the risk that the Fed will leave stimulative monetary policy in place too long. More detail on these structures can be found in the Inflation Derivatives Products section of the User's Guide.

Euro area

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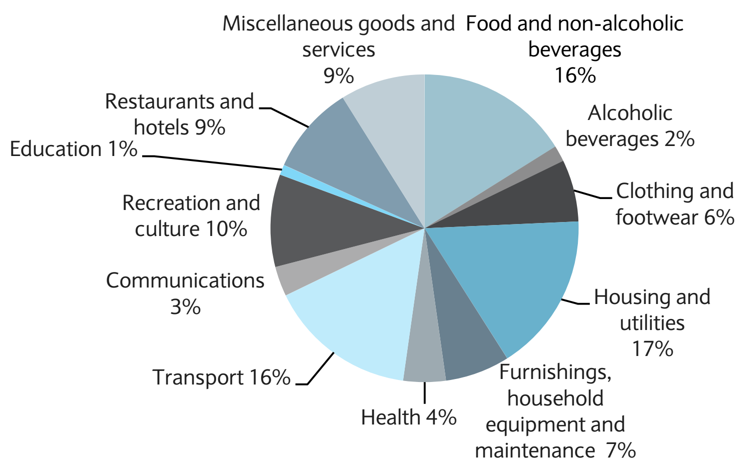
Since its initiation in 1998 until the financial turmoil of 2008-09, the European linker market continued to develop largely unchallenged. The market successfully navigated the global crisis, but the European debt concerns and the disinflationary trend of late have posed new challenges. As a result, the structure of the market has changed notably amid exacerbated volatility. Activity in the derivatives market remains a core element of European inflation, with end users active in inflation swaps and a relatively well-defined volatility market. Activity in individual euro country indices other than French CPIx remains limited, with exposures still more commonly hedged via the broader euro HICPx market.

Euro HICPx Index

The Euro Area Harmonised Index of consumer prices, all items excluding tobacco (referred to as HICPx), is currently the main inflation-linking index for euro area government inflation-linked bonds, with around 85% of such tradable issues by face value tied to it as of mid-June 2014. The HICPx is computed as a weighted average of the individual euro area countries' harmonised price indices. The weights are determined according to each country's share of consumption expenditure within the euro area as measured by the "household final monetary consumption expenditure" in national accounts data. Therefore, the country weights change over time, being reviewed each year and applied with the January data (ie, the January inflation figures published in February). Countries joining the European Monetary Union are also added to the index.

FIGURE 1
Breakdown of euro HICPx by major category in 2014



Source: Eurostat

In 1996, the Eurostat statistical agency was charged with creating "common statistical standards for consumer price indices". The headline all-items HICP Index, also known as the MUICP or Monetary Union Index of Consumer Prices, is the main inflation reference for monetary policy for the European Central Bank (ECB). The ECB has a mandate to maintain price stability, which it defines as a level of MUICP inflation close to but below 2%. MUICP inflation swaps traded before the launch of the first French euro HICPx-linked bond, but after France had issued its first bond, HICPx became the most widely used inflation swap base, too. As most Italian domestic inflation liabilities also exclude tobacco, the Italian government used the same index for its first €i bond, confirming the benchmark status of euro HICPx for both bonds and swaps.

HICP indices, in common with most other CPI indices nowadays, are geometric chain-weighted Laspeyres indices. While there is annual chain indexation at the start of each year to reflect changes in consumption weights between and within countries, some euro countries prior to 2012, particularly Germany, had detailed re-weightings only every five years. The German resetting in February 2003 caused significant revisions to the inflation profile, but all bonds and swap contracts are based on unrevised index values. Following the German rebasing in February 2008, Eurostat decided to allow changes to affect the HICP series only from January 2008, which introduced a notable structural break in the package holiday sub-component of the series in 2008.

Final euro area inflation data is usually released around the 17th of the following month, but a flash estimate of MUICP inflation is released around the end of the month in which data are collected, and individual countries release data in advance of the euro total, leaving only limited uncertainty in the final release. Final January inflation data are released very late in February as a result of extra calculations needed for annual re-weighting, which causes a complication for the bond market. When an inflation reference value is unknown for settlement, the official formula to calculate the index ratio is to extrapolate the last known y/y inflation rate to the latest index value. This is a poor approximation for January m/m inflation as the seasonal factor for this month is the most extreme negative of the year. As a result, the market no longer trades on the official convention at the end of February, preferring to short settle when the index ratio is unknown. The rebasing of the HICPx Index at the end of February 2006 (base year 2005 = 100) did not materially affect valuations on bonds or swaps, for which the original reference HICP was rescaled accordingly. Since February 2006, the index is published to two decimal places rather than one.

All HICP data published by Eurostat are non-seasonally adjusted, but a seasonally-adjusted MUICP series produced for the ECB monthly bulletin does provide information about the development of seasonal factors. In the years since the formation of the monetary union, there have been several changes to measurement by individual countries that have altered the seasonality of the aggregate index. The most notable was the inclusion of discounted sales prices in Italy and Spain from 2001, which slightly reduced average inflation but greatly increased m/m volatility. EC Regulation No 330/2009 came into force in January 2011, and imposed a different methodology for the treatment of seasonal products in the index. The consequence was a further increase in the amplitude of seasonality. The methodological changes by Destatis effective from January 2013 also introduced major changes in the seasonality of the package holiday and accommodation services components. There is still scope for further standardisation though, eg, German HICP still does not include many temporarily discounted prices, with most such changes likely to further increase the seasonality of the series. Currently, the largest negative seasonals are in January and July due mainly to sales periods, with the most positive seasonality in March. Christmas-related price increases tend to push German prices notably higher in December, but the impact for the euro area as a whole is muted.

There have been few major revisions to the composition of the euro HICPx in recent years. There is relatively little standardisation of quality adjustment measurement at present, but Eurostat has been focusing on gaining consistency. The use of hedonic pricing to adjust for changes in quality is likely to become more widespread as a result, which over the long term may produce a marginal downwards bias in the index. More important is the consideration of housing, with owner-occupied housing currently excluded from HICP indices. Housing rents make up just over 6% of the HICPx in 2014, whereas national accounts data suggest that the weight of housing in consumption is around 16%. The ECB has highlighted the need to include owner-occupied housing, and Eurostat has been working for over a decade on a project to address this, along with national statistics agencies. Eurostat's preferred methodology is a net acquisitions basis, which attempts to strip out the price of land from house prices given that land is seen as an investment rather than consumption. In effect, this will consider only new home prices (as sales of existing homes are merely transfers) and the cost of home improvements. While a decision on the inclusion of owner-occupied housing was originally intended to be made by 2006, no final decision has been taken at the time of writing.

French CPIx Index

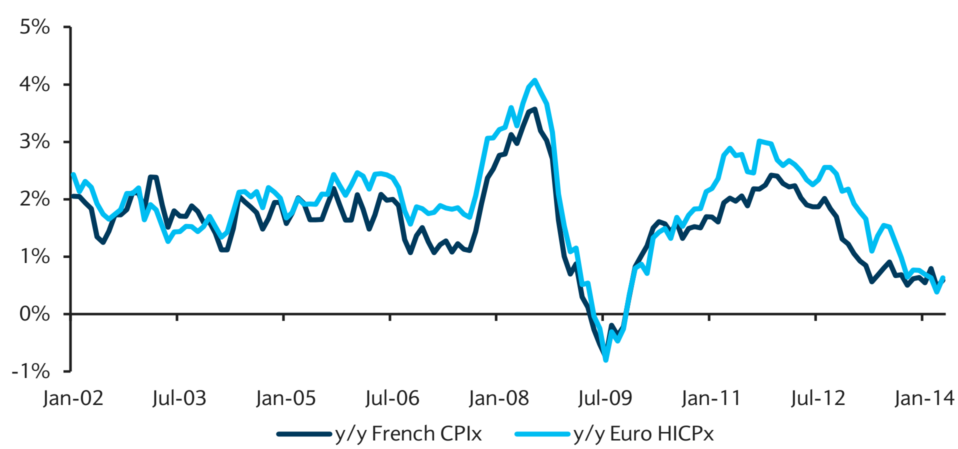
France first started issuing bonds linked to the French CPI excluding tobacco (CPIx), as indexation to tobacco prices had previously been banned in France. More substantive and difficult legislation would have had to be introduced to change this, but it also meant that any inflation liabilities similarly had no link to tobacco. The bonds are linked to the non-seasonally adjusted CPIx series, but the process of euro area standardisation has led to some changes in measurement of French components, which has increased seasonality somewhat in recent years. Daily interpolated index values for bonds are published on the Reuters page OATINFLATION01, while the index on Bloomberg is FRCPXTOB <Index>.

The level of French prices is only marginally above that of the euro area average. The index is usually released around the middle of the month, just ahead of the euro area data. Until 2005, preliminary data were released early in the month with the final series published after the euro data, but Eurostat encouraged INSEE, the national statistics office in France, to publish earlier. Since March 2005, there has been a single CPI released mid-month. The unrevised index is used for bonds and swaps. If the series is rebased, all reference calculations are adjusted accordingly. An unpublished early estimate of French HICP is provided to Eurostat for the euro HICP flash estimate and, as estimates for most other large euro countries are published by the time of the flash estimate, inferences on the French data may be drawn if the euro flash estimate surprises in either direction.

The calculation methods for the French CPI and HICP are relatively similar. Both use geometric aggregation at the lowest strata sub-indices, and have the same methodology for quality adjustments. There has been no clear, long-term bias between the two series. The difference is that HICP takes into account expenses net of rebates, while CPI uses a gross basis. This is particularly important for the healthcare component where rebates from the state are substantial in France. This leads to a much higher weight for healthcare in the CPI (10%), but also leads to inconsistencies between the two series when healthcare reform affects the degree of public subsidy, for instance reducing the items on which they are available, which causes a jump in the HICP healthcare series without affecting the CPI. While in the long term it is likely that healthcare costs will increase notably higher than inflation, this may well be offset if the trend for reduced state subsidies continues.

FIGURE 2

French and European ex-tobacco inflation



Source: INSEE, Eurostat

Development of the government market

France

France first announced its intention to issue inflation-linked bonds on 3 December 1997. The legislation to enable the launch of the new asset class was passed on 3 July 1998. On 15 September 1998, the OATi 3% Jul 2009 was syndicated, with the bond frequently re-opened by auction subsequently. Market participants were widely consulted on the main characteristics of the new bond, including the choice of inflation index to which it would be linked. It was decided that the bonds would adopt the Canadian methodology that was fast becoming the preferred global structure, but including a principal floor as the US had done. The timing of the first issue just ahead of the start of the euro area was not a coincidence. This monetary union was expected to intensify competition for financing in nominal bonds, and the hope was that France would gain a first-mover advantage by being the first euro area country to issue inflation-linked bonds.

The inflation index was agreed as INSEE's official measure of French national CPI, excluding tobacco. There was considerable debate ahead of the initial launch of French inflation-linked bonds as to whether to link the first issue to French inflation or to that of the then-forthcoming euro area. The arguments for the domestic index included the likelihood that national inflation would be a better liability match for the government. However, international appeal would clearly be broader for a euro index. In 1998, the final decision most likely came down to practicalities. At the time, the disadvantages of Eurostat's European Harmonised Index of Consumer Prices for the EMU area were material as it was a relatively new, untested index with no track record. Full index coverage was not yet complete in some countries, which left an index in flux and an associated fear of revision risk.

A second linker, the OATi 3.4% Jul 2029, was launched a year later in September 1999, again linked to the French national CPI ex-tobacco. The same issuance route was followed, with an initial syndication and occasional re-openings. Growth in the outstanding market value of these two bonds was slow but steady. There was some disappointment that the instruments did not seem to be capturing the imagination of investors in euro area countries outside of France. In October 2001, France addressed this issue head on by launching the OAT€i 3% Jul 2012 linked to euro HICPx. This bond was also launched via syndication, but with its size boosted by some direct exchanges out of the OATi09. There were some fears ahead of this issue that the launch of a second inflation-linked product may harm the liquidity of existing OATi bonds, but in fact the move gave a new lease of life to the sector as a whole. Not only did turnover in the new issue quickly grow, but interest in the existing issues was heightened, too.

France responded to an increase in interest and demand in the sector with a significant pick-up in the pace of supply. The Agence France Trésor (AFT) has steadily increased linker issuance since the product was launched. It has issued new bonds almost every year while auctioning existing issues nearly every month. Auctions normally occur on the third Thursday of every month, excluding August and December, with at least one OATi and one OAT€i auctioned each month except when a new bond is launched. Prior to 2009, the AFT was committed to a minimum of 10% of its total bond issuance each year to be in inflation-linked bonds, but with the possibility to issue significantly more if justified by demand. In more recent years, the commitment to issue a minimum of 10% of total bond issuance was changed to "around"/"approximately" 10%, likely as a response to more volatile market conditions and to increase flexibility in the programme. Issuance in 2009 was only €12bn, half its peak in 2004 despite increased funding needs. The strategy to reduce issuance in late 2008 and over 2009 was combined with a pragmatic approach, which consisted of tapping specific issues that were in demand. For instance, in October 2008, when fears about deflation were intense, only OATis were issued, given that there was still demand for French inflation due to Livret A hedging.

The AFT has steadily built up curves in both OATis and OAT€is. The OAT€i Jul 2032 was launched via syndication in 2002, including some exchanges out of the OATi29. The OATi Jul 2013 was the first issue to be launched via auction in 2003. At the start of 2004, the OAT€i20 was syndicated, but the OATi11 and OAT€i15 were launched via auction later in the year, as was the OATi17 in September 2005. In April 2006, the first BTAN linked to euro HICPx, the BTAN€i10, was launched via auction but with a T+3 settlement date for the BTAN€i (at the time nominal BTANs settled T+1) to be consistent with other inflation-linked bonds. The OAT€i40 in March 2007 and OATi23 in February 2008 were both syndicated. The launch of the OAT€i22 in the summer of 2010 was done amid a specific emphasis on the value of the par deflation floor in the bond, an emphasis which later led to strong demand for the bond in asset swap. In January 2011, the BTANi 2016, the first FRCPIx linked BTAN was launched, while the AFT syndicated the OAT€i27 the following month, plugging the gap in the 15y sector of its curve. The OAT€i18 auctioned in April 2012 was similarly a response to the need to fill the gap between the 2015 and 2020 maturities. Later that year, in October, the OATi21 was launched via auction. In February 2013, the AFT added a new point in the 10y sector (ie, the OAT€i24). In June 2014, the OAT€i30 was launched via syndication.

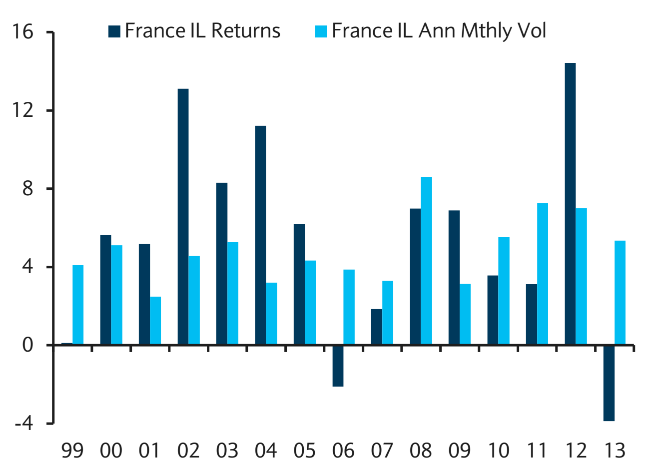
The intensification of the European debt crisis has had a notable effect on the French linker market. Apart from the fact that general conditions for issuance became more challenging, French issues suffered from linker investors being typically more risk-averse than nominal ones. Volatility in spreads thus exacerbated a significant cheapening versus nominals when French spreads were at their widest. However, ultra-cheap relative valuations triggered significant interest, mainly from domestic investors who were willing to reap the extra value offered by linkers. For that reason, the crisis did not lead the AFT to signal any reduction in its commitment to the linker programme. Having linkers referencing two indices gives France flexibility to tailor monthly issuance to demand, such that it has been, by far, the most consistent among linker issuers in the euro area.

Italy

Italy announced its intention to issue its first inflation-linked BTP on 5 September 2003 and syndicated a €7bn 5y bond within five days. The speed of the ground-breaking transaction took many in the market by surprise, but the issue was quickly accepted, enabling a syndicated reopening in October to bring the bond to over €10bn. The BTP€i 1.65% Sep 2008 followed an almost identical model to French OAT€i bonds, except that it paid semi-annual coupons like conventional BTP bonds. The bond was initially priced using an interpolated spread to the nominal BTP curve, but a maturity matched conventional bond

FIGURE 3

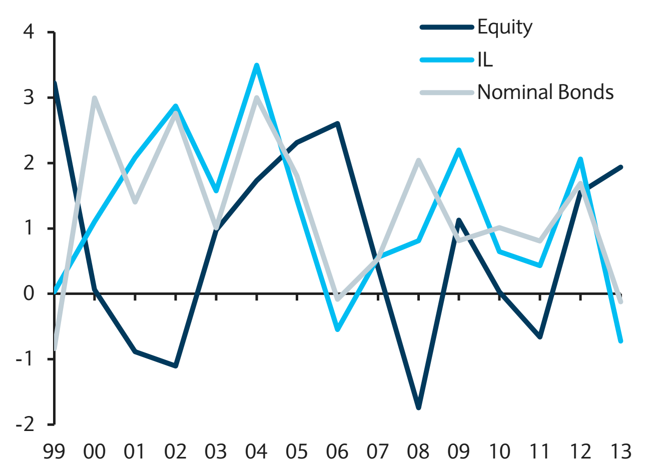
French linkers – historical performance and risk



Source: Barclays Research

FIGURE 4

Return/risk French IL versus nominals and equities



Source: Thomson Datastream, Barclays Research was auctioned the week after the launch, enabling straightforward trading of the breakeven inflation spread. The choice of maturity was determined by heavy domestic retail demand for inflation-linked notes, particularly swapped 5y MTN notes with inflation-linked coupons, which were relatively difficult for issuers to hedge without a 5y point on the OAT€i curve. Italy hoped to capture both swap-hedging demand and to appeal directly to individuals who had been buying the structured notes. More than 220 investors bought the initial syndication, with the majority placed in Italy. Much of the remainder went to the UK and US, a combination of derivative houses and long established, international inflation-linked investors, with relatively little going to other euro area countries. The first re-opening syndication in November 2003 redressed this imbalance, with almost 40% being allocated to French investors. Further syndicated supply of the issue in 2004 brought its face value up to €13.4bn. The majority of this bond quickly became held versus inflation swaps, much of which was locked away to maturity.

Having started issuance with a relatively opportunistic 5y maturity, the next new bond was a 10y, the BTP€i 2.15% September 2014. The bond was initially syndicated in February 2004 for €5bn and subsequently built up via syndications and then auctions to a notional size of €14.5bn, in line with the target size indicated at launch. The BTP€i 2.35% 2035 was syndicated in October 2004 for €4bn and was subsequently re-opened by syndication and then auction. The BTP€i10 was syndicated in January 2005 as the second 5y issue, being built up by auctions subsequently as was now standard. In June 2006, the 10y BTP€i 2.1% September 2017 was sold via syndication. The BTP€i 2012 was the first Italian linker to be launched via auction in March 2007, but the Tesoro reverted to the syndication method in June to launch the BTP€i 2023, its first 15y linker. In addition, Italy issued private placements of two ultra long-dated euro HICPx linkers maturing in September 2057 and September 2062, which, alongside similar issuance from Greece, sparked two-way interest in ultra-long euro HICPx swaps. Italy has subsequently privately placed shorter maturities, but the size remains small compared with the BTP€i market. In May 2008, the 10y BTP€i 2019 was launched via syndication.

In 2005, Italy overtook France as the country with the largest stock of bonds linked to euro HICPx. Similarly to France, Italy reduced its inflation-linked issuance significantly from the third quarter of 2008 and over 2009, as a response to reduced demand, with the scheduled auction of October 2008 cancelled and smaller sizes for other reopening. After a year of notably reduced issuance, supply subsequently picked up, with the BTP€i41 syndicated in October 2009, followed by the BTP€i21 in April 2010. The BTP€i16 was launched via auction in Jan 2011 and the BTP€i26 via syndication in June 2011. However, just after this bond was launched, the condition of the Italian bond market worsened notably, with spreads to Germany widening sharply. The response of the authorities included adding Italian (and Spanish) bond purchases to the ECB securities markets programme in August 2011. However, these purchases did not include BTP€is, significantly distorting breakeven valuations. Furthermore, with much focus at that time on credit ratings downgrades of peripheral countries and future eligibility of their bonds to remain in bond indices, BTP€is saw significant selling pressure from investors. While there was a similar trend in nominal BTPs, it was somewhat more pronounced in BTP€is. This was because the threshold for inclusion in Barclays main inflation-linked bond indices was (and still is) higher than for nominal bond indices, which implied that BTP€is were closer to being excluded from those indices. Many investors acted in anticipation of this removal, some choosing to switch to benchmarks excluding BTP€is while others actively underweighted BTP€is versus benchmark. Without the ECB to absorb the flow in linkers, real yields were pushed sharply higher and the high in nominal spreads in late November 2011 coincided with breakevens troughing at negative levels out to 10y. BTP€is eventually were excluded from Barclays' main linker indices at the end of July 2012 following Moody's downgrade of Italy; however, the fact that many investors had already adjusted their portfolios meant that the market impact of selling flows at month-end was limited. Furthermore, ECB President Draghi delivered his "Whatever it takes" speech late July 2012; the general positive tone on peripheral spreads that the ECB instilled in markets likely cushioned the impact of the index exclusion on BTP€i valuations.

Despite extreme market conditions, Italy indicated its intention to continue with the monthly issuance of BTP€is, indeed it even conducted a reopening at the most extreme point of the market stresses in November 2011. As in late 2008, the Treasury attempted to maintain market functionality by conducting both buybacks and switch auctions out of BTP€is. Nonetheless, the guidelines for 2012 public debt management indicated that the share of BTP€is in Italian debt would likely fall given the redemption of the BTP€i12 (a €10.3bn notional issue), which implied intentions for notably less supply than previously. Indeed, 2012 saw no new BTP€is, although this is very likely partially explained by the success of the BTP Italia programme (see later) that year. The Tesoro maintained its commitment to the BTP€i segment though, with the new BTP€i18 auctioned in January 2013. In March 2014, despite a challenging context for European inflation markets as a result of a very low inflation backdrop, Italy offered a new BTP€i24 via syndication.

Auctions dates were adjusted slightly from 2012; they now occur three working days before month-end at the same time as nominal CTZ auctions. This overlap may provide more flexibility for Italy to cancel BTP€i supply in a month where linker dislocations are severe without it being seen as a sign of a broader lack of market access. Auctions are not held in months when new issues are launched via syndication.

As with a conventional BTP, a BTP€i pays its coupon every six months, but its yield is quoted on an annual basis. Calculations work in exactly the same way, with inflation accrual calculated on a daily interpolated basis between the inflation data from three and two months previously. Italy likely chose the same index as France mainly for market convenience, as it is the index most widely used in inflation swaps and MTN bonds as well as OAT€is, although domestic Italian indexation has usually excluded tobacco too.

In March 2012, Italy introduced a new inflation-linked product, designed to appeal to domestic retail investors. BTP Italia references Italian FOI inflation excluding tobacco, in a structured form so that cash flows are not back ended. The FOI, "Famiglie di Operai e Impiegati" is a CPI index derived only from the consumption basket of households of workers, with FOIx (Bloomberg code ITCPIUNR) the most commonly referenced series for Italian indexation. The initial BTP Italia 2.45% March 2016 was brought for almost €7.3bn following a four day offering window through which both individuals and institutions could apply to buy bonds at par both directly through via banks, both directly and over the internet. The coupon of the issue was only fixed after the window had closed, but a guaranteed minimum real coupon of 2.25% was announced before the opening of the issuance window. The Italian Treasury indicated at the start of the programme that it expected to bring three to four new BTP Italia bonds a year in future. The Treasury stated that only around 3% of the initial issue was sold to international institutions, but its statistics showed that most of the paper was sold in contracts for over €50k, which it considers as a usual threshold to distinguish retail investors from institutions. BTP Italia are traded only on the MOT retail platform and given the relatively complex cash flow formula, discussed below, the bonds trade on a price basis, with the real yield an unsafe metric given the nature of the deflation floor.

The second BTP Italia launched in June 2012 gathered only €1.74bn but the third bond, the BTP Italia October 2016 was launched with an impressive €18.02bn size. The apparent cheapness of the bond versus the BTP€i16, coupled with the fact that it was launched close to a nominal BTP redemption, likely helped to drive the huge issuance size. Additionally, significant participation by institutional investors was apparent, with foreign ones not negligible either. In 2013, two other BTP Italia bonds were issued, the April 2017 for

€17.06bn and the November 2017 for €22.27bn. In both cases in 2013, the Tesoro closed the issuance window on the third day, having reserved the right to do so ex-ante. That said, it appeared that the early closure of the issuance window did little to prevent the BTP Italia issuance books from growing to sizes that were probably more than what was desired or expected by the issuer. In particular, it appeared that a significant chunk of the buying came from institutional investors. The Tesoro changed the issuance mechanism for the bond launched in April 2014, which was a six-year bond (maturing in April 2020) while previous issues were 4y. The first three days of the issuance window was reserved for retail investors (with an option of early closure on the second day), with the fourth day dedicated to institutional investors. The bond's total size reached €20.56bn, of which €10.50bn was placed on the fourth day, ie, the day reserved for institutional investors.

The indexation structure of the BTP Italia is not straightforward. The coupon rate is applied to a principal, which is revalued and reset in each six-month period, but with a floor mechanism and a dependence on previous levels reached by the index. Also, unlike a BTP€i, inflation accretion on the revalued principal is paid out semi-annually alongside the coupon, ie, like a "pay-go" structure. The principal is then reset at par semiannually.

The mechanism is best explained with a concrete example, the first BTP Italia 23 April 2020 issued in April 2014. The FOIx index reference for the initial settlement date (23 April 2014) is 107.22667 (noted I_0). This is calculated using the same two-to-three-month lag interpolation methodology as for Canadian-style linkers. We note I_1 the index reference for the first cash flow payment date (on 23 October 2014, six months after issuance), I_2 for the second, etc. If I_1 is above I_0, then the first semi annual coupon would be paid off the revalued principal, with the revaluation factor being I_1 divided by I_0. The accretion in the principal due to inflation is also paid to the holder. If I_1 is below I_0, then the principal is not revalued and the coupon is paid off a principal of par; the principal is therefore protected against deflation.

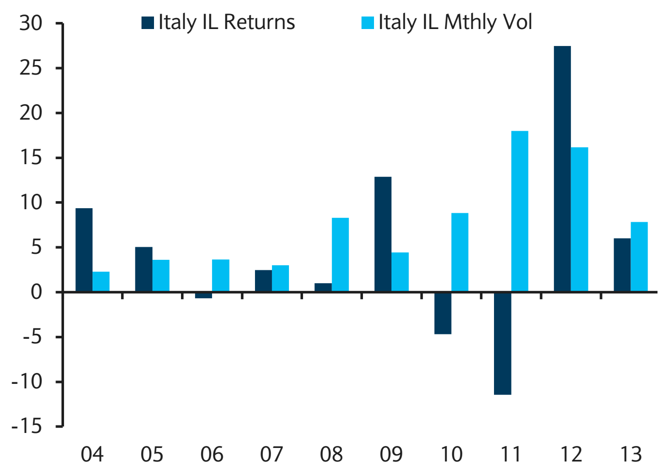
We now look at the second scheduled cash flow payment (ie, for 23 April 2015). Let us assume that I_1 is above I_0 and I_2 is above I_1. The coupon will be paid off a principal revalued by a factor of I_2 divided by I_1, with the revaluation of the principal also paid off to the investor. The principal has therefore been revalued only with inflation over the second semi-annual period, which is very different from a traditional linker where the principal revaluation factor is calculated from the first accrual date of the bond.

Let us consider the case where I_1 is above I_0 but I_2 is below I_1, ie, there is deflation in the second semi-annual period. In that case, on 23 April 2015, given deflation over the relevant period, the principal is not revalued and the coupon is paid off a principal of par. The third cash flow payment (on 23 October 2015) will depend on I_3. If I_3 is below I_2, then the principal is not revalued. However, even if I_3 is above I_2, the principal is revalued only if I_3 is above the highest value reached by index references for past cash flow dates. In this case, the highest point was reached by I_1. If I_3 is above I_1, the principal is revalued by a factor of I_3 divided by I_1. The BTP Italia therefore has, what is commonly known as, a "high watermark" feature. In other words, the principal for any payment date is revalued only if the FOIx index reference value is above all past semi-annual reference fixings.

The floor mechanism embedded in the BTP Italia is therefore significantly more complex than YoY or zero-coupon inflation options that are traded in the broker market on euro HICPx. A rigorous pricing for the BTP Italia's embedded optionality would need to take into account the path-dependence of cash flows. Given that the market is not particularly active even for simple YoY or zero coupon structures on FOIx, there is unlikely to be consensus on the value of the new issue's embedded optionality.

FIGURE 5

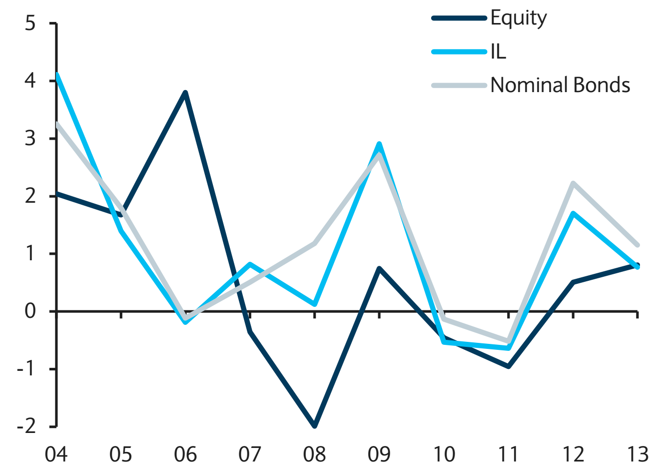
BTP€is – historical performance and risk



Source: Barclays Research

FIGURE 6

Return/risk BTP€is versus nominals and equities



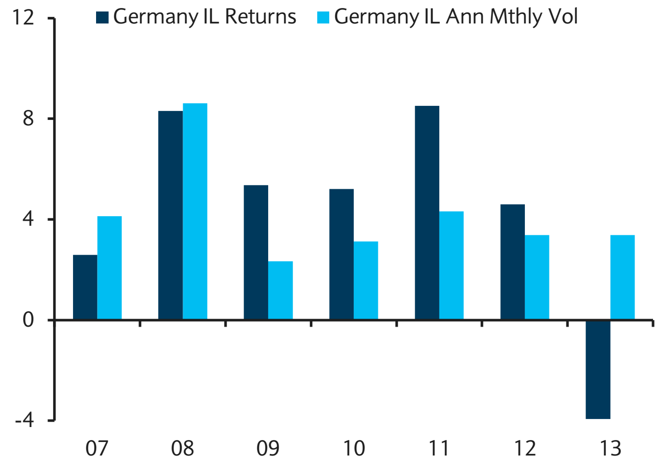
Source: Thomson Datastream, Barclays Research

Germany

The intention to issue euro HICPx-linked bonds was announced by German finance ministry officials in November 2004, but it was not until March 2006 that the initial bond was launched. The inaugural inflation-linked bond meant that all G7 countries were issuers of inflation-linked bonds. The 10y DBR€i 1.5% April 2016 was issued via syndication with an initial size of €5.5bn, including €0.5bn retained to boost liquidity in secondary market trading, and was priced against the nominal Bund January 2016. The German Finanzagetur indicated its intention to tap the bond up to three times to a volume of €10-15bn. The bond was re-opened in September 2006 via syndication for €3.5bn, including €500mn retained. Germany switched to an auction procedure for the second tap of the DBR€i16 in April 2007 for €2bn and has subsequently auctioned all its linker issuance. The second euro HICPx German linker, the OBL€i 2.25% April 2013, was issued in October 2007 for €4bn. The DBR€i 2020, which came in June 2009, was the first euro linker launched after the episode of extreme, deflation-led fall in breakevens during the second half of 2008. This reaffirmed Germany's commitment to the inflation market, given that the development of the German real €i curve had been slow compared with what was broadly expected when the programme was launched in 2006. The OBL€i18 was launched in April 2011 and the DBR€i23 in March 2012, but the pace of issuance remained moderate. From 2013, there has been a stated commitment to monthly issuance (except in August and December), a development in terms of transparency for market participants. For 2014, that transparency was strengthened with the Finanzagentur specifying that such auctions of the Inflation-linked Federal Securities generally take place on the second Tuesday of a month. In April 2014, a DBR€i30 was launched. The longest linkers issued by Germany up to then had been 10y benchmarks, so a 16y bond was an innovation. That said, according to comments relayed by Bloomberg on 1 April 2014, the German Finanzagentur's spokesman said that the 2030 bond is an "extended 10-year" benchmark and is neither the start of a new 15y segment nor indicative of plans for a 30y issue.

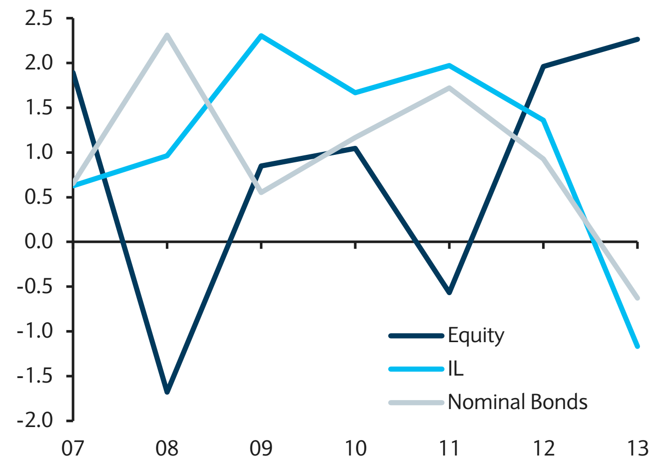
The focus during the launch of the first German linker was on seasonality pricing. Before the launch of the DBR€i16, bonds linked to the euro HICPx had maturities of 25 July (French and Greek linkers) and 15 September (Italian linkers). The fact that the DBR€i16 would redeem on 15 April 2016 meant that it would accrue less positive inflation seasonality compared with a BTP€i and much less versus an equivalent OAT€i. Although the bond was being priced against the nominal Bund January 2016, the market was also focused on estimating fair value versus the OAT€i15, and estimating the difference in the seasonality component

FIGURE 7
German linkers – historical performance and risk



Source: Barclays Research

FIGURE 8
Return/risk German IL versus nominals and equities



Source: Thomson Datastream, Barclays Research

of the two bonds was key in determining this fair value. This seasonality difference becomes increasingly important in basis point terms as bonds roll shorter on the curve. While increased cross market distortions since 2011 make direct inference of seasonal estimates difficult, comparing relative asset swap valuations implies that the increase in seasonality following 2010 HICP measurement changes have been partly priced in, limiting the underperformance of OAT€i breakevens versus Germany.

Greece

Before it entered the euro area, Greece had issued bonds linked to domestic CPI in small size, in a Canadian format, but the last of these redeemed in 2007. Greece became the second sovereign to issue a euro HICPx benchmark, the GGB€i 2.9% Jul 2025 in March 2003 via syndication. It was subsequently increased via syndications, before a GGB€i 2.3% July 2030 was launched in March 2007. A few weeks before this, Greece issued a 50y bond linked to euro HICPx via private placement. In 2012, Greek linkers were subject to the same binding bond exchange as nominal Greek government bonds, with the final inflation accretion of the issues fixed on 24 February, the date that the exchange notice was issued.

Spain

The latest newcomer to the European government inflation-linked bond market to date is Spain with the SPGB€i November 2024 issued via syndication in May 2014 for €5bn.

Euro inflation-linked STRIPS

In June 2007, the Agence France Trésor (AFT) made it possible to strip all French inflation-linked issues. The Italian Treasury followed suit in January 2008, making it possible to strip all BTP€is. Each linker under the stripping process can be decomposed into a series of coupon payments and a principal repayment, whereby each individual component is traded as a zero-coupon instrument. Coupon payments of a bond with CACs are not fungible with those of a bond without CACs. In other words, coupon payments with the same maturity and linked to the same index are fungible and have a single ISIN, provided that all their underlying bonds have the same status in terms of CACs. This means, for example, that a coupon payment from the BTP€i24 to be paid on 15 March 2017 will be fungible with a coupon from the BTP€i18 to be paid on the same date, given that both bonds contain CACs. On the other hand, they will not be fungible with the coupon payment from the BTP€i19 (which does not contain CACs) to be paid on 15 March 2017. Given that coupons from two different bonds will have two different base reference inflation indices, an adjustment is needed. In order to achieve fungibility for coupon iSTRIPS, there is an adjustment that transforms the base reference inflation index value for each coupon strip to 100.

For French government issues, each linker has one principal component, identified by its own ISIN. Conventions for the principal component are exactly the same as for the underlying issue except that there is a floor on the principal. Hence an investor receives at least the face value of the position at maturity. If inflation has occurred since the underlying bond was issued, the investor receives the face value multiplied by the index ratio, ie, the reference inflation index at maturity divided by the initial reference inflation index value for the underlying bond. While the value of the par floor option on its own is usually very small, the guarantee of nominal principal repayment may be worth notably more for investors who are unable to buy bonds without floors.

The coupon-stripping process for BTP€is, initiated as from 2008, holds an additional complexity compared with French bonds. Investors can actually request that the principal be split into a nominal component and a floored inflation uplift component. This introduces a major innovation to the principle of iSTRIPS, given that this three-component stripping model does not exist in any other inflation-linked bond market.

Inflation strips provide increased flexibility to hedge inflation-linked liabilities. Demand may come from insurance and pension sectors in countries with inflation-linked liabilities but with difficultly accessing inflation swaps, for example. For accounting purposes, inflation-linked strips can be more favourable than inflation swaps as they are considered unleveraged inflation-linked bonds on a held-to-maturity basis, with no embedded derivatives under an IAS accounting regime.

Regulation, accounting and taxation

Compared with the UK, regulatory and accounting factors have been less important in the development of the European linker market. The evolution of the framework allowing investors to hold inflation-linked bonds has been a determinant. For example, prior to 2002 in France, insurance companies could not report principal accrual as earnings as it was unrealised. The revision of this rule in 2002 opened the linker market to a deep investor base, with the French insurance sector now structurally a major player in the market. Some German investors were restricted from holding inflation-linked bonds prior to 2004, and one factor that delayed Germany from issuing in 2005 was ensuring that accounting and regulatory restrictions from investing in government issues were removed or addressed.

The pressure for life insurers and pension funds to address liabilities with the introduction of IAS19 has been similar to that in the UK, but far fewer liabilities are explicitly inflation-linked in the euro area and of these, most are linked to indices that are very different from euro HICPx. Pension reform in Europe may crystallise more demand to hedge long-dated, inflation-linked liabilities but beyond demand from pension schemes that were previously unfunded, to date this has not happened. The Netherlands, the euro country with the largest private defined benefit pension assets, currently has a regime where indexation is conditional, ie, only paid out when nominal solvency levels are sufficiently high, to unconditional. Inflation hedging demand there has been limited over the past few years as solvency ratios have been at low levels. They improved from 2012 but while the move to ultimate forward rates improved them further, the minimum for conditional indexation has also been raised accordingly. In a possible new framework, some schemes may no longer have conditionality in indexation. An eventual move towards supervision that relies on a real funding ratio could ultimate increase the share of inflation-linked bonds in the asset mix, but inflation swaps may not benefit.

The development of the FRCPIx inflation-linked bond and swap markets has been largely driven by the decision to partially link the remuneration rate on Livret A savings accounts (called Livret Bleu when distributed by the Credit Mutuel network) to the FRCPIx inflation rate. The decision, taken in 2004, was meant to depoliticise the rate-setting decision. The original formula determined the rate as half the y/y FRCPIx rate plus half the 3mth Euribor rate plus 25bp, rounded to the nearest 25bp, and was used in the twice-yearly revision of the rate. The Livret A rate is used to determine the remuneration rate on various other savings accounts and in 2004, around €270bn of instant access account deposits became, de facto, linked to French inflation. Funds collected on Livret A and Livret Bleu savings accounts have traditionally been centralised at the DFE (Direction des Fonds d'Epargne), an agency administered by the state-owned financial institution, CDC, which finances social housing schemes at lending rates that depend on the Livret A rate.

From an ALM perspective, there is therefore an automatic hedge for funds centralised at the DFE and used to finance social housing. However, hedging of the exposure to French CPIx inflation is needed from commercial banks which distribute savings accounts linked to the Livret A rate, either through OATi bonds or FRCPIx swaps. The reform of the Livret A, undertaken in 2008 and effective from the start of 2009, had important implications with regards to the latter. From 1 January 2009, the distribution rights for the Livret A were extended to the whole banking network in France (as opposed to only La Banque Postale, the Crédit Mutuel and the Caisse d'Epargne in the past). This led to a surge in total Livret A and Bleu outstandings, including an increase of more than €17bn in January 2009 alone. Probably more important in terms of potential demand was the fact that the centralisation rules with the DFE changed. Under the new regulation, commercial banks were allowed under some conditions to keep Livret A funds on their balance sheets. The expected and realised increase in Livret A outstandings therefore implied a substantial increase in hedging demand and the impact on the French inflation market was obvious.

Nevertheless, the change in the rate-setting formula, and especially inconsistency in setting the rate according to the formula, has weakened the formulaic link between French inflation and the Livret A. In 2008, an element of non-linearity was added to the formula: it referenced the maximum of y/y FRCPIx +0.25% and half the sum of y/y FRCPIx and the average of 3M Euribor and Eonia. The addition of Eonia lowered the weight of 3M Euribor in the formula. The aim there was to reduce the volatility in the rate from Euribor fixings in the context of the 2007 financial turmoil. At the start of 2009, a condition was added such that the magnitude of change in the Livret A rate between the two consecutive fixings cannot be more than 1.5%, a non-linear condition that makes hedging less appealing. Furthermore, since 2009, the government can change the rate between the usual February and August fixing dates if changes in money market rates or inflation are viewed as significant. The rate given by the formula has been overruled most frequently since the beginning of 2008. This means that the once strong formulaic link, the basis of hedges and justification of those hedges from an accounting perspective, was broken. In our view, Livret A-related hedging demand has structurally decreased as a result of inconsistencies in the rate-setting decisions. In particular, there is less value in undertaking precise hedges involving swaps tailored to the formula (Livet A swaps) for instance, but broad hedges involving some element of inflation protection are still carried out. Indeed, despite formula overrulings, the Livret A payoff is still perceived to have a link to French inflation over the long term and simpler hedges involving standard FRCPIx swaps or even FRCPIx-linked bonds are to a greater extent preferred. To some extent, hedging in euro HICPx swaps or bonds is not uncommon either, when they are sufficiently economically cheap to their FRCPI equivalents.

The ceiling for Livret A deposits was increased in October 2012 and again in January 2013, which led to further sharp increases in outstandings. In September 2012, attention turned to a report commissioned by the French government. The "Duquesne Report" recommends a new Livret A formula in which the inflation rate carries a significantly higher weight than before. It also recommends the Livret A remuneration rate be determined only by the mathematical formula – ie, with no possibility of it being overruled. If the recommendations of the Duquesne Report were to be adopted, the implications on hedging behaviour could be important. The report recommends that the remuneration rate is calculated as the sum of y/y inflation and 10% of the economic growth rate when the latter is positive. This means that fixings would be determined almost exclusively by y/y FRCPIx. In the current formula, this is the case when money market rates are low enough such that the y/y FRCPIx+0.25% floor is struck; otherwise, in "normal" conditions, inflation makes up only half of the fixing. Equally important, we think, the report recommends that the fixing should be completely automatic, with no possibility to overrule the formula. If uncertainty regarding the fixing mechanism is eliminated, hedging appetite could increase substantially, and given the higher weight of inflation in the proposed formula, FRCPIx demand would surge.

The uplift of euro inflation-linked bonds is generally taxable. This is one of the main reasons for the existence of the structured inflation market, on which taxation is paid only on coupons as they are paid. OATis and OAT€i bonds are taxed similarly to other French government bonds, ie, the inflation accrual is taxable for domestics while there is no withholding tax payable for international investors. Retail investors can pay all withholding tax at maturity or sale. Institutional investors pay tax both on interest received and annually on inflation as it accrues. BTP€i bonds follow the same tax rules as conventional BTPs. This means that domestic entities are taxed on inflation uplift as well as on real returns. International investors are exempt from paying withholding tax as long as they are within countries that Italy does not define as tax havens, and they send in the necessary initial documents that are on the Treasury website. At the time of writing, countries excluded from the "white list" of tax-exempt countries include Switzerland, as well as some offshore tax havens.

Euro non-government inflation-linked bonds

Two distinct strands of non-government bonds have been issued in the euro market with cash flows linked to inflation. There has been issuance of bonds in a similar accreting Canadian-style format in line with that issued by governments. There has also been considerable issuance of structured notes whose cash flows are linked to inflation. The accreting style issuance has been directed at similar institutional investors to those buying government linkers and has generally not involved accompanying derivative transactions. Most structured note issuance has been to individual investors, and the inflation exposure of these notes has largely been hedged using inflation swaps.

Government-style bonds

Agencies, quasi-agencies and regions have mostly issued inflation-linked bonds in a government-style format. The largest non-government issuer has been the Caisse d'Amortissement de la Dette Sociale (CADES). This sovereign agency was created in 1996 as a vehicle to consolidate and service the debts of the French social security funds. Its revenue comes from a ring-fenced tax on income called CRDS, making it a natural issuer/payer of French inflation. As of end 2013, CADES reported that 9.4% of its total debt of €132.6bn consisted of inflation-linked bonds. Historically, these issues have been built up via multiple syndications and in practice have traded similarly to OATis, albeit with notably lower liquidity, helping to define the curve when there were relatively few government issues.

Other non sovereign issuance has come from Réseau Ferré de France (RFF), the owner of French railway infrastructure, whose 2023 HICPx-linked bond has reached €2bn face value, having initially been syndicated for €800mn in February 2003. Caisse Nationale des Autoroutes (CNA), which grants loans to toll road companies, issued a €600mn 2016 French CPIx-linked bond in 2001. The Italian agency, Infrastrutture (ISPA), which had inflation-linked revenues from some projects such as high-speed railways which it funds, issued a €750mn 2019 bond in February 2004. This issue, which was subsequently redefined as Italian sovereign credit, was the first benchmark inflation-accreting bond to be linked to FOIx inflation. The first major true corporate inflation-accreting bond came from Veolia Environnement in June 2005, a euro HICPx-linked 2015 bond initially for €600mn. As an owner of a range of utilities in France and across Europe, Veolia ought to be well suited to using the inflation-linked market as part of its funding strategy. Terna S.p.A. became the first Italian listed company to issue a bond linked to the Italian FOIx in October 2007. The €500mn issue matures in September 2023 and was priced against the BTP€i September 2023, which carries the same maturity date. Given its revenues derive from regulated activities, Terna is a natural payer of inflation. In August 2008, France Telecom issued a 2018 bond linked to euro HICPx.

Inflation structured notes

While there was issuance in inflation structured notes even before the first OAT€i was issued in 2001, notably an inflation-protected, equity-linked note issued by the Italian Post Office, it was in 2003 that the market really took off. There was over €18bn of inflation structured note issuance in 2003, with almost all of it sold into Italy. As with other structured products sold mainly to individuals, the popularity of this kind of product faded, particularly as falling real yields made it increasingly difficult to structure sufficiently appealing cash flows. Total 2004 issuance was around €10bn, while there was less than €3bn issued in 2005. Issuance picked up slightly in 2006 with around €7bn in issuance but issuance in subsequent years has been somewhat less, other than in 2009. The widely dispersed nature of this issuance means that while there are several issues of over €500mn, liquidity is very limited. In 2003, most issuance was 5y, but as yields fell and the type of demand changed, issuance moved longer, with 10-15y supply becoming as common as 5y.

Most issuance in 2003 was of bonds paying an annual coupon at the rate of inflation plus a fixed percentage but with a fixed principal. Coupons were usually floored at the fixed rate, although in 2004 higher floors became more common. Coupons were often backward-looking, eg, paying inflation from the previous year and high fixed coupons early in the life of the bond were commonly offered as enticements. As distribution of this type of bond became more widespread, there was increased interest from corporates as well as individuals, but fees were such that most institutional investors were deterred. With the slight revival of issuance in 2006, products with coupon payments linked to inflation (mostly euro HICPx) with leverage became more popular. These notes often carried a fixed attractive coupon at the beginning and a cap and/or floor on the subsequent floating payments. 2006 also saw several structures with coupons linked to the differential between euro and French ex-tobacco inflation. The issuance of such products thrived on what was perceived as an anomaly on the forward breakeven differentials in the swap market. Indeed, forward French inflation breakevens were higher than on the euro HICPx curve because of Livret A-related demand. These notes proved popular as French inflation was expected to be lower than European inflation over the medium term. 2007 saw the appearance of inflation range accruals, where pay-offs are dependent upon the length of time that inflation remains within a specified range. The development of these products marked a stepping stone as they helped increase liquidity in the market for inflation caps and floors, but with realised inflation breaking above the top of the ranges specified by the end of 2007, holders of the notes suffered poor performance and demand for them waned. In 2008, notes paying a coupon linked to a multiple of the y/y inflation rate were widespread, with activity driven by demand from retail investors given the high inflation environment. The structuring of attractive pay-offs was also relatively easy as a result of expensive credit/funding for financials.

Most structured inflation notes have been issued by financials, although opportunistic swapped issuers including the EIB and KfW have also been involved. Greater retail scepticism over bank names has limited the scope for issuance since the Lehman bankruptcy. This exacerbated a trend towards more institutionally-focused structured issuance. The fees involved in this kind of note are often lower due to smaller distribution fees, providing access to investors who are unable to take direct advantage of the development of the inflation swap market. Even so, a significant increase in issuance likely requires a combination of higher real yields and fear of inflation. In 2011, the heaviest demand for structured notes was evident in Germany, but this fell away as euro sovereign fears increased. Overall, inflation-linked structured has been limited in recent years, partially due to lower funding rates for financials.

An area in which there appeared to be much scope for further development was that of domestic inflation bases. Issuance has been relatively significant on occasion, for instance in 2006 there was significant issuance in structures linked to Spanish inflation. Demand for German inflation linked notes was apparent when German CPI swaps were cheaper than euro HICPx in 2009, but has not been a significant feature in more recent issuance. In smaller countries it is hard to see how a structured note market can develop in any size without structural paying of inflation in swaps, or government issuance of bonds with a local inflation reference.

Inflation swaps and other derivatives

Euro HICPx

The benchmark format for euro HICPx quotes is the zero-coupon structure, with a standard lag of three months, meaning that the base inflation index for the swap is the value of the HICPx three months before settlement. Towards the end of the month, swaps on the next base month also begin to trade. There will be a discontinuity in the quoted “breakeven” at the time of the roll from one month to the next, reflecting typical seasonality between months. Barclays displays live prices for the currently trading base month on Bloomberg page BISW1. The most commonly-traded maturities are the 5y and 10y, but annual maturities above 2y trade regularly trade out to 30y and sometimes longer. Activity at the front end used to be very limited, and the inflation futures were never active enough to provide significant transparency or to cater for hedging needs. However, this changed from 2012/2013 given a very active resets market; the 1y point, in notional terms, is now probably as liquid at the longer benchmark points.

Euro HICPx swap broker volumes began to pick up substantially from late-2002, driven by a rise in the need to hedge retail products and structured MTNs. In 2003, it accelerated further, aided by the issuance of BTP€i08, the most suitable hedge for most of these exposures. Typical monthly broker volumes moved from €500mn in mid-2002, to €5bn by mid-2004, a level that was maintained in 2005 even though structured issuance fell notably. Liquidity in the market has been increasing since, with typical monthly broker volumes rising to €15bn in 2007. Total volume traded surged in 2008 in the interbank market but mainly because of the Lehman collapse. Direct interest in trading inflation swaps, from proprietary desks and hedge funds for instance, meant volumes did not suffer even when issuance hedging flow slowed down, while liability hedging has continuing. Liquidity in swaps suffered notably less than in euro linkers during the sovereign spread turmoil of Q4 2011, though activity in early 2012 was driven by significant forced swap unwinds on the back of Greek restructuring, which left previous asset swap exposures orphaned.

Government linker asset swaps often represent a significant proportion of volumes in the euro area inflation swap markets. The relatively high level of activity in asset swaps often helped align swap and bond breakevens more closely than has been seen in other markets. The private placements of ultra long-dated linkers by Italy and Greece in 2007 raised the prospect of the euro inflation curve stretching out to the 50y maturity as in the UK, but the depth of demand at such extreme liabilities remains limited. During the financial turmoil from 2007, many speculative participants or natural investors in linker asset swaps were no longer very active, which led to a wide distortion between swap and bond valuations in 2009. The cheapness of linker asset swaps then attracted demand, mainly from bank treasuries, but with a notably narrower investor base than before the crisis. This investor base narrowed notably further as euro sovereign woes increased, with very little interest in asset swaps in France or Italy beyond domestic banks and insurers, albeit demand was encouraged by 3y LTRO related liquidity.

Activity in inflation caps and floors on euro HICPx was boosted in 2007 by the issuance of inflation-range accrual notes. Given that these rely on inflation remaining within a specified range, this means that dealers selling them were actually long inflation volatility and they have tried to offset their risks by selling inflation caps and floors in the market. The increased trading activity on inflation options provided a clearer picture of the implied inflation volatility. Hefty issuance in leveraged notes over 2008 also encouraged hedging activity in the cap/floor market, which led to a significant rise in implied volatility. The presence of embedded floors in previously issued notes and increased volatility in realised inflation led to a sharp repricing of the cap/floor vol surface in 2008-09. The link between the vol and the swaps market is very tight towards the end of 2008, when increasing deflation fears pushed short-dated swaps lower, leading to a downward spiral of valuations at the short end of the curve as dealers sought to delta-hedge their short floor positions. The pick-up in asset swap activity after Q1 2009 was accompanied by much better definition in the market for zero-coupon floors, a process which appeared to help the recovery in the y/y vol market, with dealers becoming more comfortable in comparing their long zero-coupon floor positions to their structural short in y/y inflation. The inflation volatility market has to date come through the travails inflicting euro inflation-linked bonds relatively unscathed. Although still limited, liquidity overall has improved from around 2010, with some hedge funds active in that space.

French CPIx

The French CPIx market is slightly less transparent than that in euro HICPx, with much less structured inflation issuance to be hedged. The default format for French CPIx zero-coupon swaps is also different, as it is based on the same interpolated daily reference value as used for OATis, rather than the monthly format used in other euro area markets. This avoids the discontinuity of the HICPx method and aligns swap methodology more closely with bond methodology. On the other hand, it discourages short-term tactical trading within the same monthly inflation base that is seen in HICPx and makes it more difficult to compare market movements within a given month, as it can impose a drift on the level of breakevens.

The French CPIx market is the oldest major euro area inflation market, first trading in 1998, just ahead of the launch of the first OATi and before the HICP market that began almost as soon as the euro currency was created in 1999. The earlier development of the OATi bond market and short-dated issuance by French agency CADES allowed the French CPI swaps to initially have better liquidity than HICPx. Some domestic real money investors started using swaps to match cash flows as the market developed. However, it was not until trading of the basis against euro HICPx began, with broker screens becoming readily visible, that the market gained any depth. Compared with the size of the underlying bond market, however, outright paying flows are more common than in euro HICPx, while liability hedging is significantly broader than just Livret A-related flows.

The decision to link the Livret A French public sector savings rate to inflation from August 2004 greatly heightened activity levels in French CPIx. With banks being restricted on the amount of bonds they could hold versus their liabilities, the flow became increasingly skewed towards using derivatives as a solution. A variety of swap types have been used to hedge liabilities, including zero coupon across the curve, tailored maturity inflation swaps matching the inflation element of reset on the Livret A rate and Livret A swaps covering the nominal as well as the inflation element of the reset. In aggregate, there has been a tendency for hedging activity to decrease as real yields fall but also to move longer on the curve, with relatively little apparent sensitivity to breakeven levels. Bank hedging demand at times has led to more significant deviations between OATi asset swaps and those of nominal OATs than in the €i market. There is a significant percentage of OATis that are held in asset swap form until maturity as a result of the Livret A hedging pressure, but there is also two-way asset swap interest.

In 2006, the richness of French CPI swaps triggered substantial issuance in structured notes paying euro versus French inflation, usually with a leverage factor. These notes were actually hedged in the corresponding swap markets, correcting the squeeze created by Livret A-related hedging. FRCPIx again richened significantly versus euro HICPx swaps toward the end of 2008/beginning of 2009, given the extension of Livret A distribution rights to the whole banking network in France. However, the fact that the formula was changed in 2008, and then over-ruled most of the time in 2008 and 2009, implies that French inflation is no longer a good hedge for Livret A-related liabilities, at least from a pure formulaic perspective.

Other euro area inflation markets

While an underlying government bond market and developments on the regulatory front (Livret A) have helped to create liquidity in the FRCPIx swap market, activity on other euro area domestic inflation swap markets remains muted. Italian and Spanish inflation swap markets are the most active of these other countries, with live prices even available from some dealers, but activity in these indices has been relatively muted since 2008. There has been a pick-up in interest in German CPI, but activity remains sporadic. Other inflation bases are usually quoted as a spread against the more liquid euro HICPx basis, with the pricing dependent on the expected evolution of each index relative to the euro area. From a general perspective, activity on these swap markets could gain momentum if there is growing demand to hedge explicit liabilities linked to domestic inflation, especially as increased divergence in inflation rates implies that euro HICPx may not prove an appropriate hedge against domestic indices.

German CPI

Explicit indexation to German CPI had been illegal prior to 2003, but the German government's intention to issue inflation-linked bonds, even though this was euro HICPx, spurred a market to develop. Prices are available from Barclays on Bloomberg page BISW27. Until 2009, the higher real yield that a German inflation basis offers compared with one linked to euro inflation created some interest to retail and corporate investors. This prompted limited structured note issuance, which tended to narrow the spread, and from mid 2010 onwards, German inflation has traded richer than euro HICPx. Until now, supply in German inflation has come primarily from property securitisation and rental leases. The tendency towards utility privatisation may produce paying flows, particularly if there is indexation embedded in the formulae for renewable energy projects. Banks may have some willingness to pay German inflation through swaps because of its weight in the euro HICPx, such that the basis risk involved is less of an issue than for other domestic inflation indices.

Pension liabilities in Germany were traditionally backed by company assets, meaning that implicit or even explicit inflation risks tend to be ignored. The trend towards funded schemes in Germany implies that embedded domestic inflation risks in liabilities are likely to be addressed on a larger scale. However, the extent to which this will effectively create substantial demand for German CPI is debateable. Liabilities rarely reference national headline CPI but can be based on various other indices, and where the basis risk of the relevant index versus German CPI is high, hedging needs may as well be met using the euro

HICPx swaps market. Furthermore, even in cases where the relevant index is the German CPI, pension funds may prefer to hedge euro HICPx swaps, given relative liquidity and with the basis risk versus European inflation perceived to be low.

Italian FOIx CPI

Traditionally the most active inflation swaps market without a substantive underlying government bond market to hedge against is the market for Italian FOI inflation (ex tobacco). This was initially driven mainly by substantial retail note issuance in Italy on this basis, and the market slowed from 2005 with less structured issuance. The FOIx market is quoted with the same conventions as euro HICPx, including lagged basis month. Prices are available from Barclays on Bloomberg page BISW25. Most of the retail issuance which occurred has now redeemed and the swap market had been quiet in recent years prior to the launch of the initial BTP Italia. The market for Italian-linked retail notes started in 2002, at which time there were small issues in both FOIx and the alternative NIC basis (Bloomberg code ITCPNIC). The FOIx measure became the most widely used measure because it is more widely referenced in Italian inflation-linked liabilities. While retail notes were predominantly sold to individuals, there was some demand from corporates to hedge TFR exposure, which was 1.5% plus 75% of FOI ex tobacco inflation.

Prior to the mid 2011 sovereign spread widening, most investors with Italian inflation exposures seemed content to hedge with euro inflation, given that the level of prices in Italy converged with the euro area average in the first 10 years of the single currency. It is notable that the turmoil in late 2011 saw domestic Italian expectations rise sharply, to their highest level since euro notes and coins were introduced 10 years previously. We suspect this reflected fears of a return to a domestic currency, a concern which likely underpinned demand for the BTP Italia product. With the disinflationary momentum in 2013/2014 being driven by peripheral countries, FOIx currently trades well below euro HICPx.

Spanish CPI

The market for Spanish CPI developed in 2004 with some limited swapped structured note issuance. Structured note issuance, however, rose strongly in 2006. These notes typically had 10y and 15y maturities, and the hedging of these triggered a strong demand and richening in Spanish CPI swaps as the street was left short. The rise in demand coincided with a period when actual inflation was high on the back of the real estate boom, thereby accentuating the richening versus euro HICPx swaps. Demand for Spanish CPI was mainly from the insurance and retail sectors, while natural supply came from residential property leases and property securitisation. Spread levels to euro HICP swaps decreased in 2007, from the very rich levels observed in 2006, helped in part by speculative selling from some, who viewed the spreads as unsustainable, and a narrowing of realised inflation spreads.

The first half of 2008 saw renewed activity in Spanish CPI swaps on the back of structured note issuance. The interesting feature of structured note activity in Spain during 2008 was that the underlying was commonly the domestic index, in contrast to demand in other countries. This led to renewed relative richening in sub 10y Spanish CPI swaps, while the long end lagged versus euro probably due to infrastructure-related paying flows. While swap valuations from 2013 cheapened notably versus the euro area, potential for domestic demand remains, in our view. This has been met by bond issuance by several regions and municipalities, with swap activity relatively muted. Spanish CPI prices are available from Barclays on Bloomberg page BISW26.

Dutch CPI

The Netherlands is the euro area country that has the largest potential demand for long-end domestic inflation protection. Given the size of Dutch defined benefit pension schemes, demand for Netherlands CPI ought to be considerable. However, because of the conditional indexation of liabilities to inflation, there has been no regulatory pressure to address inflation risks akin to that in the UK. Indexation is usually to either sector-specific or general wage inflation rather than Dutch CPI and, in the absence of large natural inflation payers, most pension funds have accepted that they cannot match their liabilities. Regulatory reform may ultimately lead to increased demand, as indexation aims will be more explicit, but in the medium term it reduces the likelihood of liability hedging until the new regime is implemented. Some funds are willing to pay a significant premium to source specific inflation though, inducing payers mainly from the infrastructure and property firms. This is a market of one-way flow, with all inflation receiving by pension funds locked to maturity. Barring the unlikely event of the Dutch state issuing domestic CPI-linked notes, not much is likely to change. Dutch pension funds tended to address the conditional indexation on an ad-hoc basis when funding ratios are high enough. Given the liquidity of the euro HICPx market and the absence of any other suitable alternative, pension funds tend to take the basis risk created by long exposures to euro inflation, albeit there was significant unwinding on the back of Greek related euro HICPx strength in early 2012, which coincided with low solvency ratios. While the short-term basis risk between Dutch CPI and euro HICPx is significant, so too is the basis risk between wages and Dutch CPI. The absolute price level in the Netherlands has remained close to the euro area's since the start of monetary union, suggesting that euro HICPx is a relatively effective hedge of Dutch inflationary risk in the long term.

Belgian Health Index CPI

In our view, Belgium has the potential to develop into a relatively significant inflation market. The relevant index against which almost all inflation liabilities are based is the Health Index measure, which excludes alcohol, tobacco and fuel oils (Bloomberg code BECPHLTH). As with other smaller markets, local government, infrastructure and property developments may bring the most likely payers of Belgian inflation. Until now, supply has come mainly from rental leases paying Belgian Health inflation, but also Belgian CPI and HICP.

Irish CPI

Ireland has a longer history of inflation paying than anywhere else in the euro area. Supply historically came mainly from housing associations and Public Private Partnership (PPP) deals in swap form. Pension fund liability needs are more explicit than in most other euro countries, with significant indexation in an LPI format, floored at 0% each year and capped at 4%. This, coupled with the longer history of the market, often results in relatively complex structures. The size of the market is such that it is unlikely to affect valuations elsewhere, but it may encourage innovation in other markets, particularly given the trend for pension funds of multi-national companies to base themselves in Ireland. Given the demographic structure in Ireland, pension fund demand for inflation tends to be in long maturities. The mortgage component is a function of both interest rates along with long-term house price growth. This helped to drive Irish CPI substantially negative, down more than 5% y/y at its trough in 2009.

Other euro area countries

Of the other countries within the euro area, Portugal has seen a higher degree of potential payers than elsewhere, while pension funds have mostly chosen the more liquid euro HICPx options rather than addressing their liabilities directly, producing a relatively balanced market. By contrast, in Finland, even though there is interest to receive domestic inflation from pension funds, the lack of Finnish CPI payers restricts the development of a market. Austria has seen little activity due to limited explicit liabilities linked to Austrian CPI, even though the government has previously issued swapped structured HICPx notes. Recent entrants from the east European block have relatively undeveloped private pension systems. Thus, we would be surprised if domestic inflation markets emerged there.

INFLATION MARKETS

United Kingdom

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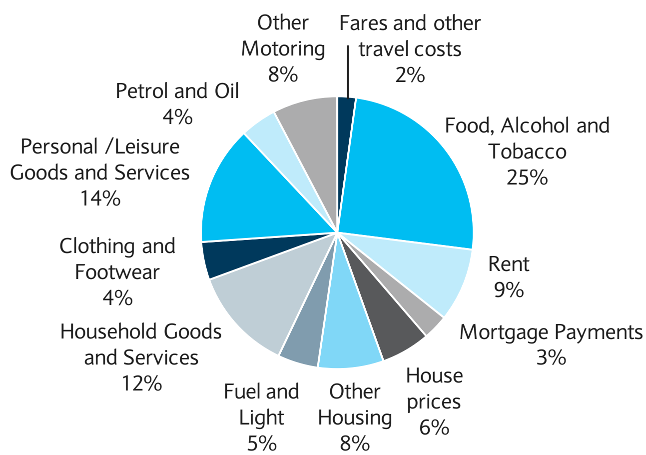
The UK Treasury has been issuing gilts whose principal value is linked to the Retail Prices Index (RPI) since March 1981. At the end of 2013, linkers comprised 25% of UK government bond debt by market value, or over £370bn – a fairly large proportion of the overall debt stock relative to other comparable markets. This reflects the embedded inflation indexation in many UK defined benefit pension liabilities, which provides a natural demand base for the asset class. Following legislative changes in 2010, many liabilities reference a mixture of RPI and CPI exposure. The UK inflation market is almost exclusively RPI-based; while CPI gilt issuance is a theoretical possibility in the longer run, it would risk a fragmented market and, thus, is unlikely in the near term.

The Retail Prices Index

The Retail Prices Index, or RPI, has been used as a measure of UK inflation since 1947 and was the main measure of headline inflation for over 50 years, although it was never formally adopted as a targeted inflation series for monetary policy. Since December 2003, the Bank of England's Monetary Policy Committee has had an inflation target based on CPI. UK CPI was developed as a harmonised index of consumer prices, using Eurostat's HICP principles, but the name was changed from HICP to CPI in June 2003, when it was announced that the inflation target would be changed. Previously, the inflation measure targeted by monetary policy was the RPI excluding mortgage interest payments, RPIX. Raw data for the RPI are collected in the middle of each month, with the new index published on a Tuesday in the middle of the following month. Weights are recalculated annually, with re-weighting calculated for the January data.

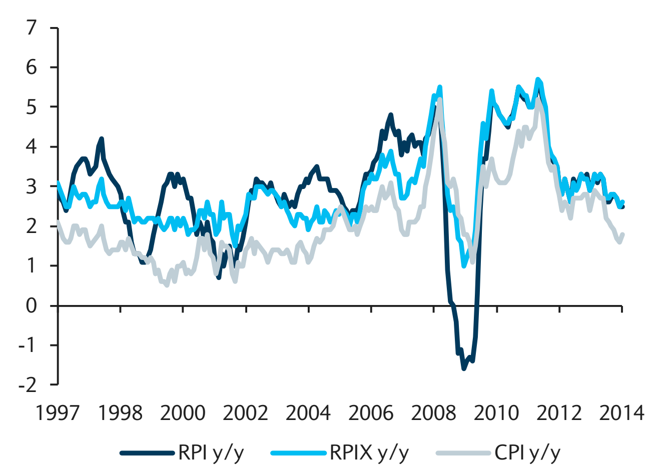
In contrast to most consumer price indices collected internationally – including the UK CPI – the RPI is constructed with arithmetic, rather than geometric, aggregation. As this aggregation is based on the average of relative prices rather than a ratio of averages, it produces an upward bias compared with a geometric aggregation. This statistical bias, often referred to as the formula effect, has been worth almost 1pp in recent years. Methodological changes to the treatment of seasonal prices have been responsible for greater inflation dispersion in the clothing and footwear component in RPI, which has

FIGURE 1
Breakdown of RPI by major category



Source: ONS, Barclays Research

FIGURE 2
UK RPI, RPIX and CPI inflation



Source: ONS

largely been responsible for the increased impact of the formula effect from 2010. Historically, the bias had consistently been worth close to 50bp, which was the basis on which the Bank of England's inflation target was adjusted from 2.5% RPIX to 2.0% CPI, with tolerance bands remaining at 1% on either side of the target. If inflation is outside of these bands, the Governor of the Bank of England is required to write a letter to the Chancellor of the Exchequer each quarter accounting for this deviation, outlining when the committee expects inflation to return to target and what steps are being taken to anchor inflation. Even though monetary policy is now focused on CPI inflation, gilt linkers are likely to remain indexed to RPI inflation for the foreseeable future, after the government decided against issuing CPI-linked gilts following consultation in 2011.

The RPI measure was the source of some controversy, and even market panic, from Q2 12 until Q1 13. The now-disbanded Consumer Prices Advisory Committee (CPAC) had been deliberating means of managing the RPI formula effect, and ultimately held a consultation on how best to proceed. Participants in the UK inflation market had feared that the formula effect would be substantially or wholly eliminated, resulting in lower inflation accrual over the maturity horizon of their linker holdings. Indeed, CPAC recommended excluding the Carli measure of aggregation from the RPI since it has been internationally discredited given the upward bias it imparts into inflation indices, which gives rise to the formula effect. On 10 January 2013, the National Statistician announced that no changes would be made to the aggregation formulae in RPI, effectively preserving the formula effect. Additionally, it was noted that revisions to RPI should be limited to just routine updates of the inflation basket and methodology. RPI has been stripped of its 'National Statistic' designation and is now classified as an 'Official Statistic'. This has almost no consequence for the inflation markets because the ONS is obliged to continue producing RPI and, at the time of writing, continues to publish a full and detailed RPI breakdown in the official inflation release each month. The market stabilised quickly after the decision was announced, and the episode has now largely been confined to history by most market participants, though there is arguably now a greater focus on the RPI/CPI basis.

Modelling the RPI/CPI basis

The RPI/CPI basis (or wedge, as it is sometimes called) is of interest for two reasons. First, information from inflation-linked bond and derivative markets is of interest to policymakers as a gauge of market expectations regarding the credibility of inflation-targeting regimes. By the same token, inflation targets are often viewed by market participants as a reasonable assumption of medium-term breakeven fair value. In the UK, the inflation target is 2% CPI, so an RPI/CPI basis assumption is needed to assess the fundamental fair value of breakevens on a CPI basis. Second, those hedging CPI liabilities with RPI product require a framework for the RPI/CPI basis to provide a realistic gauge of the likely hedging error.

The Office for National Statistics provides a breakdown of the RPI/CPI basis, divided into the following components:

- **Formula effect.** The magnitude of the upward bias to RPI relative to CPI stemming from the different aggregation formulae used in the two indices. RPI relies heavily on Carli (arithmetic) aggregation, whereas CPI is largely a Jevons (geometric index). A Carli-based average is always higher than a Jevons average. Clothing and Footwear is the primary source of the formula effect, which is proportional to the extent of dispersion within its individual subcomponents.

- **Mortgage interest payments (MIPs not in CPI).** Historically, the most volatile component of the basis, given its sensitivity to interest rates. Calculation based on a 23-year average house price, and the average effective mortgage rate (AER). Prior to 2010, the calculation referenced the standard variable rate (SVR); so, in future rate cycles, MIPS will be less volatile than previously.

- **Housing depreciation (not in CPI).** Exponentially smoothed house price series. Can be modelled using third party house price indices (eg, Nationwide, Halifax) including an appropriate lag structure.

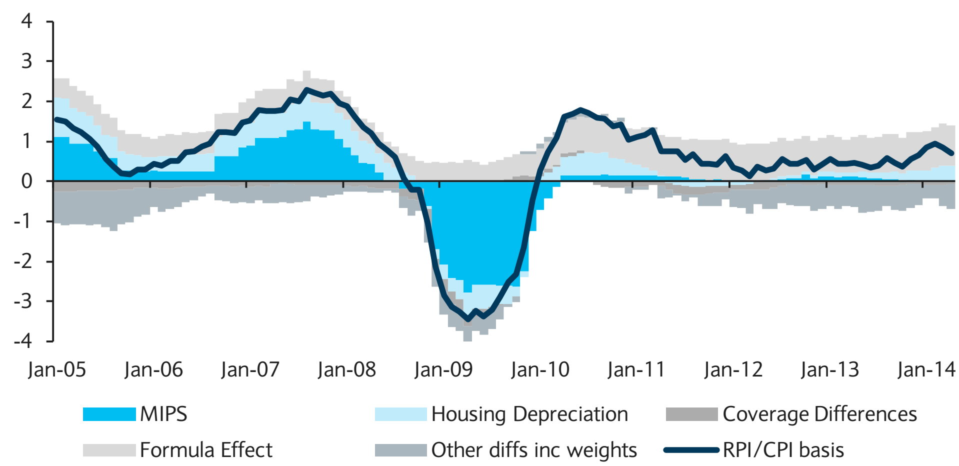
- **Differences in coverage between RPI and CPI.** Some items, such as stockbroker fees and overseas tuition fees, are not included in RPI but are in CPI. Historically, other components fell into this bracket, but this proportion is diminishing.

- **Other differences including weights.** This is the most idiosyncratic component of the RPI/CPI basis because it encapsulates the spread between the two indices as a result of the different weightings of volatile components such as Food, Petrol, Air Fares, etc. Insurance costs (particularly motoring) have also been an important driver recently. We forecast this component using a model based on selected volatile components of CPI. This component has been responsible for much of the narrowness of the RPI/CPI basis in the past few years.

We model or take a view on each of these components to produce short- and long-run estimates of the RPI/CPI basis. Over the long run, we project an RPI/CPI wedge of 1.1-1.4pp, compared with the BoE estimate of 1.3pp in the February 2014 *Inflation Report*.

FIGURE 3

RPI/CPI basis breakdown



Source: ONS, Barclays Research

Development of the UK inflation market

The first index-linked gilt, the 2% Sep 1996, was auctioned by the UK Treasury on 27 March 1981, for £1bn. An ongoing commitment from both the Treasury and the investor base has seen market capitalisation grow to £374bn by the end of 2013, 25% of the total outstanding value of the gilt market. More than 30 bonds have been issued, with 23 bonds still outstanding as of June 2014 on a real yield curve that stretches out to 2068. "Old-style" 8m lag linkers are no longer issued, while Canadian model 3m lag bonds are actively supplied with both November and March maturities.

The creation of a linker market was formally recommended by the "Committee to Review the Functioning of Financial Institutions (1977-80)" (known as the Wilson Committee, after its Chair Sir Harold Wilson). However, indexation of debt was not a new idea in the UK – the UK Government's National Savings department had been issuing inflation-linked savings certificates for retail investors since 1975, while Keynes recommended the move as early as 1924. In the 10 years prior to the launch of the first linker, annual RPI inflation moved between 6% and 26%, prompting strong demand for inflation protection, but pension funds were allowed to buy the new asset class for the first year only. Issuance of indexed debt contributed to the credibility of the government's anti-inflationary rhetoric by diminishing the incentive to debase the real value of the outstanding debt, but as inflation fell the programme proved a windfall for government finances. Early breakevens were about 9%, an expected inflation accrual cost considerably higher than was realised; within two years of the inception of the market, RPI dropped below 5%. RPI generally stayed below 5% with the exception of the boom and oil price shock at the end of the 1980s, but rose above this level during the sharp rise in energy prices in 2008. After a period of negative inflation as the MPC lowered Bank Rate to a record low of 0.5%, RPI touched a local high of 5.6% y/y in September 2011, fuelled by increases in consumer energy prices and hikes in VAT to shore up the UK public finances.

Other than a bond issued in 1983 that was convertible into nominal debt, the 2% 1999, dubbed "Maggie Mays" (a reference to the then Prime Minister, Margaret Thatcher – 'Maggie may or may not convert the issue'), all gilt linkers issued prior to 2005 had the same idiosyncratic format that has not been copied in other countries. Since September 2005, starting with the first syndication by the UK government of the 2055 linker, a new curve has been built up of Canadian-style bonds. By 2007, all new issuance was in Canadian-style bonds, with six issues with maturities of 2017 and longer being launched by the end of that year. This rapid issuance of new bonds contrasts with the 2035 old style linker, which was the only bond launched between 1992 and 2005.

The prospectuses of linkers issued before the 2035 bond contained "comfort language", giving some protection against adverse RPI measurement changes. In the event of changes to the coverage or to calculation of the RPI, which the Bank of England (acting as "index trustee") deems "materially detrimental", investors will be given the right to sell bonds back to the government at indexed par (ie, adjusted for inflation), although that is of limited comfort at present because all stocks under this protection are trading well above indexed par. This clause has also been copied by some corporate issues, where the reference gilt is an old-style. There was considerable concern in late 2012 about the potential effect of such clauses on both gilt and corporate linkers, and we believe the related possible ramifications are one reason the aggregation of RPI was not altered. For the 2035 and new Canadian-style bonds issued by the Debt Management Office (DMO), the choice of linking index is at the Chancellor's discretion, with the proviso that there is consultation with a body with "recognised expertise in the construction of price indices". This choice will be "conclusive and binding".

Government funding plans are laid out annually in a "Gilt Remit" within the Treasury's "Debt and Reserves Management Report". This generally coincides with the Budget, just ahead of the beginning of the new fiscal year in April. The remit contains an estimate of the total size of linker sales, by cash value, to be carried out in the new fiscal year. Planned auction dates for the year are released at this time, and there is often guidance as to how plans might be altered in the event of changes to the health of public finances. Formal remit revisions can happen at any time, but two key times are early in the new fiscal year once the prior year's finances are known and in the final quarter of the calendar year, just after the Treasury's Autumn Statement is announced. Auction stocks are announced quarterly, although they are subject to remit revisions, with size details announced on the Tuesday in the week before an auction.

Prior to 2009, the vast majority of linker issuance since November 1998 was via auction. Linker auctions are single-price – ie, all successful bidders pay the same price, in contrast to nominal gilt auctions, which use a multiple price mechanism. Since 2009, there has been an additional 10% of stock for each auction that may be sold to successful bidders at the clearing price in a post-auction facility. The DMO also sells linkers via mini-tenders, which are auctions of about half the size of regular auctions that are announced at shorter notice and for which there is no post auction allotment. Mini-tenders are a relatively small element of total issuance, and are seen as a safety valve or as a vehicle for opportunistic issuance in small size. Institutional buying at auctions must come via index-linked gilt-edged market makers (IL GEMMs). In the past, only some nominal market makers were IL GEMMs, but it is now common for most GEMMs to trade linkers. These banks are also the route through which the DMO can conduct syndications, switch auctions, taps and other market activities. IL GEMMs can also access the DMO's standing repo facility (10bp below Bank of England's Policy Rate), though with a few exceptions, it is rare for the linker repo to stray far from general collateral rates for long.

Syndicated issuance of gilt linkers was first used in September 2005 for the launch of the 2055 linker, due to the extreme extension of the curve and the innovation of the new bond format. Syndicated gilt linker issuance was not used again until 2009, when the DMO noted in its response to the consultation on the supplementary methods for distributing gilts in March 2009, that it would use syndicated issuance alongside the auction programme in FY09/10 to issue larger volumes of gilt linkers and long nominals than it judged would be possible via auction. While initially used sparingly for supplementary issuance, syndications have become an important feature of the UK gilt remit. Particularly for linkers, syndications are able to provide sufficient liquidity to draw deep demand for particular bonds, which would not be feasible at a regular auction. From FY13/14, the DMO focused on holding fewer but syndications than in preceding fiscal years, with an aim of increasing the size on these to facilitate deep demand for long conventionals and linkers to best meet the needs of those hedging sizeable liabilities.

While there has been some non-government issuance of sterling inflation-linked bonds since the mid-1980s and RPI swaps have traded since the early 1990s, until the early 2000s gilt linkers were by far the dominant feature of the UK market. In 2000, when the Minimum Funding Requirement (MFR) encouraged pension funds to favour gilts, asset swaps were sufficiently attractive for significant supranational swapped supply. This helped to kick start what was until then a niche RPI swaps market. As equity markets declined in the following two years, the life insurance industry began to focus on the potentially more accurate liability-matching benefits of using inflation derivatives rather than bonds. In particular, the PS16/04 regulation hastened the use of inflation swaps by the insurance sector. Initially, they covered their life policy RPI exposure before focusing on immunising bought-out and in-house pension portfolios. It was not until 2004 that pension-specific, rather than insurance business, became the main driver of the UK swaps market; however, having been spurred on by heavy swap activity around the time of the IL55 launch in September 2005, it quickly grew to dominate end-user demand.

In the mid-2000s, inflation derivatives became the main source of inflation liability hedging; however, the significant increase in gilt linker supply from 2009 saw focus revert back to inflation-linked bonds as the main instrument used for liability hedging. Even with the government's increased issuance, the market remains far too small to address the liabilities completely. Fundamentally, there remain notably more RPI-linked liabilities in the UK than available assets. The Pension Protection Fund (PPF) survey of 7800 pension schemes showed estimated private sector pension liabilities to be £1,266.8bn at the end of April 2014. The PPF liability measure is more conservative than most schemes report in their accounts with measurement based on nominal and inflation-linked gilt curves. However, there are few new inflation liabilities effectively accruing in the private sector, given scheme closures and most remaining exposures being capped at 2.5%.

FIGURE 4
The changing face of pension indexation

Measure announced	Effective	Change(s)
Social Security Act 1986	6 April 1988	Guaranteed minimum pensions for contracted-out service required to have 3% LPI
Pensions Act 1995	6 April 1997	Statutory indexation introduced, capped at 5% RPI
Pensions Act 2004	6 April 2005	Minimum RPI cap reduced to 2.5%
8 July 2010	January 2011	CPI used for uprating most benefits and public sector as well as for revaluation order under Pensions Act 1993
16 June 2011	–	Government response to impact of using CPI as measure of price increases on private sector pensions schemes rules out overriding scheme rules stipulating specific RPI accrual
Budget 2014	–	Requirement for defined contribution pensioners to purchase annuity removed

Source: HM Government, Barclays Research

As recently as 2003, insurers and pension funds owned over 90% of all gilt linkers, but their share of the total market has fallen steadily since as the size of the market has increased. Demand from insurers stems mostly from life insurers who are matching real annuity obligations and, increasingly, pension fund obligations that have been bought out (ie, the risk of pension funds has been transferred to the insurer). When a scheme is bought out, the purchaser tries to immunise as much risk as possible, typically with a much higher asset allocation into inflation than before the liabilities are transferred. Buy-out demand was probably the largest single source of end-user demand in the linker market in 2008, whereas in 2009 a more important driver appeared to be the significant number of very large pension schemes that were closing further accruals to existing members. When schemes close, they often also choose to de-risk, particularly if closure also involves a cash injection from its sponsor, as the uncertainty of their future liabilities is reduced considerably without active members.

UK linkers faced a demand shock in July 2010 following a surprise announcement that the government intended to switch the reference inflation measure for statutory pension indexation from RPI to CPI. This left significant uncertainty regarding the nature of existing liabilities, as there was concern that all RPI-based liabilities might be transformed to CPI, rather than just those indexed to the 'statutory minimum'. Following a Department of Work and Pensions consultation on the matter, the government announced in its response to the consultation in June 2011 that it would not offer overrides to schemes explicitly referencing RPI indexation, thus removing the layer of uncertainty. A DWP survey of defined benefit schemes, published in 2011, estimated that 72% of schemes referenced RPI explicitly for indexation purposes, but that for revaluation 61% reference CPI. This means that the majority of schemes will pay out benefits uprated by RPI subject to any caps or floors upon retirement of individuals, but that most benefits will accrue indexed to CPI prior to retirement upon leaving service. This presents something of a conundrum for some schemes in hedging their liabilities, but without a viable CPI inflation market, hedging will likely take place with RPI instruments for now. The government announced it would not issue CPI linkers in fiscal year 2012-13, due in part to the uncertainty about the status of CPI with regard to changes such as the inclusion of owner-occupied housing, but it may reconsider potential issuance in the future.

Traditionally, most linkers have been held versus an index benchmark rather than directly matching liabilities, but the percentage of the market held this way has been declining steadily as investors have increasingly moved towards liability-driven investment (LDI) strategies even in their bond portfolios. Over-5y indices are more widely used than all linker indices; it is not a coincidence that the yield on the FTSE over-5y gilt linker index used to be the reference for minimum funding requirement (MFR) liability measurement. This means that when a bond drops below five years, there can be a significant dislocation to the market, with the bond itself seeing forced selling, but the bonds remaining in the index are likely to be supported due to an extension of index duration.

Pension regulation encourages recognition of the nature of pension liabilities and has been a major factor behind increased inflation-linked demand since the 1990s. However, unlike the MFR, regulation in recent years has surprisingly not prescribed how pension funds should address their exposures. There is no longer a generally accepted discount curve dominating all others. This is likely to have encouraged the use of swaps, which are likely to be closer than gilt linkers to the FRS17/IAS19 accounting definition. Buy-outs are typically priced off a gilt linker curve, with insurers tending to have more regulatory flexibility if their base investment is in gilt linkers rather than swaps. Neither the Pensions Regulator nor the Pension Protection Fund actively push schemes backed by strong sponsors towards lower-risk or liability-driven solutions. The Pensions' Regulator has pushed for pension schemes to be safeguarded when firms are taken over by lower-rated, or foreign, entities, which has led to significant capital injections into pension funds, but a scheme's trustees decide whether to use this injected money to immunise risks. The Pension Protection Fund does oversee risk reduction by schemes that are in assessment for being taken over by the Fund, but it is not prescriptive beyond this universe, even though its Section 179 liability estimate is referenced off the gilt linker curve. When schemes are significantly in deficit and scheme sponsors are cash rich, this can encourage cash injections to shore up scheme funding. This is typically followed by de-risking activity, which can encourage price-insensitive demand for linkers.

Mechanics of UK linkers

While new issuance is in Canadian-style linkers and most of the stock of UK linkers is now in new-style issues, there are still many old-style bonds. The new-style issues have a virtually identical framework to US TIPS, with the exception that they have no deflation floor (ie, they can be redeemed below par if RPI falls over the lifetime of the bond), consistent with old-style linkers. The mechanics of new-style linkers are addressed earlier in this guide, but calculations for old-style linkers are more complex and are set out below.

Instead of trading in real space, with a real price and with settlement amounts adjusted to reflect the inflation experienced over the life of the bond, old-style linkers trade in clean price cash terms (not real), with the traded price including inflation that has occurred. An example of the difference in price evolution between the old-style 2.5% IL Jul '24 and the new-style 0.125% IL Mar '24 is shown in Figure 5. In a positive inflation environment, the clean price of the old-style linker tends to drift higher; linkers first issued in the 1980s now trade with prices above £300 in some cases. Since the price of an old-style linker already includes accrued inflation, no index ratio is used to create the settlement price, unlike for new-style linkers, and accrued interest is calculated on the cash value of the coupon and paid on an actual/actual basis.

FIGURE 5

Example of difference in pricing styles between old-style and new-style linkers

Linker	Clean price	Index ratio	Accrued interest	Dirty price
UKTI 0.125% Mar '24 (new-style)	104.78	1.05019	0.02	110.06
UKTI 2.5% Jul '24 (old-style)	333.20	N/A	0.22	335.41

Note: As of the close on 20 May 2014, settling 21 May 2014. Source: Barclays Research

To trade in nominal space, it is necessary to know the inflated value of the next coupon so that accrued interest can be calculated. As a result, the inflation indexation for the coupon of an old-style linker is done with an eight-month lag (a coupon's cash value will need to be known six months before it is due, and it takes some time to gather and publish the price information for the final month). Accrued interest is then calculated in the usual way for gilts but using the known inflated value.

For example, the eight-month lag means that the principal value of the UKTI 2.5% July 2016, issued in January 1983 and redeeming in July 2016 will be uplifted by the ratio of the RPI for November 2015 versus May 1982. So, investors "gain" the inflation for the eight months prior to the bond's issue, but "lose" the inflation for eight months prior to the bond's maturity. This term mismatch is not especially large in a benign inflation era, but history shows that, at times, the effect has been large on the realised return.

Using this methodology, the cash value of semi-annual coupons for old-style linkers are calculated as follows:

Coupon paid = $$\left(\frac{C}{2}\right)\left(\frac{RPI_{m-8}}{RPI_{i-8}}\right)$$

Where: *C* is the quoted annual coupon

RPIt is the RPI for month t

m is the payment month

i is issue month

Similarly, the cash value of the redemption amount is:

Redemption value = $$100\left(\frac{RPI_{r-8}}{RPI_{i-8}}\right)$$

Where: *r* is the redemption month.

Therefore, to calculate the settlement amount for an old-style linker, we simply add the accrued interest to the clean price (which already includes uplifted inflation).

A few extra stages are required to find the real yield corresponding to the quoted nominal price of the old-style linker. To calculate the real yield for a linker with a nominal pricing convention, a model for the future value of the nominal cash flows is required. These are defined by future RPI prints; as such, the future nominal cash flows are unknown as future inflation is inherently uncertain. For analysis of Canadian-style linkers, this is irrelevant because they are quoted at a real price, which is translated into a real yield by using the same calculations as for a nominal bond. The price is then uplifted for inflation already accrued at settlement. For old-style linkers, the convention is to apply a fixed inflation assumption to determine the future nominal value of the bond cash flows. It is then relatively straightforward to calculate the money yield, or nominal yield of the bond.

To arrive at the nominal yield or "money yield", it is assumed that the RPI grows at a fixed rate beyond the most recently published RPI print. By convention, this assumption has been 3% per annum since the mid-1990s (prior to this, it was 5% and, originally, 10%).

Therefore, an unknown RPI for month *t* is given by;

$$RPI_t = RPI_{t-1}(1+f)^{\frac{1}{12}}$$

Where *f* is the RPI assumption (in this case, 3%).

Using this RPI assumption, the coupon payments and redemption value of an old-style linker are then mapped out according to the assumed future path of RPI this creates. From these cash flows, the internal rate of return, or "money yield", is then calculated for any given dirty price in the same way as the internal rate of return for a nominal bond.

DMO's Real Yield Formula

The DMO's "*Formulae for calculating gilt prices from yields*", 16 March 2005 update, gives a closed solution real yield formula. It also highlights the detail of Canadian-style linker calculations. The yield formula, expressed algebraically, is daunting, while a practical spreadsheet calculation is less so.

The real yield formula covers traditional bonds with two or more cash flows left (when there is only one coupon remaining, the bond has known nominal value and, hence, is best valued using a money market yield). The term "quasi-coupon date" is the theoretical cash flow date determined by the redemption date; weekends and holidays may mean true payment dates differ.

Any errors of duplication are ours. We have also trimmed and altered the wording of the explanatory notes. Readers should refer to the above official publication to see complete details.

$$P = \left[d_1 + d_2(uw) + \frac{acw^2}{2(1-w)}(1-w^{n-1}) \right](uw)^{\frac{r}{s}} + 100au^{\frac{r}{s}}w^{\frac{r}{s}+n}, \textit{ for } \quad n \geq 1$$

Where:

P = The "dirty" price (ie, including accrued) per £100 face.

d_1 = Cash flow due on the next quasi-coupon date per £100 face.

d_2 = Cash flow due on the next but one quasi-coupon date per £100 face.

c = (Real) coupon per £100 face.

r = Number of days from settlement date to next quasi-coupon date.

s = Number of days in coupon run containing settlement date.

g = Semi-annual real yield.

$$w = \frac{1}{1+\frac{g}{2}}$$

f = Assumed inflation rate (3% is the current convention).

$$u = \left(\frac{1}{1+f}\right)^{\frac{1}{2}} = \left(\frac{1}{1.03}\right)^{\frac{1}{2}}$$

n = Number of coupon periods from next quasi-coupon date to redemption.

$RPIB$ = The Base RPI for the bond – ie, for the month eight months prior to issue date.

$RPIL$ = Latest published RPI.

k = Number of months from the month whose RPI determines the next coupon to the month of the latest RPI.

$$a = \frac{RPIL}{RPIB}u^{\frac{2k}{12}}$$

Once the "money yield" is found, the inflation assumption is then removed to give the "real yield" by using the following calculation, which is the convention:

$$\left(1+\frac{g}{2}\right)^2 = \frac{\left(1+\frac{y}{2}\right)^2}{(1+f)}$$

Where g is the real yield, y is the money yield and f is the RPI assumption.

Old-style linkers in practical terms

Beyond liquidity issues, the greatest source of confusion for old-styles comes from the different inflation carry model from new-style linkers. New-style, Canadian model linkers accrete inflation daily with the standard 3m interpolated lag. However, for old-style linkers, each time an RPI inflation print is released, it replaces one month of the 3% inflation assumption with the actual value. As can be seen in the box above, the pricing formula for old-style linkers references the latest known RPI print. Given that old-style linkers are priced in nominal terms, the linker market tends to anticipate imminent RPI prints and adjust accordingly; typically, the consensus forecast for the forthcoming RPI print is used as a reference. Accordingly, if RPI prints in line with consensus, then, all else equal, the price of the linker is unlikely to change. However, the pricing model for old-style bonds means that the real yield will mechanically adjust depending on the degree to which the m/m realised inflation print differs from the 3% annual (0.247% m/m) assumed inflation schedule.

In the formula above, the 'a' term is proportional to the latest known RPI, and the 'u' term inversely proportional to the real yield. Thus, if m/m inflation is firmer than 0.247%, then the real yield mechanically moves higher, making the bond appear cheaper. This is counterintuitive at first given that one might expect real yields to richen on 'high' inflation prints as a consequence of greater demand for inflation protection. If inflation prints higher than consensus, real yields often rise less than the mechanical adjustment motivates – ie, the bond richens in price, thus mitigating the optical yield effect. An alternative interpretation of the apparent cheapening on a firmer m/m inflation print than implied by the inflation assumption is that this is equivalent to inflation carry. Thus, the instantaneous forward yield is higher than the previous spot yield, and positive carry is accrued. On an inflation print less than 0.247% m/m, a negative mechanical adjustment is applied to the yield such that it falls. In our experience, the mechanical adjustment causes more confusion than it ought and is simply a consequence of the arcane format of the real yield model. Figure 6 presents an example of mechanical adjustment.

FIGURE 6

Sample mechanical real yield adjustments on old-style linkers for an RPI print

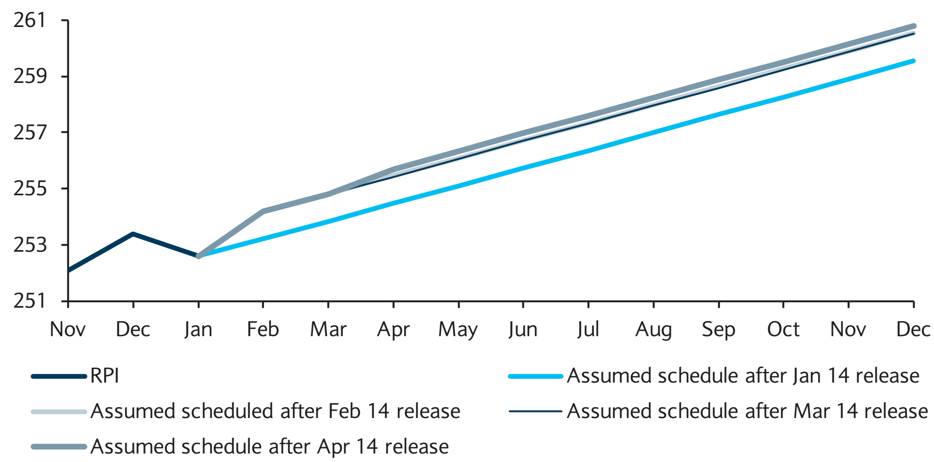
Projected RPI (April 2014)			Real yield adjustment on 20 May 2014 (bp)				
Index value	m/m	y/y	IL16	IL20	IL24	IL30	IL35
255.2	0.16%	2.28%	-4.0	-1.5	-0.9	-0.6	-0.5
255.3	0.20%	2.32%	-2.2	-0.8	-0.5	-0.3	-0.2
255.4	0.24%	2.36%	-0.4	-0.1	-0.1	0.0	0.0
255.5	0.27%	2.40%	1.4	0.6	0.4	0.3	0.2
255.6	0.31%	2.44%	3.2	1.3	0.8	0.6	0.4
255.7	0.35%	2.48%	5.0	2.0	1.2	0.9	0.6
255.8	0.39%	2.53%	6.8	2.7	1.6	1.2	0.9
255.9	0.43%	2.57%	8.6	3.3	2.1	1.5	1.1
256.0	0.47%	2.61%	10.4	4.0	2.5	1.7	1.3
256.1	0.51%	2.65%	12.2	4.7	2.9	2.0	1.5
256.2	0.55%	2.69%	14.0	5.4	3.3	2.3	1.7

Note: Example uses projection for April 2014 RPI print, which printed 255.7. Source: Barclays Research

In this example, April 2014 RPI printed 255.7, or 0.11% m/m, higher than the 0.247% m/m inflation assumption embedded in the pricing formula. Hence, real yields on old-style linkers mechanically adjust upwards immediately after the RPI release by the amount of the difference between the actual data and the assumption. As Figure 6 shows, this equated to a mechanical cheapening of the IL16 real yield by 5.0bp. Because indexation is a price effect, the adjustment applied is inversely proportional to the modified duration of the bond and is thus greatest for shorter-dated linkers.

FIGURE 7

The effect of RPI releases on the assumed RPI schedule



Source: Barclays Research

Although some investors may feel more comfortable with the gradual adjustments of the mark-to-market value of the inflation-linked bond with respect to the price index (with the 3-month interpolated lag) that the Canadian model incorporates, old-style UK linkers have an advantage in terms of the speed with which they compensate the investor for the value of an inflation surprise. Instead of waiting up to six weeks for the effect of a large month-on-month number to filter through to the reference index ratio, old-style issues react immediately and price in all available information upon publication. However, this argument does not offset the downside of the eight-month lag for coupon indexation.

As breakevens and actual inflation trend away from 3%, the use of this assumption can become very misleading for shorter maturity bonds. In the final year of a bond's life, it can be difficult to meaningfully compare its screen real yield with the yield on its nominal comparators or the real yield of longer-dated gilt linkers. In this situation, value for a traditional linker is better assessed in an alternate way. It is fairly straightforward to evaluate the implied total return for a short linker for any given percentage change in the RPI over the remainder of the bond's indexed life at the current price, which can then be compared with either a short-dated gilt or with Sonia to assess value.

We prefer a z-spread asset swap comparison for micro valuations of old- and new-style gilt linkers because this measures the inflation elements versus a consistent curve. A more straightforward, but less complete, method is to compare the yield of traditional linkers with that of new-style linkers forward to the end of their known carry period because this leaves the same known inflation data in the pricing of both bonds. While this is an appropriate simple method to compare moves in real yields and breakeven, the distortions due to the embedded 3% assumption in traditional linkers do not make the spreads between bonds using this approach representative, especially at shorter maturities.

Corporate UK linkers

At the end of 2013, the market value of non-government bonds in the Barclays Sterling Linker Index was almost £32bn. However, non-government inflation-linked issuance from anything other than Network Rail has been very limited in recent years. This contrasts sharply with 2005-07, which saw almost as much corporate inflation-linked bond issuance as in gilt linkers. However, most new corporate linkers were not bought by bond investors and, hence, were not eligible for inclusion in the Barclays Sterling Inflation-Linked Index. By the end of 2007, there were about £20bn of corporate inflation-linked bonds that had been monoline-wrapped to transform them into AAA issues based on utility, PFI and infrastructure projects. Of those issued between 2005 and 2007, the vast majority had been absorbed by asset swap investors, particularly covered bond investors, who provided for the inflation swap needs of pension funds by translating these into real rate swap paying flow. However, as AAA insurers themselves lost their ratings, this demand effectively ended.

The only major non-gilt inflation-linked supply in recent years came from transport infrastructure, specifically Network Rail. Network Rail has been unusual in conducting much of its real rate funding on a programmatic basis, launching benchmark issues at 20y, 30y and 40y in 2007. However, following a change in the classification of Network Rail debt in December 2013, the government announced it would explore whether Network Rail could be funded more efficiently than issuing under its own name. In April 2014, the DMO announced that the government determined that the value for money for the taxpayer would be best secured by Network Rail borrowing directly from the government. At the time of writing, the detailed arrangements were still being discussed, but our interpretation is that future UKRAIL linker issuance is now unlikely.

Beyond Network Rail, there have been other isolated examples of corporate linker issuance, but much smaller than gilt linker issuance; most deals of this type are typically 'reverse enquiry'. In early 2014, Heathrow Airport issued a 2032, 2039 and 2049; otherwise, there have been a few student accommodation and social housing deals, in which either rents or project cash flows have RPI linkage. Social housing rents are now CPI indexed, which may form a potential source of CPI supply to the market if such bonds are brought, though without a liquid gilt-based pricing reference, this would likely be a niche segment of the market. There have also been a few small (ie, < GBP100mn) deals related to funding of solar farm projects according to Bloomberg data, though these have not been widely publicised.

Realistically, inflation-linked issuance is logical for corporates if the breakeven rate achieved is high enough to represent cost-effective funding versus nominals. Yet, despite the improvements in the credit markets, the overhang of old monoline wrapped supply may limit the scope for corporate linker supply from utilities. The largest single utility issuer in corporate linkers is National Grid Plc, which has electricity and gas prices linked to RPI. With the overhang of positioning limiting potential issuance to institutional investors, National Grid sold a 10y bond in October 2011 focused specifically on retail investors, albeit in a standard Canadian-style format, with its size eventually exceeding £280mn, the largest non-government-related issue since 2007.

Private Finance Initiative (PFI)-related deals were another source of non-gilt issuance. PFI deals involve a private company building infrastructure and being paid an income stream until the asset comes under the ownership of the relevant authority. Most hospital-related projects involve RPI-linked cash flows that will be paid to the financier once the hospital is operational, making them ideally suited to funding via inflation-linked issuance. Thus, this kind of issuer has been numerous, although other large PFI projects have also involved partial inflation-linked financing. Almost all of these issues were wrapped with credit guarantees to enable AAA ratings, and, as with utility supply, most ended up with asset-swap investors. Due to specific accounting restrictions, PFIs almost always issue bonds rather than paying swaps. In duration terms, PFI financing has been a less important factor than utilities in recent years since most, particularly hospital bonds, are amortising either immediately or after a number of years in which the building project is expected to be complete and the offsetting of cash flows begins. Hence, while many utility linkers have durations above 30, it is rare for those of PFI bonds to be much longer than 15 years.

UK inflation derivatives

While RPI swaps have been traded since at least 1994, prior to 2005 the derivatives market was more opaque than that in the euro area. It was traditionally characterised by just a few banks looking to match pension demand and corporate supply, with these banks concealing what were often reasonably large, but infrequent, long-end flows. Inter-dealer broker trading still makes up a smaller percentage of activity than in other major markets. UK inflation swaps saw notably more inflation duration traded than any other market between late 2005 and early 2008, as the launch of the IL55 in September 2005 and resultant tactical asset-swap activity provided sufficient momentum for the market to become self-sustaining. However, liquidity in UK inflation swaps fell dramatically in 2008, and distortions between inflation swaps and gilt linkers became extreme as position unwinds and an absence of inflation swap supply drove swaps richer than bonds. Previously, the frequent asset swapping of new non-government inflation-linked paper had provided an environment in which gilt linkers did not always trade at a discount in asset swap to nominal gilts. Once leveraged investors ceased supplying non-government inflation-linked flows via asset swaps of wrapped corporate inflation-linked issuance while pension demand for swaps continued, the market gradually became unbalanced.

The absence of asset swap paying flow led to significant distortions between inflation bonds and swaps, with gilt linker asset swaps becoming much cheaper than nominals in Q4 08 and long forward real rates pushing into negative territory. Many of these distortions corrected significantly, and the inflation swap and gilt linker markets still interact via asset swap activity, now concentrated in gilt linkers. The level of linker asset swaps fell in 2009 from the extremes reached in Q4 08 as pension funds and life insurers who had already immunised inflation and duration were significant buyers of gilt linkers on asset swap. This flow accelerated as relative z-spreads gapped wider versus nominal gilt asset swaps in March 2009 on the announcement of BoE gilt purchases. Hence, despite quantitative easing deliberately not focusing on linkers to avoid falling real yields, causing problems to the pensions sector, linker yields were actually affected significantly. This has also been the case in the more recent round of QE conducted by the BoE from October 2011, during which real yields turned negative at every maturity across the curve.

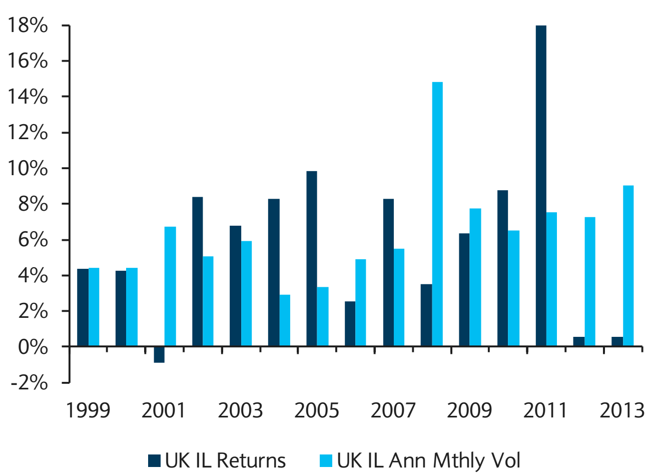
While the underlying liquidity of the inflation swap market recovered significantly in 2009, it is no longer consistently superior to inflation-linked bonds. The most frequently traded maturity is still 30y. Liquidity in the very front end is improving slowly but steadily, but remains prone to heightened volatility. While the most common format of inflation swap in the UK market remains zero-coupon RPI swaps, real-rate RPI swaps can also trade directly, both zero coupon and in a par-swap format, providing a consistent comparison with nominal swaps. The standard initial lag for almost all swap transactions other than asset swaps is a two-month calendar lag. While domestic pension funds provide the main source of demand for RPI swaps, they are also traded by a variety of other leveraged and real-money investors. Forward trading in inflation and real-rate swaps is present, even at long maturities, and to some extent, this aids liquidity and helps reduce relative value distortions across the curve. It is also possible, albeit rare, to see trading in forward swaps versus other markets. Dealers also offer screens for CPI swaps, but in the absence of CPI-linked gilt issuance, liquidity in the CPI swap market is likely to remain extremely limited, with only modest clips traded so far.

Inflation vol markets are notably less active in the UK than in the US and Europe. A lack of deflation floors in gilt linkers means that zero coupon floors are not readily supplied to the market via asset swap activity, unlike in US and Euro inflation markets. Activity in UK inflation options is predominantly in Limited Price Indexation (LPI) swaps, though activity in y/y floors has picked up in recent years, particularly to hedge bank products. LPI historically has been the dominant form of pension inflation indexation, which entails paying RPI inflation but with a cap and a floor. LPI[0,5] is the most common structure traded as the largest number of pension liabilities have this exposure. Prior to the switch of statutory minimum indexation to CPI, LPI[0,2.5] was the legal minimum indexation, but as RPI has tended to be higher than 2.5% y/y, there has been little incentive for schemes to hedge this exposure. To date, there has been no activity in CPI-based limited price indexation (LCPI), and nor is there likely to be without an active CPI swap market, but given the legislative change, LCPI[0,2.5] liabilities are now widespread.

There has been a degree of uncertainty recently about the sustainability of long-dated RPI based trades: because they can be risk-weighted asset (RWA) intensive in an environment in which balance sheets experience greater scrutiny, they can be onerous for banks to hold. There has been a general market expectation for a number of years that inflation swaps would soon be clearable, but the timescale for this has frequently been rolled back. Additionally, under the European Market Infrastructure Regulation (EMIR), domestic pension funds are able to apply for a temporary clearing exemption. The response of the RPI market has been 'business as usual' amid a lack of clarity, and liquidity concerns amid the 2008 financial crisis had already led to a preference for cash over derivatives for some pension funds, which may well continue if regulation or executing and holding RPI derivative positions no longer becomes cost effective for pension schemes.

FIGURE 8

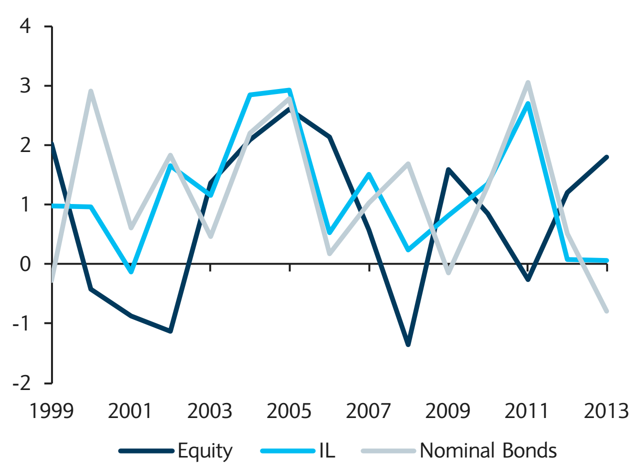
UK linkers: Historical performance and risk



Source: Barclays Research

FIGURE 9

Volatility-adjusted UK asset returns



Source: FTSE, Bloomberg, Barclays Research

Japan

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Issuance of JGBi, suspended in 2008, resumed in 2013 with the launch of a new "floored" product. With support from a pick-up in inflation, the new JGBi have taken off smoothly, with solid results at all of the auctions conducted to date. In terms of supply and demand, the market has also drawn support from investment, starting in FY14, by the Government Pension Investment Fund (GPIF). As issuance rises, the GPIF is expected to increase its buying.

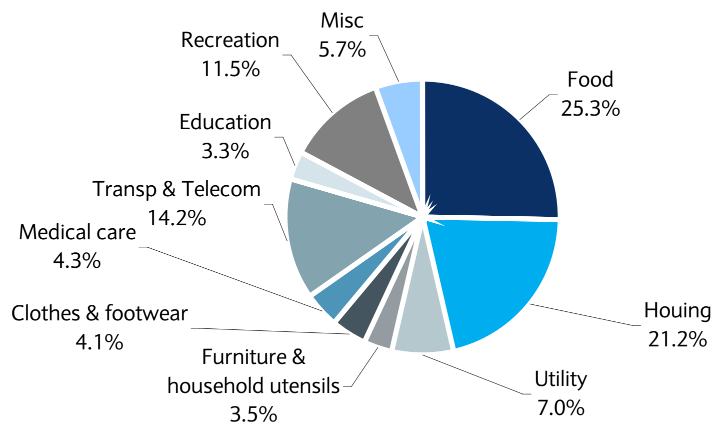
The Japanese CPI: Technical overview

Inflation-linked Japanese government bonds, the few corporate linkers issued so far, as well as JPY inflation swaps all reference the non-seasonally adjusted consumer price index excluding perishable food items, such as fresh fish, vegetables and fruits (Bloomberg ticker: JCPNJGBI <Index>); perishables are excluded due to their very high volatility, but energy prices are included. The index is commonly referred to as the "core CPI" and is released monthly by the Ministry of Internal Affairs and Communications (MIAC) Statistics Bureau, including a preliminary mid-month index for Tokyo and a nationwide index covering the previous month. The data, which are disseminated at 8:30am on Friday of the week that includes the 26th of each month, currently cover over 550 items that account for at least 1/10,000 of the total consumption expenditure of Japanese households (including imputed rent in goods and services). The prices of items used in calculating the consumer price index are, in principle, the retail prices for each item in the various municipalities nationwide, according to retail price data. Japan's CPI broadly conforms to the international standards regarding consumer price indices set by the International Labour Organization (ILO). The basic 10 categories have been standardized globally, but there are differences in their respective weights by country. The breakdown of the Japanese core CPI is shown in Figure 1.

The Japanese CPI is calculated based on the Laspeyres method, which compares the prices of goods and services according to their weights at the time of the base year (currently 2010) with the y/y change in those figures. Under the Laspeyres price index, the weight (quantity) of various goods and services is fixed at the base year. Accordingly, goods that have undergone steep price drops in recent years, such as IT goods, do not reflect any increases in real volume accompanying such price drops (for the calculation of the price index for such items, the MIAC uses the Hedonic adjustment method based on the correlation between the price of products and their performance derived from available sales data). Goods undergoing price increases, on the other hand, tend to be overestimated in the calculation because there is an increasing effect due to the fixed weightings. As a result, the Laspeyres method tends to show an upward bias, which increases the further one moves away from the base year. To address this issue, from January 2007, the MIAC began to release CPI numbers based on the chain-weighted calculation method as a supplement to the fixed-weight CPI, where weights are adjusted each year to reflect changes in spending patterns.

FIGURE 1

Major items in the Japanese core CPI (2010-base index)



Source: Ministry of Internal Affairs and Communications (MIAC), Barclays Research

Meanwhile, base revisions to the index are conducted once every five years for years ending in "5" and "0". The last such adjustment took place on August 2011, when the CPI data were rebased to the year 2005 (ie, the July 2011 nationwide CPI had the year 2010 as a base, and 2010-base data were made available retroactively from January 2010). Aside from a few item changes, the main changes in weights included one for TV from 0.27% to 0.97%. At last year's rebasing, the overall effect was estimated to be about -0.7%. While this number was significant, the effect on JGBi was limited, as the new weights were released in advance. Further details on the Japanese CPI in the English language are available from the MIAC Statistics Bureau (http://www.stat.go.jp/english/data/cpi/index.htm).

In terms of monetary policy, the BoJ is conducting quantitative and qualitative monetary easing (QQE) with a CPI price stability target of 2%. Japan's core CPI inflation, which had been hovering around 0% y/y, has now risen to about 1%, due in part to the effect of JPY depreciation, but the market remains largely sceptical about the prospect of reaching 2%. Although the long-term expected inflation rate (including VAT hike effects) has risen according to private sector surveys, it has yet to reach 2% (Figure 2). Reflecting this outlook, JGBi breakevens remain in the lower-1% range.

Seasonality in CPI

Seasonality of the Japan CPI is shown in Figure 3. Prices tend to fall early in the year due to New Year's sales. After bottoming around February, they turn up and peak during the summer holiday season, when travel, leisure and other service prices rise sharply. Then, from fall to winter, they tend to fall slightly, led by service prices. Even during 2013, when inflation strengthened steadily due to the effects of JPY depreciation, actual CPI numbers were heavily influenced by seasonality, which e believe will remain an important factor in determining positive and negative CPI carry.

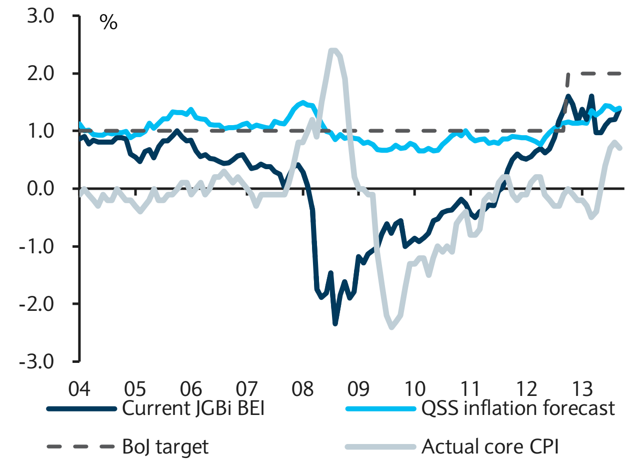
Inflation-linked government bonds

JGBi issuance and JGBi market through 2013

Discussions about the possible issuance of inflation-linked government bonds in Japan kicked off in September 2002. Some market participants also voiced concern about issuing such instruments in deflationary times (spot inflation had ranged between -0.7% y/y and -0.9% y/y throughout 2002), but as deflationary pressures eased and borrowing needs remained high, a year and half later, in March 2004, Japan issued its first inflation-indexed government bond (JGBi1), with a 10y maturity and a small pilot size of JPY100bn (Figure4).

FIGURE 2

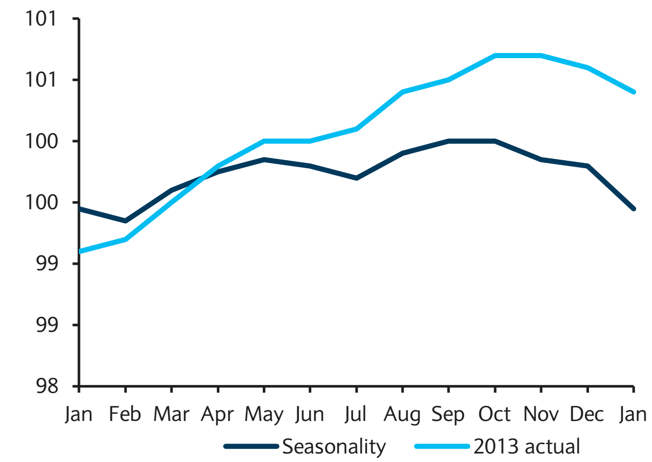
BoJ inflation target and BEI



Source: QSS, Barclays Research

FIGURE 3

Japan CPI seasonality



Source: Barclays Research

The bond came in at a low 15.5bp BEI (spot inflation was -0.1% y/y at the time), but shortly thereafter, market perceptions turned favourable and breakevens subsequently rallied to a high of 94bp during the same year (for details, please refer to Figure 5).

Between 2004 and the global financial shock in 2008, the market evolved rapidly, in terms of size and depth. By August 2008, the MoF had issued a total of 16 bonds, and the market size had reached almost JPY10trn (about USD96bn, or nearly 1.4% of the then total JGBs outstanding), placing Japan ahead of other inflation-issuing countries with longer experience with the product, such as Australia and Sweden.

As the global financial shock reached its climax during September-October 2008 and JGBi BEIs sank to unprecedented levels, the MoF cancelled two JGBi auctions planned for October 2008 and February 2009. Issuance was suspended from then until 2013, when it was resumed with a new floored product, as noted below.

JGBis became eligible for MoF buyback operations in January 2007. Until April 2008, the MoF held five buybacks, on each occasion retiring a modest JPY40-50bn worth of linkers. From April 2008, the Ministry stepped up its JGBi buybacks to JPY80bn in response to the sudden decline in linker prices around March (the on-the-run 10y linker's BEI briefly touched -2bp, Figure 5), when deleveraging by investors distorted many asset prices. Then, after BEI dropped sharply due to the 2008 financial crisis, MoF increased the size and frequency of buybacks. The precise buyback amounts have been determined on a quarterly basis, with the choice between linkers, floating-rate JGBs or fixed-coupon JGBs made following MoF hearings with the primary dealers; since October 2008, the weight has been placed on linkers, rather than floating-rate or regular JGBs (Figure 6).

In addition to MoF buybacks, from the end of 2008 JGBis have also become eligible for BoJ outright purchase (Rinban) operations, under which the Bank buys JPY1.8trn/month of government securities from dealers in an auction format. The Rinban purchases have been more modest than the MoF's buybacks, being held on a bi-monthly basis (usually odd months) in amounts of JPY20bn. As of the end of April 2014, the BoJ's total JGBi holdings amounted to JPY1.26tn, or 11% of the MoF.

FIGURE 4

JGBi product specifications

	Old	New
Maturity	10 years	
Type of issue	Coupon-bearing bonds	
Coupon frequency	Semiannual	
Issuance method	Public offering	Public offering with switch auction
Auction method	Yield-competitive auction for reopen/Dutch-style auction for new	Price Dutch style auction
Reference Index	Japan nationwide CPI ex-fresh food (Japan Core CPI)	
Reference Index digit	third digit	third digit, but planned to increase to 5th digit
Reference Index frequency	Monthly	
Reference Index seasonality adjustment	No seasonal adjustment	
Indexation lag	3 months	
Indexation style	Canadian Model (linear interpolation to the 10th of the month)	
Floor	No floor	with floor
Transfer restriction	Individuals and corporates cannot hold JGBis (this ban was partially lifted in January 2015)	

Source: MoF

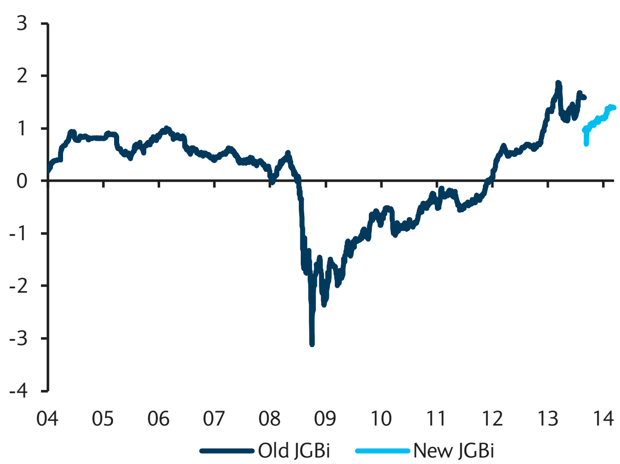
Resumption of JGBi with a new floored product

Issuance of JGBi, suspended in 2008, resumed in October 2013 with the launch of a new product incorporating a deflation floor on the principal (Figure 4). In FY13, the MoF issued JPY300bn each in October 2013 and January 2014. Under FY14 plans, it was scheduled to issue JPY400bn each in April 2014, July 2014, October 2014 and January 2015. The JPY100bn increase per issuance in FY14 corresponded with the above-mentioned entrance into the market by the GPIF.

JGBi are issued by Dutch-style price-competitive auction (0.05 yen bidding scale). New issues are auctioned in October and April and re-openings are held in January and July. The coupons, announced in the morning on auction days, are determined based on market yields with a floor of 0.1%. As real yields have recently been negative, new issues have carried a coupon of 0.1%.

FIGURE 5

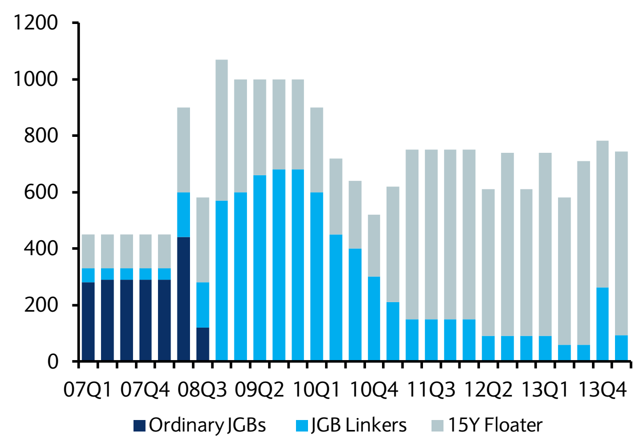
History of on-the-run JGBi BEI (%, March 2004-current)



Source: Barclays Research

FIGURE 6

Breakdown of MoF buyback (JPY bn)



Source: MoF, Barclays Research

Since the launch of the new JGBi, the MoF has bought back old JGBi through the traditional method in months when there are no new auctions and conducts switch auctions for the old and new JGBi when there are new auctions. On auction days, there are two opportunities to sell old JGBi: once during the morning buyback auction (basically conducted through the usual buyback method) and once in the afternoon (when additional sales are offered). Under the latter system, investors who buy the new issue are able to sell additional old JGBi in proportion to the amount they purchase less the amount they sell during the morning buyback auction. In this case, the sales price is the average price of successful bids during the morning buyback auction. As the announcement of the results for the first buyback auction (around 12:30) comes after the deadline for the new JGBi auction, participants are unable to buy the new issue with knowledge of the price for additional sales. The schedule on auction dates is outlined in Figure 7. BoJ buying operations continue to be conducted as usual with new issues eligible for purchase, contrary to MoF buybacks.

The JGBi auctions conducted since the resumption of issuance have gone smoothly, supported by strengthening inflation. Although the sale of old JGBi through switch auctions has produced mixed results, about JPY100bn, or one-quarter of the issuance, was sold at the auction in April 2014, suggesting there is still a certain level of demand to sell old JGBi. There has been no official announcement on how long the switch auctions will be conducted, but they appear likely to continue through at least the end of FY14.

FIGURE 7

Scheduled on auction days

	New JGBi auction	Old JGBi buyback auction
10:10		Offer
10:30	Offer	
11:30		Cut-off
12:00	Cut-off	
12:30		Results announced
12:45	Results announced	

	Non-Price-Competitive Auction II for JGB Market Special Participants	Additional buyback auction
14:00	Offer	
14:30	Cut-off	Offer
15:00		Cut-off
15:15	Results announced	
16:00		Results announced

Source: MoF

FIGURE 8

JGBi issuance: auction history and outstanding

Auction no.	Auction date	Bond	Redemption date	Coupon	Bid/Cover ratio	Amount issued (JPY bn)	Secondary non-comp. auction (JPY bn)	MoF + BoJ repurchases (JPY bn)	Amt outst. by bond (as of Apr14)
Old 1	4 Mar 04	JGBi1	10 Mar 14	1.2	4.84	99.8	0	-	-
Old 2	3 Jun 04	JGBi2	10 Jun 14	1.1	7.50	299.5	0	276.1	23.4
Old 3	7 Dec 04	JGBi3	10 Dec 14	0.5	3.58	499.7	0.7	441.3	59.1
Old 4	7 Jun 05	JGBi4	10 Jun 15	0.5	2.51	499.6	28.6	490.0	38.2
Old 5	6 Sep 05	JGBi5	10 Sep 15	0.8	3.41	499.6	43.9	476.8	66.7
Old 6	6 Dec 05	JGBi6	10 Dec 15	0.8	3.23	499.6	8.8	445.3	63.1
Old 7	7 Mar 06	JGBi7	10 Mar 16	0.8	3.69	499.7	0	441.3	58.4
Old 8	6 Jun 06	JGBi8	10 Jun 16	1.0	3.59	499.7	0	900.3	99.3
Old 9	3 Aug 06	JGBi8R			4.23	499.9	0		
Old 10	5 Oct 06	JGBi9	10 Sep 16	1.1	5.34	499.7	0	382.5	117.2
Old 11	7 Dec 06	JGBi10	10 Dec 16	1.1	4.84	499.8	31.5	888.7	144.7
Old 12	6 Feb 07	JGBi10R			3.21	499.8	2.3		
Old 13	5 Apr 07	JGBi11	10 Mar 17	1.2	4.49	499.7	4.7	432.1	72.3
Old 14	07 Jun 07	JGBi12	10 Jun 17	1.2	4.85	499.4	8.6	870.6	154.8
Old 15	07 Aug 07	JGBi12R			4.11	499.5	17.9		
Old 16	04 Oct 07	JGBi13	10 Sep 17	1.3	4.01	499.7	0.8	410.6	89.9
Old 17	06 Dec 07	JGBi14	10 Dec 17	1.2	3.45	499.7	7.8	827.7	185.6
Old 18	07 Feb 08	JGBi14R			3.63	499.5	6.3		
Old 19	03 Apr 08	JGBi15	10 Mar 18	1.4	2.92	499.9	39.6	442.3	97.2
Old 20	05 Jun 08	JGBi16	10 Jun 18	1.4	4.07	499.8	48.9	722.3	327.0
Old 21	07 Aug 08	JGBi16R			2.52	499.6	1.0		
New 1	08 Oct 14	JGBi17			3.74	299.9	43.8	34.8	611.9
New 2	09 Jan 14	JGBi17R	10 Sep 23	0.1	2.87	299.5	3.5		
New 3	03 Apr 14	JGBi18	10 Mar 24	0.1	2.89	399.8	21.9	0	421.7
					Total mkt size			7,226.3	2,630.5

Note: "Secondary Non-Comp. Auction" refers to the additional JGBi amounts issued in secondary non-competitive auctions (held about two hours after the main auction), where primary dealers have the right to buy up to 10% of amount issued in the main auction at the clearing price. Source: MoF, BoJ, Barclays Research

At present, reference CPI and index ratios are rounded down to the third decimal place. Due to this, index ratio changes every few days. Figure 9 shows an example for May-June 2014 for JGBi18 with reference CPI changing by 0.3 (from January to February). When rounded to the third digit, the index ratio changes only three times during the month. In this way, JGBis do not accrue CPI carry smoothly. MoF plans extend the digit likely in 2015-16, when the new BoJ net starts working. The change is intended to affect all JGBi, including the seasoned issues.

FIGURE 9

Example of uneven changes in index ratio

base CPI	100.60

Reference CPI for	10-May-14	100.500 (February index)
	10-Jun-14	100.800 (March index)

	Ref-CPI	Index Ratio (third digit)		Index Ratio (fifth digit)
10-May-14	100.500	0.999		0.99901
11- May-14	100.510	0.999		0.99911
12- May-14	100.519	0.999		0.99919
13- May-14	100.529	0.999		0.99929
14- May-14	100.539	0.999		0.99939
15- May-14	100.548	0.999		0.99948
16- May-14	100.558	**1.000**	<- changes here only	0.99958
17- May-14	100.568	1.000		0.99968
18- May-14	100.577	1.000		0.99977
19- May-14	100.587	1.000		0.99987
20- May-14	100.597	1.000		0.99997
21- May-14	100.606	1.000		1.00006
22- May-14	100.616	1.000		1.00016
23- May-14	100.626	1.000		1.00026
24- May-14	100.635	1.000		1.00035
25- May-14	100.645	1.000		1.00045
26- May-14	100.655	**1.001**	<- changes here only	1.00055
27- May-14	100.665	1.001		1.00065
28- May-14	100.674	1.001		1.00074
29- May-14	100.684	1.001		1.00083
30- May-14	100.694	1.001		1.00093
31- May-14	100.703	1.001		1.00102
01- Jun-14	100.713	1.001		1.00112
02- Jun-14	100.723	1.001		1.00122
03- Jun-14	100.732	1.001		1.00131
04- Jun-14	100.742	1.001		1.00141
05- Jun-14	100.752	**1.002**	<- changes here only	1.00151
06- Jun-14	100.761	1.002		1.00160
07- Jun-14	100.771	1.002		1.00170
08- Jun-14	100.781	1.002		1.00180
09- Jun-14	100.790	1.002		1.00189
10- Jun-14	100.800	1.002		1.00199

Source: Barclays Research

GPIF participation

As part of public pension reforms under the Abe administration, the GPIF began to buy JGBi in FY14, when it is scheduled to purchase a total of JPY400bn. As JGBi issuance will increase by JPY100bn per auction (and there are four auctions per year), this will effectively offset the direct effect on supply and demand. However, private pension funds are also considering investment into JGBi, following the GPIF's lead, so the indirect effects must also be considered. The GPIF has a portfolio exceeding JPY100trn, so buying JPY400bn JGBi per year will not be enough to hedge inflation risk. We expect the GPIF to increase its buying as JGBi issuance expands.

Consumption tax issue

A draft bill to raise the consumption tax was finally submitted to the Diet at the end of March, with a plan to hike to 8% in April 2014 and to 10% in October 2015. Now that the first hike has gone according to plan, attention has turned to the second. A final decision on the first hike was reached around October 2013. At that time, the latest available annualized GDP growth figures (Q2 13) exceeded the targeted levels of 3% nominal and 2% real. A final decision on the second hike will be reached when the FY15 budget is compiled. Due in part to the drag from the first hike, it may be difficult to expect GDP growth to exceed those targets at judgment time. In this sense, there may be a greater risk of delay or suspension in the second hike. On the assumption of a 60-70% pass-through to the CPI, the effect on 10y BEI would be a maximum of 10-15bp if the hike were scrapped.

Indexation features and calculations

The JGBi inflation indexation mechanism follows the Canadian style adopted by most developed inflation markets. That is, within a given month, the rate of inflation accrual is constant at the rate of month-on-month inflation between the inflation index three and two months previously. However, there is one notable difference: JGBi inflation accrual is based on the tenth of the month (rather than the first), due to the relatively late release of inflation data each month, which would otherwise cause uncertainty at the end of some months. JGBi principal and coupons accrue based on the ratio of the Daily Reference CPI (DRI) value to the Base Reference Index (base CPI) at issuance (this number obviously does not change throughout the life of the bond, although rebasing the CPI every five years requires additional adjustments to link the old and new indices). This ratio is referred to as the “CPI ratio,” or “inflation ratio.” The official calculation formula for the daily reference CPI and the CPI ratio is illustrated below.

First, the daily reference CPI (DRI) for day N in month M is:

1. If N = 10, the reference CPI is the index three months previously, ie, CPIM-3
2. If N > 10, the reference CPI is:

$$\mathbf{DRI = CPI_{M-3} + (CPI_{M-2} - CPI_{M-3})\ x\ \frac{(N-10)}{\text{No. of days from 11th of month M to the 10th of month M+1}}}$$

3. If N<10, the reference CPI is:

$$\mathbf{DRI = CPI_{M-4} + (CPI_{M-3} - CPI_{M-4})\ x\ \frac{\text{No. of days from 11th of month M-1 to N}}{\text{No. of days from 11th of month M-1 to the 10th of month M}}}$$

Next, the CPI ratio for any given day N is calculated as DRIN/Base CPI

An important feature of JGBis is that due to rounding conventions, inflation accrual does not develop smoothly across the month. As mentioned above, the ratio of the reference CPI on settlement to the base CPI on which the settlement price is based is rounded to only three decimal places (the CPI itself is published to one decimal place, unlike other countries such as the US), in contrast to other markets where it is usually rounded to five decimal places. Because of this, carry on a 10y JGBi jumps almost 1bp when the rounded index ratio changes by 0.001, a situation not seen in other inflation markets. The number of these “carry jumps” exhibited by linkers’ CPI ratio in any given month obviously depends on the magnitude of the month-on-month change in the CPI.

JGBis are traded in real price terms (ie, without incorporating inflation adjustment). In the broker market, linker prices move in five-sen increments, and daily closes are also rounded to the nearest 5 sen. While this is not a strict rule, it is an appropriate degree of accuracy, given the approximately 10-sen jumps in nominal price terms that occur with inflation accretion. Settlement and day-count conventions applied to the nominal market are also used for JGBis (T+2 for all JGBs from 23 April 2012, ACT/365). The simple bond calculation between price and yield is used; therefore, real yields are determined by the rate that equates the traded price with the sum of the bond's cash flows discounted to present value.

Accounting and tax treatment

JGBis can be held under the "available-for-sale" category; gains or losses do not have to be immediately reflected in the income statement. Furthermore, at the end of October 2008, the ASBJ allowed domestic investors to book their holdings of illiquid instruments, including floating-rate JGBs and JGBis, at theoretical value, rather than market levels. To date, many domestic investors, including large banks, have used this accounting rule for floating-rate notes, but the absence of a benchmark forward CPI curve made the theoretical valuation of inflation-linked JGBs problematic from an accounting perspective. As the implementation of IFRS is postponed, the accounting is unlikely to be an issue for domestic investors for the time being.

The National Tax Agency formally clarified at the end of 2005 that JGBis' interest and the gains or losses on principal would be exempt from withholding taxes if they are held by "entities entrusted to manage corporate pensions approved under the tax systems in the UK and the US, provided the bonds are held in book entry form."

Corporate and derivative markets

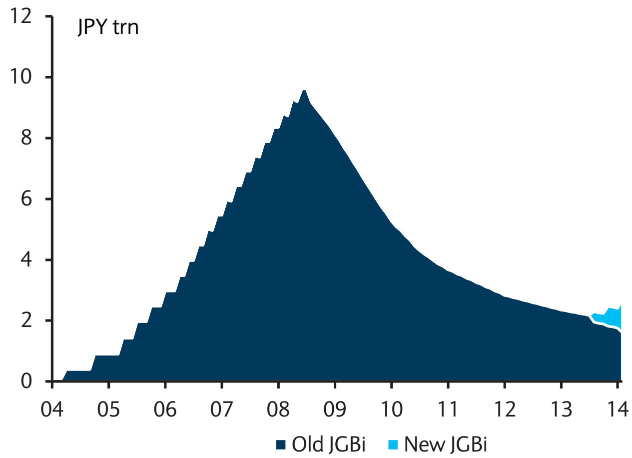
The corporate market in Japanese inflation-linked bonds has been limited. The only issuer of note of straight inflation accreting bonds was the Japan Finance Corporation for Municipal Enterprises (JFM), which in 2005 was able to issue JPY40bn of 10y bonds at yields well through those of matched-maturity JGBis (the first bond's coupon was 0.47%, and the second one's was 0.45%, versus prevailing government bond real yields of 65-75bp) because it featured a deflation floor. The EIB also issued a JPY50bn accreting bond as an opportunistic swapped funding in 2004, also maturity matched to a JGBi. This bond offered a par floor that made it attractive to real money investors, despite having an aggressive principal cap at 110%, equivalent to 96bp per annum, which greatly limited upside at a time when JGBi breakevens were 85bp.

In Japan, the typical inflation derivative transaction has been the zero-coupon inflation swap. Inflation swaps are traded by investors who prefer derivatives to cash and also by dealers who hedge inflation structured products.

Since 2007, JGBis started to trade on asset swap, as spreads have been tighter versus Libor relative to nominal asset swap spreads of similar maturities. Prior to 2008, long-dated JGBii asset swaps were quoted at Libor-4bp to Libor-8bp, mid-market, about 12bp cheaper relative to nominal asset swaps. As has been the case in other inflation-linked bond markets, the major asset price disruptions in 2008 left JGBis exceptionally cheap on an asset swap basis, with the long end of the JGBi curve at times indicated at Libor+80bp. However, as the market's cheapness corrected gradually throughout 2009, asset swap margins normalized as well, hovering around Libor+16bp to Libor+28bp across most issues by early 2010.

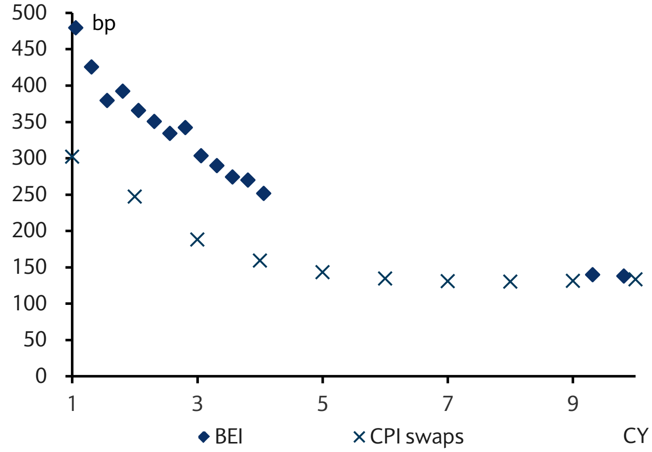
Old JGBi asset swaps have recently become extremely rich due to the rapid decline in the balance of outstanding issues as a result of switch auctions since 2013. The BEI of JGBi1-16 are trending 100bp or more above CPI swaps of the same maturity (Figure 11). The BEI of new JGBi (17, 18), on the other hand, are roughly in line with CPI swap rates, and asset

FIGURE 10
Outstanding of JGBis (JPY tn)



Source: Barclays Research

FIGURE 11
BEI and CPI swap curve in May 2014



Source: Barclays Research

swap spreads are trending at -15bp to -20bp, about the same as nominal bonds of the same maturity. Old JGBi should continue to be absorbed, which is likely to keep their BEI extremely rich relatively to CPI swaps of the same maturity.

INFLATION MARKETS

Canada

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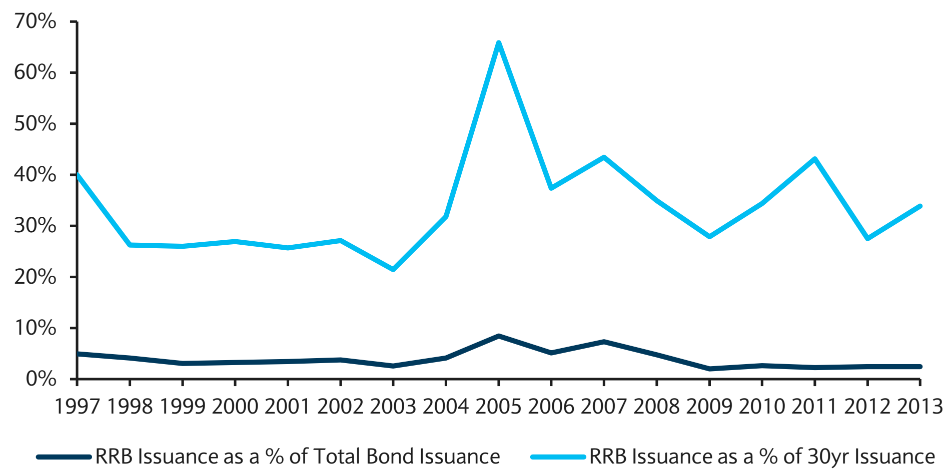
Canada first issued linkers in 1991, and its securities have been the model for most sovereign issues that have followed. As of May 2014, the market value had grown to CAD65bn, nearly unchanged from May 2012, when this guide was last published, and it remains concentrated among local participants.

Real return bonds (RRBs) were first issued by the Canadian government in December 1991, and there are currently seven issues outstanding. The initial issue, the 4.25% 2021, was a 30-year maturity and is now the shortest RRB on the curve. The Treasury had been issuing new bonds at four-year intervals: ie, the 4.25% 2026 issued in 1995, the 4% 2031 in 1999, the 3.0% 2036 in 2003 and the 2.0% 2041 in 2007. This pattern meant the initial maturity was extended by one year with each new issue. However, this pattern ended when it issued the 1.5% 2044 in May 2010 and followed with the 1.25% 2047 in 2013. The Treasury holds four RRB auctions per year, which have totalled CAD2.2bn each of the past six years. As of April 2014, with an adjusted principle amount of CAD46.7bn, RRBs made up 7.3% of total marketable Canadian government debt, 9.8% of Canadian government coupon debt and 30.1% of Canadian government debt with maturities longer than 10 years. In 2013, RRBs made up 2.4% of all Canadian government coupon issuance and 34% of issuance in the long end, down from peaks of 8.4% and 66%, respectively, in 2005 (Figure 1).

FIGURE 1

RRB issuance as a percentage of Canadian government coupon issuance



Source: Bank of Canada

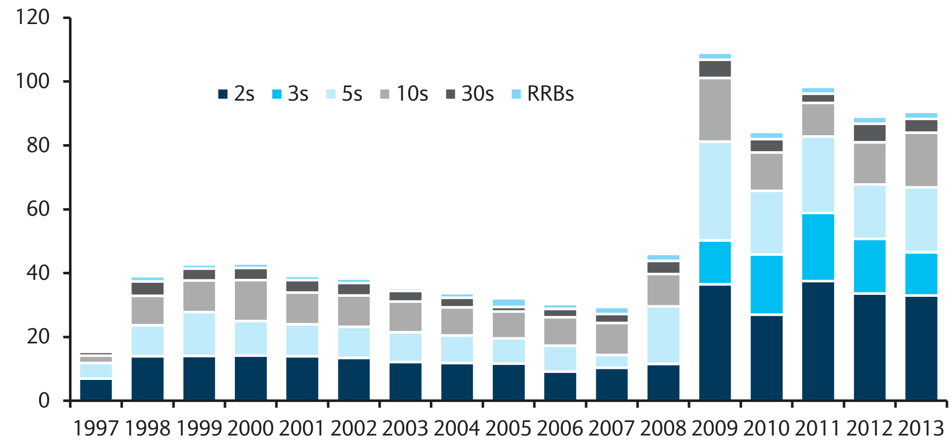
Given its maturity profile and size, the Canadian inflation-linked bond market has been largely the domain of pension funds. However, from time to time, international investors have taken advantage of real yield differentials versus other more heavily traded international markets such as the UK and US, and RRB issuance can have a valuation effect on the long end of other markets, particularly around auction time.

Because of the tendency for pension fund investing to be of a buy-and-hold nature, secondary market liquidity can be difficult to obtain. A large portion of RRBs outstanding are held as an offset to future pension liabilities, reducing the available float. Therefore, bid/offer spreads tend to be relatively wide versus much more liquid markets such as the US. Despite liquidity issues, RRBs tend to trade at general collateral levels in the repo market due to the willingness of the funds that own the bonds to lend them.

The Bank of Canada (BOC) acts on behalf of the Department of Finance to manage the financing program. The BOC currently operates under a quarterly funding schedule with one 30-year RRB auction about every three months. RRB issuance has been relatively constant despite an increase in total borrowing needs since 2008 (Figure 2). We expect the quarterly issuance to continue, as the government appears committed to using the program as a cost-effective way to diversify its investor base. At present, the Bank of Canada issues about CAD400-700mn in RRBs each quarter, up from CAD300-400 before 2007.

FIGURE 2

Distribution of Canadian government coupon issuance



Source: Bank of Canada

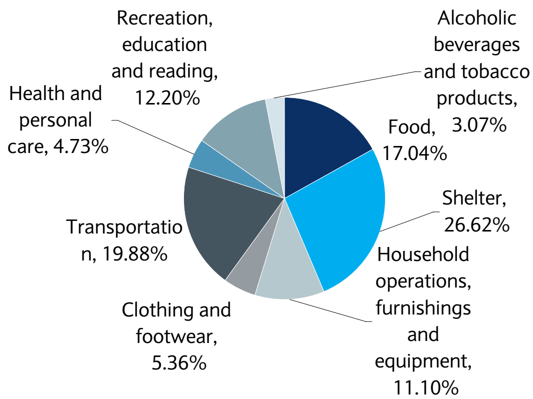
The linking index

Canadian RRBs are indexed against the Not-Seasonally-Adjusted All-Items Consumer Price Index. It includes all Canadian families and individuals living in urban or rural private households. Information on consumer expenditures is gathered through the Survey of Household Spending and the Food Expenditure Survey, which uses random samples of Canadian households. The index measures price changes using the cost of a fixed basket of commodities through time. The basket consists of about 600 goods and services including transportation, clothing, housing, food and recreation. The CPI index reflects pure price movements only because the basket includes goods and services of identical or equivalent quantity and quality over time.

The index is weighted to reflect typical spending patterns. The weights are determined based on family expenditure surveys that are conducted periodically. The current weights are based on the 2011 survey. As Figure 3 and Figure 4 show, the index comprises eight major components. The component with the highest weight is the shelter component, which includes owner-occupied and rented accommodation. The CPI includes only consumer items and excludes personal income taxes, consumer savings and investments, etc. The index uses geometric means at the first-stage aggregation of collected price data, making quality adjustments where possible. The fixed basket price index is an arithmetic average of price relatives for all single commodities contained in the basket. The index attempts to capture innovations in final prices, which include any changes in the Goods and Services Tax, as well as provincial retail sales taxes.

FIGURE 3

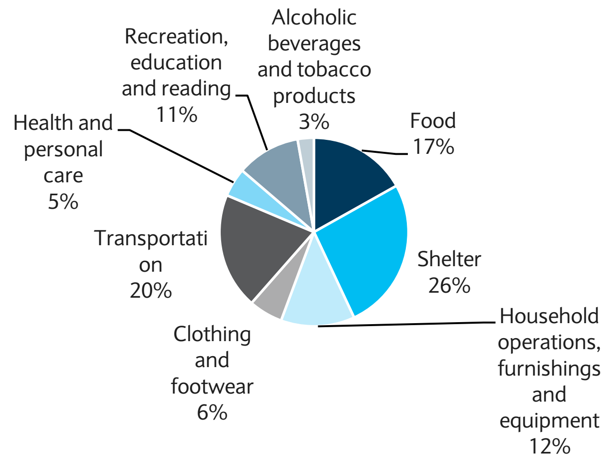
CPI weights – 2005 basket at April 2007 prices



Source: Statistics Canada

FIGURE 4

CPI weights – 2011 basket at February 2013 prices



Source: Statistics Canada

The Canadian model

The Canadian Treasury was an innovator, pioneering a simplified approach to the indexation of inflation for real return bonds. The change in the indexation process introduced with the first RRB was dramatic, with the inflation lag reduced to three months, from the eight months previously used by the UK. This enabled a more contemporaneous measure of inflation and allowed the market to trade in real space without an embedded inflation assumption. The crucial change in structure was the use of an index ratio to inflate principal and coupon for a given settlement date. This change eliminated the effect of real yields' changing when the inflation index is published. Old-style UK real yields vary each time there is an inflation release different from this assumption.

This new methodology became known as the "Canadian model" and has been generally followed by all subsequent major issuers, including all newly issued UK inflation-linked gilts. The change in methodology allowed for simpler valuation and has assisted in the relative value analysis of the product versus conventional bonds, as well as cross-currency real yields. The concepts of forward real yields and forward breakevens have become determining factors in the relative valuation of international markets that have adopted this calculation method.

Calculation methodology

A reference CPI value is calculated for every day based upon the CPI values for three months and two months prior to the month containing the settlement date. The reference CPI for the first of each month is the index value of three months previous. The reference CPI for any day during the month is calculated by linear interpolation. Unlike some other countries that issue based on the Canadian model, RRBs do not have a par floor on the inflation adjusted principal.

Reference CPI for day '*d*':

$$\frac{(d-1)}{m}(CPI_{t-2} - CPI_{t-3}) + CPI_{t-3}$$

d = day of the month (eg, the 1st implies d=1)

m = number of days in that month

The indexation factor is the reference CPI for the settlement date divided by the reference CPI for the base date. Coupons are accrued on an actual/actual basis and paid semi-annually. The gross settlement price is calculated as follows:

$$(p+c)\left(\frac{CPI_t}{CPI_{base}}\right)$$

p = clean price of the bond

c = real accrued

CPI_t = Reference CPI at time t

CPI_{base} = Base CPI

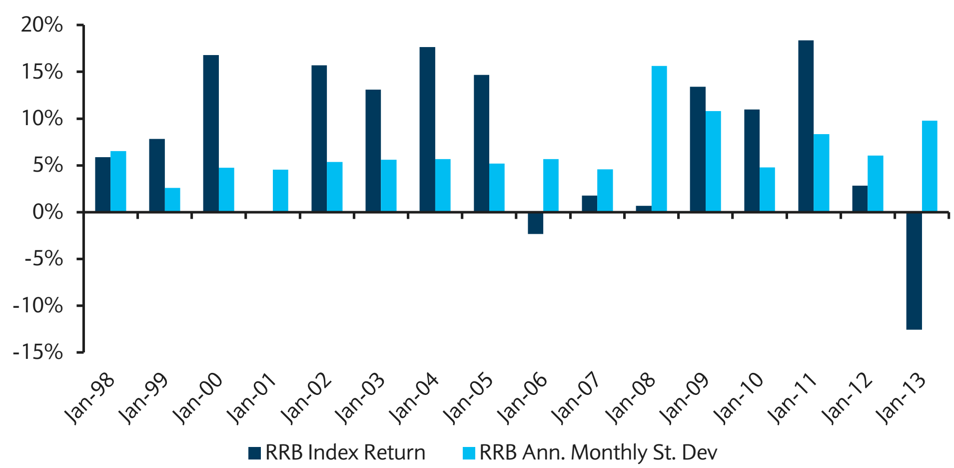
Real return bonds are taxable for residents but are not subject to withholding tax for non-residents. For residents, RRBs' income received and accrued is taxed in a given year, while the inflation accretion on the principal is also taxed. Capital gains are not taxed until realised. For non-residents, the Canadian Treasury is not ordinarily required to withhold tax from interest or principal paid on RRBs. However, the Treasury's website provides more detail on these conditions: http://www.fin.gc.ca/invest/taxtreat-e.html.

Non-government issuance and derivatives

Non-government issuance has been slow to develop in Canada. Swapped bank issuance picked up in 2008 but nearly came to a halt in 2009. The amount of corporate issuance as of the end of 2009 was rather negligible, and only one issue of significant size, CAD200mn by Teranet Holdings, has been issued since. There were several larger inflation-linked bonds issued by provinces, namely Quebec and Ontario, with the same maturity and structure as the Canadian linkers, but the last of those was in 2008.

FIGURE 5

Historical performance and risk



Source: Barclays Research

Demand for a Canadian inflation derivatives market is growing from pension funds, which already hold most of the outstanding Canadian linkers, seeking exposure through receiving inflation in swaps. Many Canadian investors have considered going to the US or other more liquid inflation-linked markets as a proxy for Canadian inflation because of the lack of an inflation swap market in Canada and depth of the RRB market.

INFLATION MARKETS

Sweden

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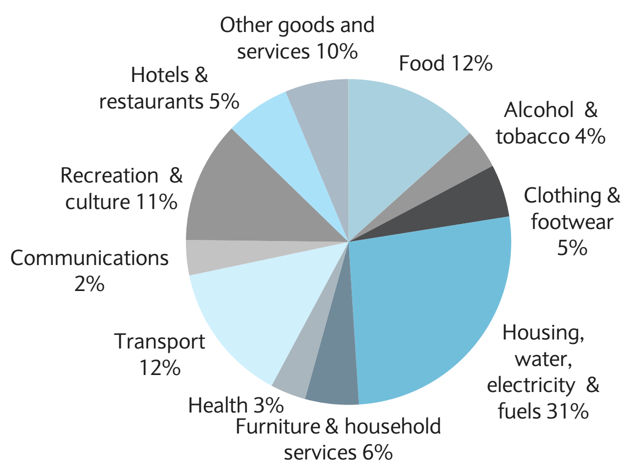
The Swedish government has been issuing linkers since 1994 and has a long-term target of 25% for the share of inflation-linked debt. The local investor base is dominant in the market, although the European sovereign debt crisis has generated significant interest from international investors looking for high-grade inflation linked bonds. There is a small, non-government, linker market while the inflation swaps market remains very small.

The Swedish Consumer Price Index (CPI)

Swedish inflation-linked bonds are linked to the Swedish CPI (domestically referred to as the KPI or Konsumentprisindex), a weighted chain index with annual links (referred to as a Walsh-Laspeyres type index) compiled monthly and a useful proxy for the consumption patterns of the entire country. The index is based on the Cost-of-living Index (COLI) economic theory, ie, a constant utility index. The full chain CPI is calculated with index reference (base) period 1980 and with the end-chain links for all COICOP groups showing the price change from the two years back to the current month (called year-to-month index). These are, in turn, compiled by using Jevons index (geometric mean of price quotes) links going from December one year to current month in the following year for each of the 350 representative product groups. The index is published by Statistics Sweden, to two decimal places since January 2006, in order to be consistent with the previous compilation of the official inflation rate. The weights and samples are revised each year and are introduced from the January index. The weights for the main and some sub-groups are based on the Swedish national account statistics and the index uses regular prices paid by the public. Value-added tax is included in the index, while subsidies are excluded.

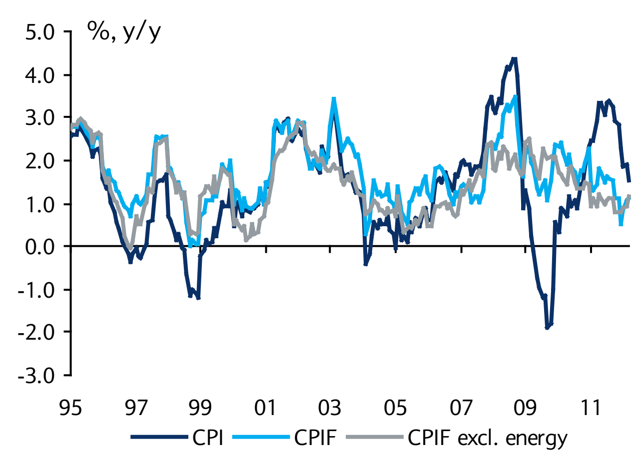
Price collection for the CPI is performed around the 15th of each month. For some non-durable goods, prices are collected in the course of a three-week period surrounding the 15th, with each monthly index based on about 40,000 price observations; and the final index is published around the 7th to 14th of each month. The composition of the index based on year 2012 weights (ie, corresponding to consumption in 2010) is shown in Figure 1. The fixed CPI index numbers used for legal purposes and inflation-linked bonds are not revised. However, on three occasions since 1980 (April 2000, September 2008, and January 2011),

FIGURE 1
Swedish CPI breakdown by major category, 2014



Source: Statistics Sweden, Barclays Research

FIGURE 2
Swedish inflation – CPI, CPIF and CPIF excl. energy



Source: Statistics Sweden, Barclays Research there have been revisions in the official inflation rate, which is calculated based on a so-called shadow index; however, at each current month, the fixed index and shadow index show the same index number. The *ex ante* expectation on revisions should in our view be 0. That said, the index construction with annual Walsh links (price index and weights, but also earlier product group Laspeyres links) allows previous errors to be included before the new, latest chain is added each January. This means that the so called 'substitution effect' in the Swedish inflation numbers are corrected both from a short- and a medium-term perspective. This should tend to bias the CPI calculation slightly lower than a standardised HICP calculation methodology, likely by less than 0.2% per annum.

Sweden's monetary policy, controlled by the Riksbank, uses a flexible inflation target (introduced in 1993) to keep headline CPI at 2% per year. However, from an operational point of view, the monetary policy is often based on the underlying inflation measure, CPIF (CPI with fixed rates). In periods of highly volatile energy prices, the CPIF excluding energy is also used for guidance (see Figure 2). To cover parts of housing costs, the CPI contains the sub-group of 'mortgage interest cost', which is a calculated cost of owner-occupied houses with one part tracking the capital amount and one part tracking the average mortgage interest rate that households faces (ie, the product of the two indices is the capital cost of a mortgage). The latter sub-index is compiled as an average of different durations on interest rates, but also moving averages for long-duration mortgage rates. The most common interest rate in Sweden is a 3m variable interest rate (c.50% of the loan stock). As interest rates are part of the CPI, any given rate change by the Riksbank is followed by the same directional movement in the CPI index. To see through this counterintuitive movement, the underlying CPIF is normally the preferred index of the Riksbank. The difference between the CPI and CPIF is that the latter doesn't contain the second part of the 'mortgage interest cost' sub-group, ie, changes in interest rates. While the inflation rate differs in the short term when interest rates change, in a steady state, the CPIF and the CPI by definition show the same inflation rate.

Official Swedish statistics also include the release of HICP, providing a consistent comparison with other European countries, with some differences compared with the domestic basket. For instance, HICP includes elderly care cost and fees for some financial services that are not included in the national CPI. At the same time, the owner-occupied housing costs carry a weight of around 9% in the CPI, but are not included in HICP. Despite some basket differences, the HICP and the underlying CPIF have had similar inflation over the long term, clearly showing that the biggest differences are changes in the interest rate sub-group. In a tightening cycle, this leaves a bias towards higher CPI than HICP and CPIF, but CPI will tend to be lower than the other measures as mortgage rates fall. However, in the long run, the lack of a house price component in HICP tends to offset its higher calculation bias from less aggressive substitution highlighted above, leaving it on average very close to the CPIF. The Swedish National Debt Office (SNDO) made it clear before the last euro referendum in September 2003, that there would be no change to the measurement index for domestic inflation-linked bonds, even if Sweden were to adopt the euro.

Seasonality in Swedish inflation is more extreme than in larger countries, resulting in relatively volatile carry. This volatility is further exaggerated by the fact that Swedish electricity is generated by hydroelectric power, with a significant minority of households opting for floating electricity price contracts. Headline CPI thus has a higher sensitivity than normal to the weather, particularly very cold winters or extended dry spells. Swedish linkers that redeem in December have a significantly favourable seasonality into redemption, as they benefit from a consistently high September print, whereas more recently issued bonds redeeming in June have a relatively neutral seasonality.

Development of the market

Although at times Sweden's inflation-linked government bond program has been fraught with challenges, as the SNDO put it, one *"cannot try inflation-linked bonds for a short time or hesitate along the way…the strategy must be carefully thought-out and long-term…the SNDO has issued inflation-linked bonds every year since 1994, although in some years the demand has been sluggish. In that case, the SNDO reduced the volume…but by nevertheless continuing to issue these bonds, we have clearly demonstrated that we believe in the growth of this market*[5]." Ongoing commitment and proactive assessments on the part of issuing authorities as to whether the product suits the domestic investor base have been a key feature of the Swedish linker program.

Historically, we can distinguish three separate regimes in the development of the Swedish linker market. The first one, lasting roughly from 1994 until 1996 was a period when the program was poorly understood by investors and auctions frequently went undersubscribed. During the second phase, lasting from about 1997 to 2001, Sweden's inflation-linked government bond program underwent numerous reforms that helped develop the market further. Lastly, from about 2002, the program reached a mature phase, with linkers enjoying stable demand from investors while evolving into a full-fledged debt management instrument for the issuing authorities.

FIGURE 3

Swedish govt. inflation-linked bonds

Loan number	Issue date	Redemption date	Initial maturity	Floored?	Coupon rate (%)	Amount outstanding (real terms, SEK mn)	Amount outstanding (nominal, SEK mn)	Index Ratio
3105	01-Dec-15	2015-12-01	17	Yes	3.5%	24.84	30.37	1.22281
3107	01-Jun-17	2017-06-01	7	Yes	0.5%	39.11	40.44	1.03405
3102	01-Dec-20	2020-12-01	25	No	4.0%	27.94	35.71	1.27836
3108	01-Jun-22	2022-06-01	11	Yes	0.25%	26.45	26.62	1.00644
3109	01-Jun-25	2025-06-01	11	Yes	1.0%	9.50	9.47	1.99722
3104	01-Dec-28	2028-12-01	30	Yes	3.5%	43.45	53.13	1.22281
3103	01-Dec-28	2028-12-01	30	No	3.5%	0.003	0.004	1.27819
Total						**171.28**	**195.74**	

Note: As of 11 June 2014. Source: SNDO

In April 1994, after consultations with the government and the central bank, the SNDO decided to launch a program of government inflation-linked bonds and started with a zero-coupon 20y instrument linked to the Swedish consumer price index, the SGIL 0% 4 Jan 2014 bond, auctioned via a single price auction. The SNDO judged that a large portion of the bids were priced too low and consequently it issued only SEK1.2bn of the bond versus original plans for SEK3.5bn. The lack of investor enthusiasm at this first auction was a harbinger of limited acceptance of the new product in the following three years or so and indeed, while the balance of linkers rose from SEK3.1bn in 1994 to SEK73.4bn in 1996, at times the SNDO was forced to cancel auctions, with breakeven inflation rates generally declining.

The long duration of the first bond (20y versus 8y for the longest-maturity nominal bond) is one of the reasons why the reception for this new instrument was chilly and the decline in spot inflation, from about 2.5% in mid-1994 to 0% by August 1996, also likely contributed. To deal with this issue, in January 1995 the SNDO issued SEK500mn of a 9y zero-coupon bond (0% April 2004 issue), a bond that it continued to sell throughout the year in small quantities at weekly auctions but in this bond's case too, it had to be withdrawn from auction on multiple occasions.

[5] "Ten years with inflation-linked bonds – a new asset class has been established," SNDO, 2004.

The second stage of the Swedish inflation-linked government bond market proved to be even more difficult as the CPI dipped into negative territory from September 1996 to May 1997 (average -0.4% y/y) and from July 1998 to February 1999 (average -0.7% y/y), due to sharp falls in the owner-occupied housing sub-component of the CPI (mortgage interest costs fell as the Riksbank cut rates) and fundamental core CPI disinflation. In addition, equity markets were overall bullish and central government finances were stronger, leading some to doubt the SNDO's long-term commitment to foster the inflation. However, the SNDO took a proactive and flexible stance, tackling the problem from various angles. The linker market-related reforms implemented during this stage can chronologically be summarized as follows:

1. The SNDO allowed private investors to purchase inflation-indexed bonds through primary dealers after each auction (June 1995) and later in 1997 it introduced retail-oriented inflation-indexed bonds (available to individuals and small companies and organizations).

2. Implementation of switch auctions (officially called "exchange transactions") enabled dealers to move from less popular zero-coupon inflation-linked bonds to coupon-bearing linkers (June 1998); the first such auction was held on 23 June 1998, when dealers could switch from the 0% April 2014 bond to a new issue to the 3.5% Dec 2028 bond. In the following years, switch auctions played an important role in the restructuring of the SNDO's debt portfolio. Linker auctions were usually held over three consecutive days, with outright auctions on the first and third days and a switch auction in between. Exchanges remain a key feature of the market to build up the size of new issues given very limited overall funding needs, with the SNDO announcing the terms for bond exchanges several weeks in advance. Exchange transactions of bonds with similar maturity are usually executed in "liquidity neutral" terms, ie, cash for cash, while exchanges between bonds of different maturities are conducted on a "price risk neutral" basis, ie, with amounts scaled for duration gaps. On the day of the switch auction, the SNDO announces the official bid yield for the bonds to be retired 15 minutes before the cut-off of the auction and the results are released 10 minutes after the auction. The switch option is technically available for auctions of new bonds as well, ie, investors can switch from their holdings of more seasoned bonds rather than buying outright, but the size of auctions is typically smaller than for exchanges.

3. The addition of deflation floors on the principal payment to all inflation-linked bonds that would be issued in the future (April 1999), a feature officially motivated by the need for the "international harmonization[6]" of the Swedish inflation-linked market, although the deflationary experience was likely another objective reason behind this move. The first bond with a deflation floor was sold in April 1999 (the 3.5% Dec 2028 bond), being the destination of the 3.5% Dec 2028 non-floored bond issued in the previous year. Thus, both bonds had the same coupon and maturity and terms were set at even yields. A second switch auction was held five days later, enabling conversion from the seasoned 0% 2014 bond into a new issue, the 3.5% Dec 2015 bond. Within the space of one year, the SNDO designed switch auctions both from non-floored zero-coupon bonds to non-floored coupon-bearing bonds, and from non-floored bonds to floored bonds.

   Most inflation-linked bonds by market capitalisation now have deflation floors, with the main exception being the 3102, 2020 maturity issue. Regarding the addition of deflation floors, we can make two noteworthy observations. First, the adoption of floored bonds did not negatively affect the performance of non-floored bonds but rather helped the overall stability of the market. Whereas around 1998-1999, when Sweden experienced deflation, breakevens turned negative (the 2y BEI reached nearly -50bp while the 10y BEI was just 18bp above zero) following the issuance of floored bonds, BEIs were stable at about 2% in

[6] "*Swedish Debt Policy*," Erik Thedéen, February 2000.

early 2004 despite the arrival of another deflationary episode. Second, the price differential between floored and non-floored bonds of similar maturity through this period of low inflation (around 6bp) suggests the market consistently discounted the existence of the floor. The 2017 and 2022 maturity benchmarks issued in recent years have traded richer on the curve than may otherwise have been expected, again suggesting their floor value is partly priced.

4. Lastly, to further promote the inflation-linked bond market and especially increase investor awareness, the SNDO introduced a new dealer system from 2000. This system was more demanding for the newly authorized inflation-linked bond dealers. The authorized dealer status is valid for one year and the following year, new dealers can be appointed if one or more of the previous year's dealers fail to perform.

The third stage of the Swedish inflation-linked market has been one where investor acceptance of the product matured and the asset class secured a stable place in the country's debt portfolio. From 2002 onwards the SNDO focused on operations to further encourage liquidity, such as buybacks, flexible auctions and offering non-competitive post auction options to dealers of up to 20%. The retail sector was allowed to buy linkers directly online at the average auction yield. Arguably the most important development for maintaining liquidity was offering linker repo to dealers at 25bp below the central bank's overnight rate.

The outstanding balance of linkers more than doubled from December 2001 to its recent peak in September 2008, moving from SEK94bn to SEK227bn, with the share of linkers in total government debt rising commensurately. The SNDO now has a long-run target that 25% of its debt should be inflation-linked, once adjusting for expected future inflation accretion. With government debt levels relatively stable and linkers' share in the debt portfolio having risen above the target level, the outstanding amount of inflation indexed-bonds has been on the decline since 2007. The size of the market in notional terms was SEK192bn in January 2007, but fell to SEK153bn by the start of April 2012, when the redemption of the April 2012 bond took the share of linkers in the debt stock very close to its target. In its Central Government Borrowing forecast and analysis from February 2014, the Debt office indicated that borrowing through linkers in2014 will increase to SEK17bn from SEK15bn in 2013. Borrowing in 2015 is expected to be SEK18bn.

Despite the declining size of the Swedish linker market, the SNDO has strived to maintain a well defined curve, issuing benchmarks maturing in 2017, 2022 and 2025 in 2010, 2011 and 2014, respectively. Bonds were brought via small initial auctions followed in the days immediately after by several switch auctions to build up their size. Switches proposed have been both in cash neutral and risk-neutral terms to cater for the needs of market participants. The SNDO proposed that it might bring a new long maturity 2039 benchmark in 2012, but this was not pursued after an investor consultation revealed limited interest. In February 2014, the assessment of the Debt Office still indicates that interest in a new long inflation-linked bond is limited.

On the demand side, the local insurance industry has been a key participant, although its holdings have fallen back somewhat in recent years. The part-privatization of the national pension system and the conversion of cash balances to government bonds at state entities in 2002 helped increase the size of the inflation-linked bond market, with the Swedish Nuclear Waste Fund in particular a natural holder. The explicit indexation of the national pension scheme to wage inflation led to linker purchases by several of Sweden's national pension funds. As mentioned above, the SNDO has facilitated the purchase of this product for retail investors as well. The decline in insurance holdings, particularly by life insurers, has been offset by an increase in holdings by international investors.

Features of Swedish linkers

Calculations for Swedish linkers are slightly more complex than for those markets that employ the standard Canadian model. Unlike the Canadian model, the prices for Swedish linkers are not expressed in real terms, but in nominal terms, including inflation uplift. The quoted real yield on Swedish linkers is consistent with the Canadian model though. Inflation accrual is calculated in a very similar manner to the three-month lag model, using a three-month lag between the inflation release and the first of the month. However, day count conventions are different, as there is linear interpolation but assuming 30-day months. Hence the reference day, d of the month is:

$$\frac{Minimum\ of\ \left[d-1,29\right]}{30}\left(CPI_{t-2}-CPI_{t-3}\right)+CPI_{t-3}$$

This convention affects daily valuations, but all coupons are paid on the first of the month. Interest accrues on a European 30/360 basis. Bonds issued since 1998 have deflation floors, with the 2020 bond the only benchmark that does not. The settlement convention for Swedish linkers is T+3. The clean nominal price (ie, after inflation accrual) of coupon bonds is rounded to three decimal places before adding on accrued interest. The settlement price is then rounded to the nearest krona.

Non-government linkers and inflation swaps

The non-government inflation-linked bond market is not large in Sweden. Virtually all corporate issuance is maturity matched to government issues and holds the same bond conventions. The largest issuer is EIB, but in recent years the most prolific issuer has been property company Vasakronan.

While conceptually the well-defined bond market means that there is plenty of scope for a liquid inflation swaps market, the Swedish CPI swaps market still remains surprisingly underdeveloped. Quotes remain infrequent across the curve, with the 10y the least uncommon. While the liquidity of the nominal swaps curve has improved in recent years, particularly at the long end, there has been no clear impetus for a more widespread use of inflation swaps.

INFLATION MARKETS

Denmark

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Prior to the first government issuance in May 2012, Danish CPI only occasionally traded in swap form. The market attracts interest from investors looking for highly-rated inflation-linked securities, although the still small size of the market means getting exposure to the market is challenging.

Consumer Price Index (CPI)

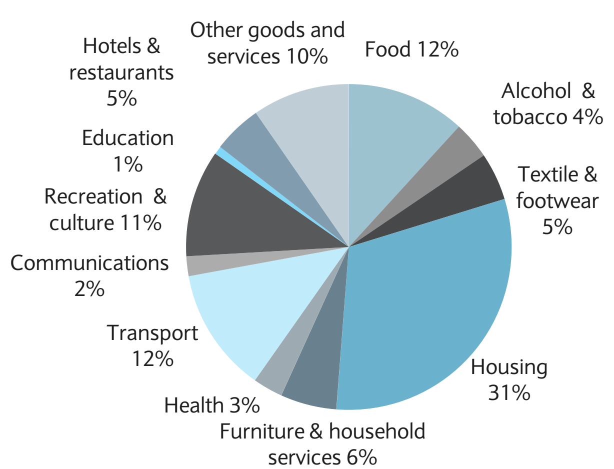
The Danish CPI (Forbrugeprisindeksks) is a weighted chain-linked index with index reference year 2000. The index can best be characterised as a fixed-weighted Laspeyres-type index (using the Young index formula) with annual links to the price reference period (for elementary aggregates) from December the previous year to the current month. The weights were last adjusted with the calculation of the index for January 2014 and are based on private consumption expenditure in 2012.

In addition, in Statistics Denmark's (DST) framework, calculations should not deviate from the EU harmonised HICP, which partly explains why the Danish CPI and HICP are highly correlated (CPI only being 0.08pp higher on average since 2001). The main difference between the CPI and HICP is the basket content, ie, the CPI contains owner-occupied housing. However, as the 'rental-equivalent' approach is used (ie, the index for rented houses is the proxy for owner-occupied housing), this is only a difference in weight.

It is noteworthy that Danish inflation is much more correlated with HICP for Germany and the euro area than for Scandinavia peers, Sweden and Norway. Indeed, Germany is by far Denmark's biggest trading partner and perhaps more importantly, Denmark's participation in the ERM II (EU's exchange rate mechanism) suggests the same exchange rate pressures as the euro area. Indeed, Danish monetary policy is set to keep the krone (DKK) stable vis-à-vis the euro (with a fluctuation band of 2.25%) by adjusting its policy interest rates or in the short term by buying and selling foreign currency in the market. This makes Denmark one of the very few countries now issuing inflation-linked bonds that does not have an explicit inflation aim as part of its monetary policy structure.

FIGURE 1

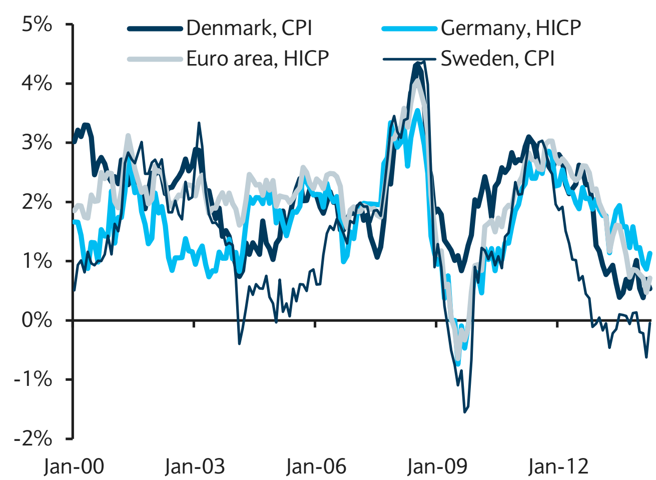
Danish CPI, sub-group weight, 2014



Source: Reuters Ecowin, Barclays Research

FIGURE 2

Danish CPI more correlated with euro HICP than Swedish CPI



Source: Haver, Bloomberg, Barclays Research calculations

Government issuance

Danmarks Nationalbank, which acts as agent for government issuance in addition to its central bank function, announced in its debt management policy for 2012 that it intended to issue a bond linked to Danish CPI. As discussed in its 2011 annual report, the largest Danish pension funds had DKK127bn (~$23bn) in inflation-linked bonds at the end of 2010, split between foreign government issues and domestic mortgage bonds. The significant distortions to euro inflation-linked bond markets in late 2011 appear to have encouraged domestic interest in government supply.

The DGBi 0.1% Nov 2013 was issued in May 2012 with an initial size of just under DKK6bn. The structure of the bond is a standard Canadian format 3m lag, with a deflation floor, with coupons paid annually. The bond has been reopened frequently since, with the outstanding just above DKK33bn in early June 2014. The bond is eligible for the central government's securities lending facility. The 15 November maturity is the standard for Danish nominal government bonds, but is a relatively neutral seasonal for inflation-linked bonds as it captures just under half the consistent upswing in prices seen each September, stemming from clothing and footwear. Following the Annual Index Governance Review in October 2012, Denmark was announced as being eligible subject to satisfying the market size rule for inclusion in the Barclays World Government Inflation-Linked Bond (WGILB) and Global Inflation-linked (Series-L) indices. The DGBi Nov 2023 therefore joined both indices effective from the March 2014 month-end rebalancing having satisfied the market size criterion at the 2013 year-end quarterly review.

Non government market

Danish CPI-linked bonds used to be a significant sub-sector of the callable mortgage bond market, but there has been no new issuance since 1999. Most mortgage bond issuers had some inflation-linked issues, as did the KommuneKredit municipal agency. The potential for development of a large derivatives market is limited by the fact that most Danish pension liabilities are nominal. However, recent reforms have weakened the guaranteed status of nominal liabilities, while some of the largest schemes have indexation aims. Other than the property sector, in which pension funds are more likely to invest directly, the only clear payment of Danish CPI comes from infrastructure projects. During the past decade, there has been occasional issuance of Danish CPI-linked notes, but in euros rather than Danish krona. The largest of these was a 2019 bond issued to fund the transport link to Sweden, a scheme which also saw inflation-linked issuance in Sweden. The Danish CPI issue reached over €600mn by 2005, but a significant proportion was subsequently bought back in 2009 and 2010. Also in 2005, there was evidence of activity in inflation swaps given that natural asset-swapping issuers including German agency KfW issued a long Danish CPI-linked issue in euros.

INFLATION MARKETS

Australia and New Zealand

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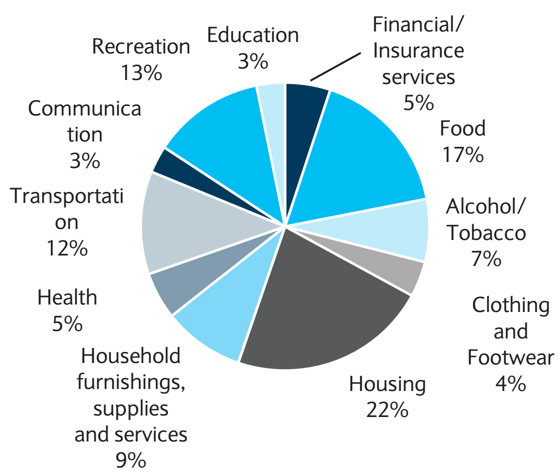
The Australian government issued inflation-linked bonds (commonly called Treasury Indexed Bonds, TIB) from 1985 until 2003, when it suspended its TIB programme due to ongoing budget surpluses. It restarted TIB issuance in 2009. New Zealand followed suit in 2012 with a 2025 issue followed by a new 2030 bond in 2013, which entered the Barclays WGILB index benchmark at the end of 2013. Both countries enjoy considerable popularity among global linker investors as highly rated diversifiers from the major inflation-linked markets, although relatively modest supply can make significant structural allocations challenging.

The Australian CPI

Australian inflation-linked government bonds, and the majority of AUD-denominated inflation structures including swaps, are indexed to the *Weighted Average of Eight Capital Cities: All-Groups Index*, more commonly known as the Australian CPI[7]. The Australian CPI is published and maintained by the *Australian Bureau of Statistics (ABS)* on a quarterly basis (three months ending March, June, September and December; the CPI figures are typically released within one month of the end of the quarter). CPI figures are compiled separately for each state capital city and the overall CPI is derived by weighting price movements (or price relatives) between the base and current period by their shares of total household expenditure in the base period. The composition of the CPI basket is based on the pattern of household expenditure observed in the weighting base period with information about consumption trends of Australian households coming from the ABS 2009-10 Household Expenditure Survey (HES) for the 16th series of the CPI.

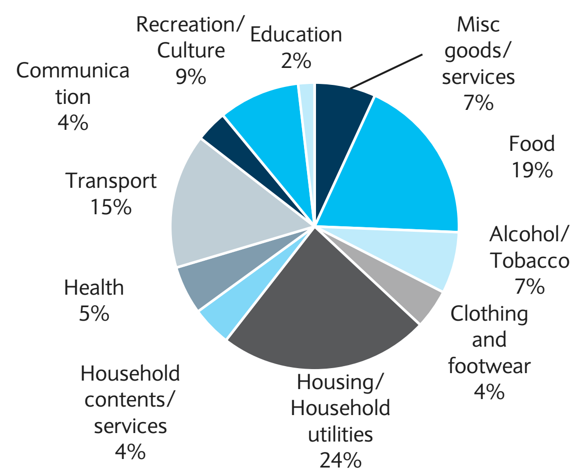
Meanwhile, the CPI basket is divided into 11 major groups, each representing a set of goods and services (Figure 1). These groups are further divided into 33 subgroups, and the subgroups into a total of 90 expenditure classes. As is the case in other developed countries, the composition of the basket and other features of the CPI are reviewed "from time to time to ensure that it continues to meet community needs".[8] The ABS undertakes these reviews at

FIGURE 1
Australia CPI composition



Source: ABS, Barclays Research

FIGURE 2
New Zealand CPI composition



Source: Statistics New Zealand, Barclays Research

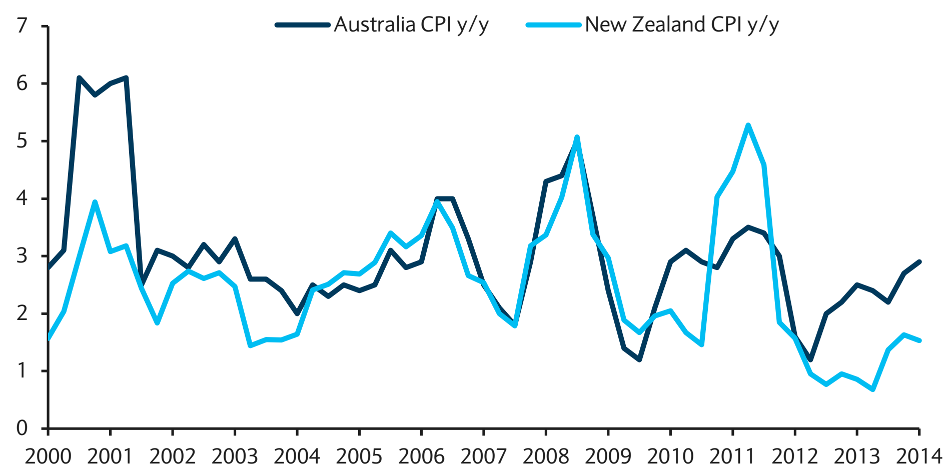
[7] The eight cities are the six state capital cities (Sydney, Melbourne, Brisbane, Adelaide, Perth, Hobart) plus Darwin and Canberra. The ABS estimates that the individual consumer population in these cities represents about 64% of Australian private households.
[8] Australian Bureau of Statistics, "Australian Consumer Price Index: Concepts, Sources and Methods", 2005.

approximately six-year intervals, with the timing generally dependent on the availability of results from the Household Expenditure Survey. The reference base period for the CPI is also updated, but at less frequent intervals From Q3 12, the reference period for the index was updated to 2011-12 = 100.0, from 1989-90 = 100.0.

In the comprehensive review of CPI calculation methodology undertaken in 1998, the ABS decided that the index would be modified from a measure of the change in living costs of employee households to a general measure of price inflation for the household sector. As a result, the population covered was expanded from wage and salary earning households to include all metropolitan households. Weights were revised to reflect new expenditure patterns and the expanded population coverage. More recently, the sixteenth series CPI was introduced in September 2011, with item weights being revised in line with 2009-10 HES expenditure patterns[9]. Australia introduced a Goods and Services Tax (GST) in 2000, which was responsible for the spike in the Australia CPI in 2000.

The Australian CPI is an important economic indicator not only for the bond market but also for the central bank, which adopted inflation targeting in 1993. The Reserve Bank of Australia's monetary policy aims to achieve, over the medium term, a target for consumer price inflation of 2-3% as the bank judges that preserving the value of money is the "principal way in which monetary policy can help to form a sound basis for long-term growth in the economy." The central bank's commitment to containing inflation helps explain why, with the exception of a brief period during the 2008 global financial crisis, Australian breakeven inflation rates have tended to trade around a long-run average of 250bp.

FIGURE 3
Australia and New Zealand CPIs



Source: ABS, Statistics New Zealand, Barclays Research

New Zealand CPI

The New Zealand CPI shares many features with its Australian counterpart – it is published quarterly and comprises 11 main subgroups with broadly similar weightings. The CPI is based on spending on goods and services by New Zealand households at June 2011 quarter prices, based on information from the 2009/10 Household Economic Survey and other sources. The New Zealand CPI forms the basis of the Reserve Bank of New Zealand's inflation target, which is to keep CPI inflation outcomes between 1% and 3% on average over the medium term, with a focus on keeping future average inflation near the 2% target midpoint.

9 For further details on the Australian CPI please refer to the Guide to the Consumer Price Index published by the ABS (www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/6440.02005?OpenDocument).

The New Zealand CPI has generally tracked the Australia CPI reasonable closely since 2001, when the effects of the Australian VAT dropped out of the index. However, New Zealand CPI spiked higher following the Christchurch earthquakes of 2010-11 which spurred significant construction spending. Thereafter inflation fell sharply in New Zealand, helped by falling dairy prices and telecommunications prices as a result of increased broadband data caps and decreases in cellular communications tariffs. CPI has since picked up from the local low of 0.7% y/y in Q2 2013, but at Q1 14 is still in the lower end of the 1-3% RBNZ tolerance band.

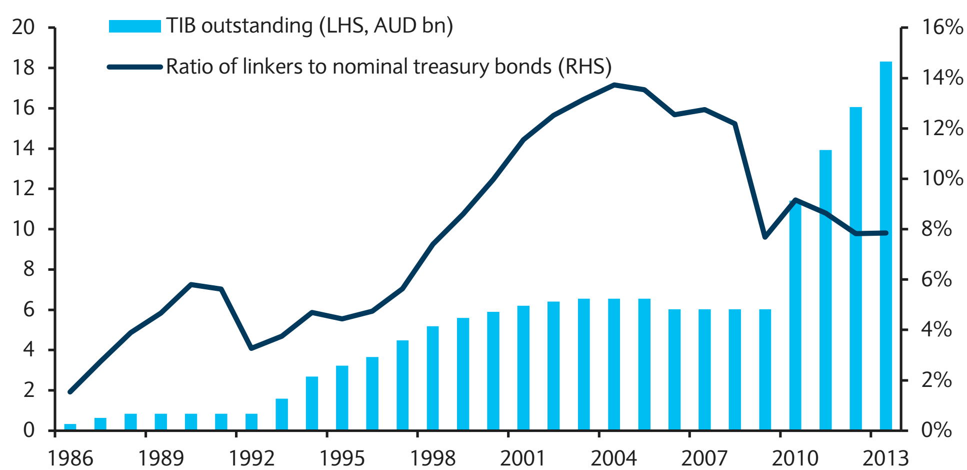
The Australian government bond market

Australia's first index-linked bond was issued by the State Electricity Commission of Victoria in August 1983. Two years later in July 1985, four Treasury Indexed Bonds (TIBs) were issued by the Commonwealth government for a modest total size of AUD100mn. Two of these issues were capital-indexed bonds (CIB), while the other two were rarer interest-indexed bonds (IIB), paying a fixed coupon plus an inflation accrual on the principal every period (the principal, however, was not adjusted for inflation at redemption). The maturities of these first bonds were 10y and 20y. As the Australian government's fiscal situation improved sharply from 1988, against a backdrop of limited appetite for inflation-linked securities among investors, the Treasury ceased issuing linkers. It even bought back some of the existing bonds as part of its debt reduction policy.

However, the government resumed its index-linked issuance programme in 1993, with supply being "tailored to identify market demand".[10] Between 1988 and 1993, the domestic inflation market had become more sophisticated, helped by issuance by a number of state governments and growing demand for long-term linkers from the emerging superannuation or pension fund industry. Under the new programme, only capital-indexed bonds were brought to the markets, all with long maturities. The size of linker supply picked up considerably, increasing on average by about AUD640mn a year in 1993-2000, from AUD1.6bn to AUD5.9bn (Figure 7). However, TIB liquidity was generally low as the bonds were issued largely to buy-and-hold investors. Annual turnover averaged a modest AUD12bn during 2001-06 versus AUD410.3bn for nominal Commonwealth Government Securities (CGS), ie, less than 3% of that of regular government bonds despite the size of the total market being around 10% of the nominal market[11]. The number of TIBs issued was not large (the inflation-indexed programme never had more than five bonds), and additional supply came in the form of reopening seasoned bonds on average 5-6 times a year.

FIGURE 4

Australian Treasury Indexed Bonds outstanding



Note: Mid-year levels Source: Australian Office of Financial Management

[10] Commonwealth Debt Management Report, 1996.
[11] Australian Financial Markets Association, "2006 Australian Financial Markets Report."

FIGURE 5

Australian government inflation-linked bonds

	Issue date	Redemption date	Coupon	Face value (AUD bn)
Australia IL 4.00% 2015	17 May 1994	20 Aug 2015	4.00%	1.15
Australia IL 1.00% 2018	29 Apr 2014	21 Nov 2018	1.00%	2.54
Australia IL 4.00% 2020	14 Oct 1996	20 Aug 2020	4.00%	4.96
Australia IL 1.25% 2022	28 Feb 2012	21 Feb 2022	1.25%	3.59
Australia IL 3.00% 2025	8 Oct 2009	20 Sep 2025	3.00%	5.44
Australia IL 2.50% 2030	21 Sep 2010	20 Sep 2030	2.50%	3.14
Australia IL 2.00% 2035	26 Sep 2013	21 Aug 2035	2.00%	2.40

Source: Australian Office of Financial Management as of 23 May 2014

The Australian Treasury announced the suspension of the TIB programme with the publication of its budget in 2003. This announcement followed a one-year period of analysis and consultation with more than 90 domestic and foreign market participants, which sought to determine whether the CGS market was a viable going concern given the sharp fall in the Commonwealth government's financing requirement over the previous few years and the abundance of cash available from the sale of government assets (the Australian government's net debt had fallen from 18.5% of GDP in 1995-96 to 1.3% of GDP by 2004-05). On purely economic grounds, the very favourable fiscal conditions implied no need for active issuance of government securities. On the other hand, there was concern about banks' disproportionately large role within the financial markets and hence it was argued that the CGS market should be maintained. The government's review concluded that an interest rate market completely dominated by banks and corporate paper would be vulnerable to economic shocks, thus posing significant threats to financial stability and the accessibility of refinancing capital for corporates. As a result of this, the decision was taken to support government debt liquidity, and was structured in such a way that it supported the 3y and 10y Treasury bond futures contracts; but there was no room for a continuation of the TIB programme.

In 2009 the inflation-indexed government bond programme was revived after a six-year hiatus. In an announcement regarding the issuance of Commonwealth government bonds in May 2009, the Australian Office of Financial Management (AOFM) stated that resumption of linker supply "could assist in the debt financing of long-term infrastructure, since Treasury Indexed Bonds (TIB) would serve as both a pricing benchmark and a risk management tool… indexed financing can be attractive for those infrastructure projects whose revenues are linked to inflation… in addition, indexed instruments have advantages for investors with inflation-linked liabilities". We believe there are at least two more reasons for the resumption of inflation-indexed bonds not explicitly stated in the AOFM note. First, similar to other countries affected by the 2007-09 global financial crisis, the government's expenditure base had increased sharply, while tax revenue had plunged, leading to Australia's first budget deficit in seven years, which was also the largest on record (AUD57.6bn, or nearly 5% of GDP in 2009). Second, double-digit negative returns on Australian households' mandatory superannuation (pension) funds owing to financial market volatility, combined with proposals to raise the age at which individuals can access these funds, had been steering debate on asset management in the direction of safer investment guidelines, and linkers fitted this description.

Following consultation with various market participants, the AOFM decided to issue the new linker at the beginning of October 2009 via syndication, with an announced supply size of "at least" AUD1bn. The actual amount sold was four times larger, at AUD4bn. As a result, the Australian government inflation-linked bond market expanded by 66% in 2009 alone.

Another important development was the expansion of the AOFM's securities repo facility to include TIBs (both seasoned bonds and the new 2025 bond). This change contributed to the improvement in secondary-market liquidity, in line with overseas experience.

The AOFM has allowed the TIB market to continue to grow since the restart of the programme, allowing the curve to develop by adding new issues alongside regular reopenings. A 2030 issue was brought via syndication in September 2010, for an initial size of AUD1.26bn, followed by a 2022 10y benchmark in February 2012, which was launched for AUD0.9bn. The real yield curve was extended out to 2035 in September 2013, with a new 2018 launched at the end of April 2014. The Australian Office of Financial Management expects to issue around AUD4bn of linkers in FY2014-15, slightly lower than the AUD5bn issued in 2013-14. This will be conducted via two tenders in most months, of at least AUD100mn in size.

Technical features of Australian inflation-linked bonds

As is the case with other international linker markets, both income and capital generated by TIBs are indexed to inflation. Australian linkers are similar to old-style UK index-linked in that the next coupon amount is always known on or before the current coupon payment date. According to the prospectus for Treasury Index Bonds published in 1995, "the amount of inflation indexation in any given coupon period is equal to the average percentage change in the Consumer Price Index over two quarters ending in the quarter, which is two quarters prior to that in which the next interest payment falls". This means that the bonds have a six-month indexation lag compared with eight months in the UK. The interest on Australian linkers is accrued on an actual/actual basis, and the bonds are quoted on a yield basis. Interestingly, while conventional bonds pay semi-annual coupons, inflation-indexed pay coupons on a quarterly basis. Australian linkers trade ex-dividend for seven days prior to the payment date. Furthermore, as is the case with other developed linker markets, these securities contain an embedded put at maturity that protects against deflation over the life of the bond. Unlike other markets that offer an inflation floor, however, capital-indexed bonds protect both coupon and principal from deflation over the life of the bond.

The calculation of interest and principal payments for Australian index-linked bonds is significantly different than US, Canadian, Euro and Swedish bonds. The settlement price for AUD100 face value of Australian government inflation-linked bonds is provided by the following formula.

$$P = V^{f/d}\left[g(x + a_n) + 100V^n\right] K_t \quad \frac{(1+p/100)^{-f/d}}{100}$$

Where,

- $V = 1/(1+i)$, with **"i"** being the annual percentage real yield (quoted real yield) divided by 400. For example, if the annual yield is 2.5%, then "i" is equal to 2.5/400, or 0.00625.
- **"f"** is the number of days from the date of settlement to the next interest payment date.
- **"d"** is the number of days in the quarter ending on the next interest payment date.
- **"g"** is the fixed quarterly interest rate payable (equal to the annual fixed rate divided by 4).
- **"x"** is a valued of either 0 or 1 depending on whether there is an interest payment at the next interest payment date; "x" is 1 if there is an interest payment and 0 if there is no interest payment (ie, the bond is trading ex-dividend).

- **"a_n"** is the sum of the power series or V, with the highest power being **"n"** (the number of full quarters between the next interest payment date and the date of maturity). Mathematically,

  $a_n = V + V^2 + \ldots + V^n = \sum V^j$, where $j \in [1,n]$

- **"Kt"** is the nominal value of the principal at the next interest payment date (whether or not there is an interest payment due). Kt can also be expressed as
  Kt = Kt-1*(1+p/100), where Kt-1 is the cash value at the previous payment date. If there has been no previous payment date, Kt-1 is equal to AUD100. Note that Kt and Kt-1 are rounded to two decimal places.

- **"p"** is the average percentage change in the CPI over two quarters ending in the quarter which is two quarters prior to that in which the next interest payment falls; for example if the next interest payment is in November, then "p" is based on the average movement in the CPI over the two quarters ended in the June quarter preceding. Mathematically expressed, "p" is (100/2)*[(CPIt/CPIt-2)-1], where CPIt is the CPI for the second quarter of the relevant two-quarter period, and CPIt-2 is the CPI for the quarter immediately prior to the relevant two quarter period. "p" is also known as the "Australia CPI factor average change (ACIF)" and is regularly calculated by the Reserve Bank of Australia (RBA). These figures are also available on Bloomberg as ACIF Index.

Interest payments for Australian linkers are calculated as **$g*K_t/100$**, where "g" and "K_t" are the variables defined in the calculation of settlement prices above. Interest payments are rounded to the nearest cent (ie, with 0.50 being rounded up). Moreover, no interest payment is based on a nominal value of less than AUD100. If the nominal value of the principal falls to below AUD100, then the interest payment would be based on a nominal value of AUD100. Subsequent interest and/or principal payments in such cases will be reduced by the difference between the fixed interest payment that was paid in the period and the payment that would have been made under the above formula except for this provision.

The New Zealand government bond market

New Zealand initially introduced inflation-indexed bonds in 1996 with a 2016 maturity bond. However, issuance of this issue ceased in 1999 and the bond has not since been tapped. Linker issuance resumed in October 2012, with a 2025 issue launched by syndication and a 2030 launched via the same method a year later in October 2013. The technical features of the bonds are almost identical to Australian Treasury Indexed Bonds, and so we have not duplicated the pricing formulae although we note that the explanatory notation used by the NZDMO differs slightly from the AOFM. We recommend consulting the Information Memorandum for NZ linkers for further details.

Non-government linkers and Australian inflation derivatives

Although the Commonwealth Government has been the dominant issuer of Australian inflation-linked bonds, its securities represent just over half of the market. The Australian market has a range of smaller inflation-indexed issuers including state governments, quasi-government authorities and government-regulated utilities companies, as well as private issuers. Just like the Commonwealth State, local Australian governments also have a fairly long experience with inflation-linked securities, as many of them began tapping the markets in the late 1980s. Most of the initial offerings were capital-indexed bond type, but subsequently annuity-style indexed securities (called Index Annuity Bonds, or IAB) were brought to the markets. One such example is an IAB issued by the State Government of Victoria in 1993. The initial issue size was AUD603mn, a large amount at that time.

The Treasury Corporation of Queensland issued AUD268mn of 25y capital-indexed bonds in mid-2006, following the exact format of inflation-linked CGS, with the bond subsequently reopened on multiple occasions. This was followed by a total of AUD460mn worth of linker supply (maturities of 18y and 28y) at the end of 2007 by the Treasury of New South Wales. Illustrating robust investor demand for inflation-indexed bonds in August 2009, the Treasury of New South Wales issued AUD800mn of a new 3.75% November 2020 capital indexed bond at an outright real yield of 3.75% (a spread of nearly 60bp to the 2020 Commonwealth government TIB) on a book-build basis. Hints of such a pick-up in inflation supply could be seen in the entity's 2008 Annual Report, commenting that "the potential to expand the use of CPI linked debt by a broader range of clients, particularly for PTEs (public trading enterprises) with revenue streams linked to the CPI, is currently being explored… this may lead to further client demand for CPI linked funding". The New South Wales Treasury Corporation now has over AUD5bn notional in its three benchmark issues and is committed to regular quarterly tenders.

While the Commonwealth Government ceased to provide liquidity to the Australian inflation markets during 2003-2009, state governments helped to pick up the slack. Inflation-indexed security supply related to infrastructure projects was also significant. This type of issuance is sporadic but involves hefty deal sizes. Australian governments responsible for building infrastructure projects have increasingly turned to consortiums typically made of construction companies and financial institutions (for example the consortium charged with the construction of nine public schools under the so-called "New Schools Privately Financed Projects," a public-private partnership). The government enters into a long-term lease contract with the consortium, with payments adjusted to the rate of inflation. Therefore, the consortium has incentives to issue inflation-linked bonds with maturities similar to those of the lease contract in order to achieve a better asset-liability profile. However, in recent years there have been almost no new infrastructure bonds with inflation embedded within them. This is mainly due to reduced demand for the long-dated project related to credit tending to prompt direct paying of inflation revenue streams via swaps.

As the projects feature amortising cash flows, in many cases the structure of these bonds is Credit Foncier type, paying cash flows consisting of both principal and interest. When demand from end-investors for such bonds is not strong enough, the consortium typically issues only one part of the debt linked to inflation and the rest in nominal form with an inflation outlay, ie, paying inflation via the swap market. A good example is Reliance Rail, which at the end of 2006 financed the renewal of the Sydney rail network (a fleet of 78 trains) partly via AUD300mn of 29y CPI-linked annuity bonds and partly via AUD1.6bn floating-rate bullet bonds with maturities between 9.75y and 14.75y; the nominal bonds were issued along with paying CPI swaps to the tune of AUD1bn. The pick-up in non-government inflation-linked bond issuance clearly fostered the development of an AUD inflation swap market. However, trading was infrequent, with activity in the swap market spiking around the time of these large infrastructure projects. Swap market liquidity has become more consistent in recent years, helped by the government bond market becoming much better defined, facilitating two-way asset swap interest.

INFLATION MARKETS

Brazil

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Brazil has been issuing inflation-linked bonds since 1964. Having been the dominant form of local debt during periods of hyperinflation, linkers fell to a small share of national debt until 2003. Subsequently, there has been a major move towards increased linker issuance to replace floating-rate and foreign-currency debt. At April 2014, the notional of inflation-linked bonds was equivalent to USD345bn.

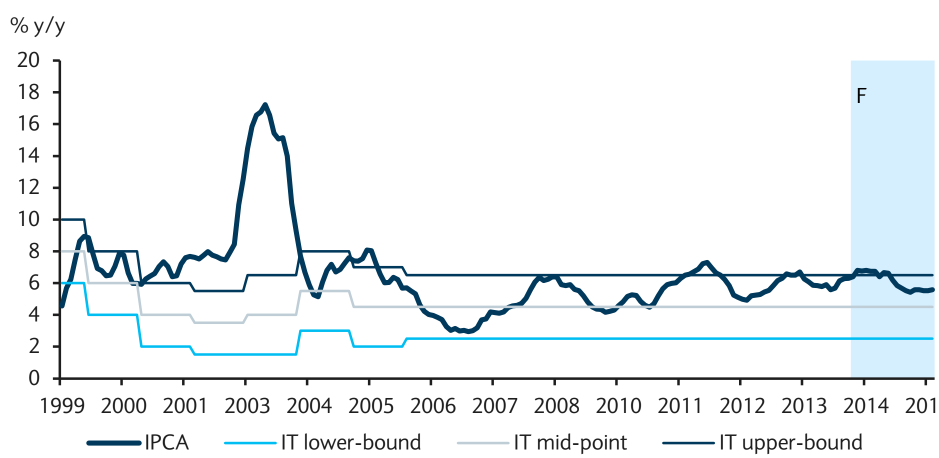
Inflation targeting

Brazil's inflation targeting (IT) regime has been tested consistently since it was implemented in 1999. However, it was during its 10th anniversary – when the Brazilian economy weathered the global financial meltdown surprisingly well – that we believe the regime finally paid dividends. For the first time, Banco Central do Brasil (BCB) was able to implement countercyclical monetary policy, helping to minimize the downturn of economic activity when capital flows were drying up dramatically and the BRL was depreciating substantially.

The 2008-09 crisis crowned the Brazilian IT regime as a very successful framework for monetary policymaking, but we believe some adjustments are in the making. There were no formal changes to the regime, but, in fact, the BCB's modus operandi has changed. Our view is that the crisis drove it to allow inflation to float more freely around the upper bound of the target range (4.5%, +/-2%). While BCB's sole mandate is to keep inflation within the target range, its reaction function is adjusting to the non-orthodox policy measures adopted in the developed world. Another challenge for the regime has been Brazil's loose fiscal policy stance, which has clogged the channels of monetary policy and offset the BCB's efforts to bring inflation back to the midpoint of the target range. But we continue to see the 6.5% upper bound of the target as a hard ceiling; hence, our view remains that this change reflects global uncertainties and abnormally high global liquidity conditions, but it does mean that inflation will remain resiliently closer to the upper bound of the target range in the coming years.

Figure 1 plots the IPCA rate (official inflation target rate, observed and forecast) with our forecasts until end-2015, along with the bands and midpoint targets of the Brazilian IT regime since it was implemented. After a volatile initial few years, reflecting both domestic and external shocks, inflation converged to the target range, floating in not only the upper, but also the lower half of the range.

FIGURE 1
The Brazilian inflation-targeting regime (targets and IPCA)



Source: IBGE, BCB, Barclays Research

Each July, the National Monetary Council (chosen by the finance and planning ministers, along with the BCB president) sets the two-year-ahead midpoint target, along with the tolerable range of fluctuation (currently at 4.5% +/- 2%). The BCB governor is nominated by the Brazilian president and the board of directors is approved by the senate. There are no fixed mandates for the board or the governors.

Indexation

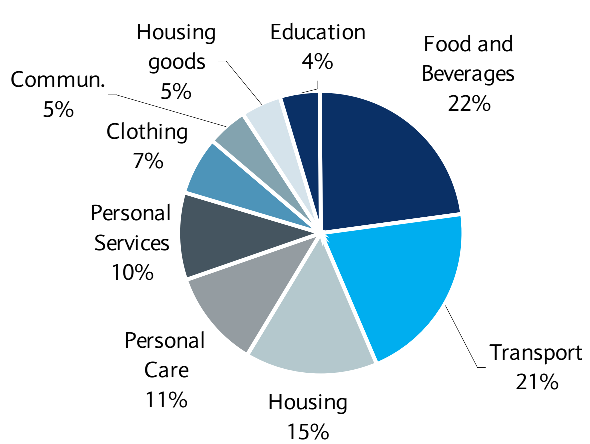
Brazil developed several inflation indices during its hyperinflation period. The most important are IPCA (BZPIIPCA Index <GO> in Bloomberg) and IGPM (IBREIGPM Index <GO> in Bloomberg). The IPCA (December 1993 = 100), calculated by the national statistics agency (IBGE), is the official national consumer price index (and the measure of inflation targeted by the central bank). IBGE publishes it around the 10th day of each month, covering the period of the previous calendar month. In other words, the February index, released in March, reflects average prices during February, and the m/m change for February represents the full-month February average compared with that for January.

IBGE announced in late 2011 the new weighting structure for the IPCA inflation index valid as of 2012. The index was constructed based on the latest consumption survey, taken in 2008-09, and reflects the consumption patterns of households with incomes of 1-40x the minimum wage. As is standard in CPI index calculations, the index weights are fixed. However, IBGE-reported weights move slightly each month, reflecting the changes in relative prices. Figure 2 shows the new weights in January 2012, with food and beverages, transportation, and housing having the largest shares. Compared with the previous (2002-03) consumption survey, the items that had the largest increases were transportation and residential goods, while education's weighting decline the most (considering only the main categories of the IPCA). The importance of the food and transportation components is increased by their high level of volatility, as they are affected by the swings in international food and energy prices. But with the government controlling fuel prices, the latter's contribution to fluctuations in inflation has been reduced. Geographical coverage comprises 13 metropolitan areas, with São Paulo having by far the largest weight, nearly 31%.

The IGP-M index (August 1994 = 100), published by the Getulio Vargas Foundation, a private institution, measures a broader set of prices. It consists of three components: a measure of producer prices (60% of the total); a measure of consumer prices (30% of the total); and a measure of construction costs, both materials and labor (10% of the total). The

FIGURE 2

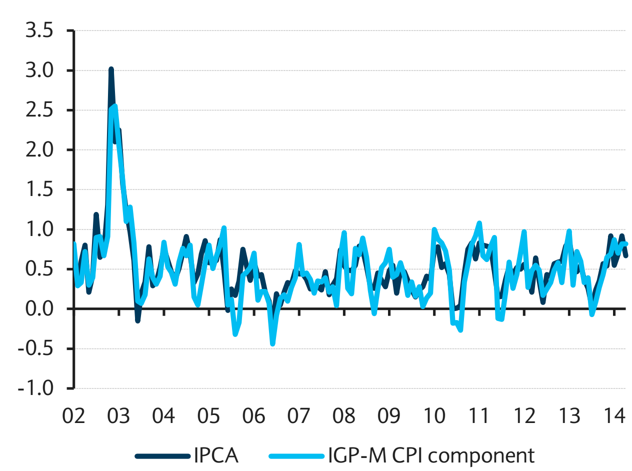
IPCA weights (%)



Source: IBGE, Barclays Research

FIGURE 3

IPCA and IGP-M CPI component (% m/m)



Source: IBGE, FGV, Barclays Research

IGP-M is also published monthly, around the 30th day of each month. Instead of calendar months, it covers a period from the 21st day of a given month through the 20th of the following month. The consumer price component tends to behave similarly to the IPCA (Figure 3), but the wholesale price component is considerably more volatile, partly because of the prevalence of raw foods in the index and partly because of exchange rate movements, which can affect tradable goods prices significantly (Figure 4). As a result, inflation, as measured by the IGP-M, fluctuates more widely than IPCA inflation. Changes in the BRL have a faster and higher pass-though into IGP-M than into IPCA.

Both inflation indices I_t are updated only once a month and evolve as a step function. To adjust the current price of the bonds correctly (see next section), one needs to account for accrued inflation from the last date the index was updated to the settlement date of the bond (generally T+1). The market convention is to use the official Brazilian Association of Financial and Capital Market Companies (ANBIMA) inflation forecast pro rata, so we have:

$$I_t^{'} = I_t \left(1 + i_A\right)^{n/N}$$

where *n* is the number of Brazilian business days between the evaluation date and the last day of the previous IPCA period coverage; *N* is the number of Brazilian business days between the last day of the previous IPCA period coverage and the last day of the next IPCA period coverage; and i_A is inflation as projected by ANBIMA. Special attention should be paid to the dates when there are releases of other inflation indices, since they are generally correlated with IPCA or IGPM or both. ANBIMA's inflation projection might change according to other data releases, affecting the value of the linkers.

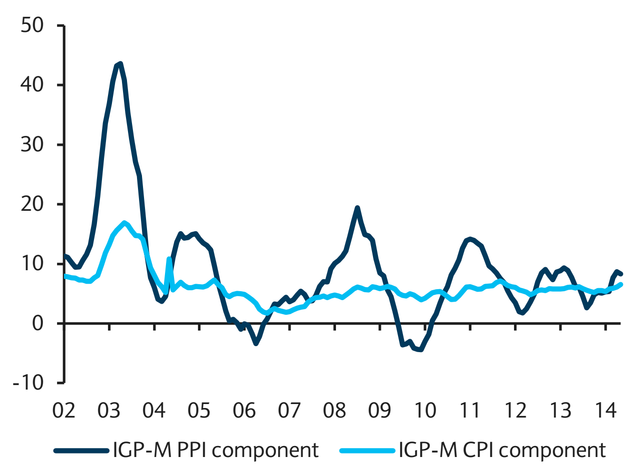
Government bonds: NTN-Bs and NTN-Cs

The Treasury used to issue two inflation-linked securities: NTN-Bs (BNTNB Govt <go> in Bloomberg) and NTN-Cs (BNTNC Govt <go> in Bloomberg). The former have their principal indexed to IPCA. They generally have semiannual payments of fixed-rate coupons on the indexed principal, though some zero-coupon bonds have been issued with indexed principal. NTN-Cs are similar to NTN-Bs, but with principal indexed to IGP-M.

Until 2005, the market for NTN-Cs was substantially larger than that of the NTN-Bs. However, demand for IPCA-linked securities has been increasing, given IPCA's central role

FIGURE 4

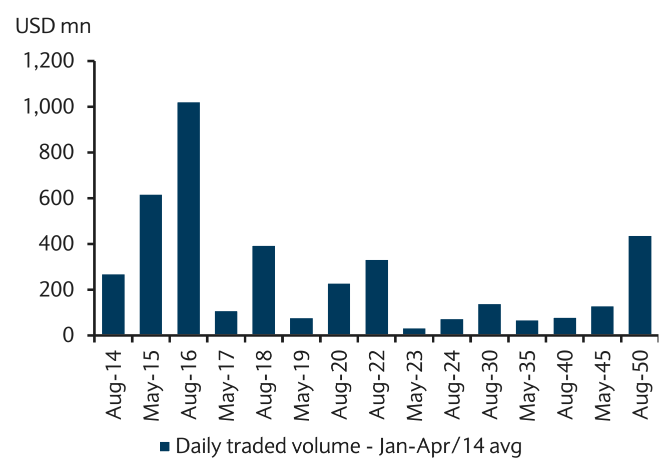
IGP-M wholesale and CPI components (% y/y)



Source: FGV, Barclays Research

FIGURE 5

NTN-B market information by maturity



Source: BCB, Barclays Research

within the inflation-targeting regime. Furthermore, from a supply perspective, the combination of 1999's devaluation and the high FX pass-through of the IGP-M led the Treasury to shift towards IPCA-linkers. In the past few years, NTN-Cs issuance has been ended and as of end-2011, NTN-Bs account for about 90% of the total outstanding amount (BRL515bn) of inflation-linked securities (Figure 6).

FIGURE 6

NTN-Bs outstanding

					Outstanding	
Maturity date	Issue date	Coupon	Coupon frequency	Day count	BRL bn (uplifted notional)	% total
Aug-14	Jan-09	6.00	Semiannual	bus days/252	43.7	6.4
May-15	Oct-03	6.00	Semiannual	bus days/252	58.2	8.5
Aug-16	Nov-10	6.00	Semiannual	bus days/252	71.7	10.5
May-17	May-07	6.00	Semiannual	bus days/252	37.5	5.5
Aug-18	Oct-11	6.00	Semiannual	bus days/252	52.4	7.7
May-19	Jan-14	6.00	Semiannual	bus days/252	10.3	1.5
Aug-20	Jan-09	6.00	Semiannual	bus days/252	45.1	6.6
Aug-22	Oct-11	6.00	Semiannual	bus days/252	74.8	11.0
May-23	Jan-14	6.00	Semiannual	bus days/252	3.2	0.5
Aug-24	Oct-03	6.00	Semiannual	bus days/252	39.8	5.8
Aug-30	Feb-10	6.00	Semiannual	bus days/252	22.6	3.3
May-35	Mar-06	6.00	Semiannual	bus days/252	32.9	4.8
Aug-40	Feb-10	6.00	Semiannual	bus days/252	31.1	4.6
May-45	Sep-04	6.00	Semiannual	bus days/252	70.3	10.3
Aug-50	Feb-10	6.00	Semiannual	bus days/252	89.7	13.1
				TOTAL	683.2	

Source: Bloomberg, BCB, Barclays Research

Liquidity is often poor for NTN-Cs, as a sizeable portion of the outstanding bonds are held by buy-and-hold pension funds, which also have long-term IGP-M liabilities acquired in the past. NTN-Bs, on the other hand, trade up to USD1.0bn on a daily basis, depending on the tenor (Figure 5). NTNs are quoted on a yield basis using the Brazilian business/252-day count convention and annual compounding. All IPCA-linkers have 6% real coupons. However, due to the local convention, the effective coupon c' (paid every 6m) is given by: $c' = (1+c)^{\frac{1}{2}} - 1$, where c is the annual coupon.

Linkers have their principal indexed from a base date that does not coincide with the issuance date; it is set at July 15, 2000, for all NTN-Bs. Therefore, newly issued bonds start with a large inflation adjustment and a nominal invoice payment necessary to acquire a bond that is materially above par. The yield-to-price formula is given by:

$$P_t = 1000 \frac{I`_t}{I_0} \left[ \sum_{i=1}^{n} \frac{c`}{(1+Y)^{ti}} + \frac{1}{(1+Y)^{tn}} \right]$$

Where *t*, *ti* and *tn* are the times (Brazilian business/252-convention) to settlement date, coupon dates, and maturity date, respectively; $c' = (1+c)^{\frac{1}{2}} - 1$ is the effective coupon; I_0 is the inflation index at the base date; I'_t is the current index level; Y is the quoted yield; and P_t is the current price of the bond.

Government debt structure

The federal government has been trying to improve the quality of public debt since 2001, when the National Treasury started publishing the guidelines for annual debt through the Annual Borrowing Plan. Broadly speaking, its main aim was to minimize the debt's vulnerability, reduce the long-term financing costs and ensure the maintenance of prudent risk levels. From a more detailed perspective, we stress the aims of the most important measures: 1) gradually increase the proportion of fixed-rate and inflation-linked share of the debt while reducing that of the FX and Selic shares; 2) lengthen the debt's maturity; and 3) implement both strategies reducing the average cost of debt.

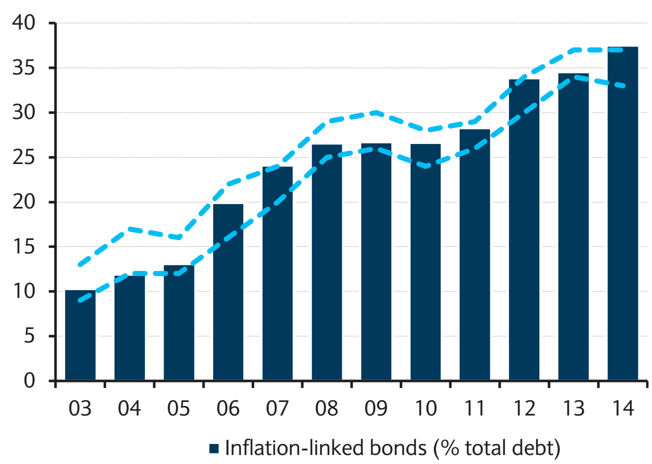
Results of this strategy became more apparent by 2003. From 2002 to April 2014, the Selic and FX-linked share of debt dropped significantly, falling to 21% from nearly 85%, while the fixed-rate and inflation-linked component moved to 79% from about 15%. From 2005 to date, the average duration of the public debt increased to 4.5y from 2.8y, while the yield of the government bonds declined considerably.

The debt management gains affected more than just public finances. Reducing the FX/Selic component enhanced the perception of fiscal solvency in periods of stress. In previous crises, the stop-and-go cycle of foreign capital forced the depreciation of the BRL, leading the BCB to start a tightening cycle to rein in inflation (observed and expected) and stem the process of currency depreciation. A weaker BRL and higher Selic rate would lift the debt-to-GDP ratio, feeding a vicious cycle of worsening fundamentals and weakening BRL. However, a larger share of fixed-rate and inflation-linked debt (smaller FX and Selic) broke this cycle and, along with large international reserves, helped pave the way for countercyclical monetary policymaking during the recent financial global meltdown.

Focusing on the evolution of the inflation-linked component, its share of total debt grew to nearly 35% in 2014 from 10% in 2003 (Figure 7 and Figure 8). From 2005-14, its average duration increased to 7.5y from 5.8y, while the yield of IPCA-linked bond dropped considerably. The yield on the NTN-B maturing in May 2017, for instance, declined to 2.5% by year-end 2012 from 8.3% in late 2008 (Figure 10) and is currently trading in the 5.8% range. In April 2014, foreign investors held 18.2% of the federal domestic debt, but they are more concentrated in the fixed-rate bonds (NTN-Fs) than in the NTN-Bs. While they hold 72% of the outstanding stock of the NTN-Fs, their share in the NTN-Bs is just 7%.

FIGURE 7

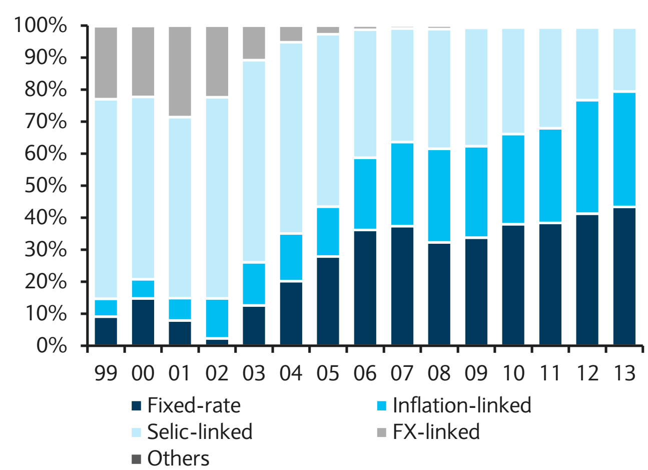
Inflation-linked bonds (% federal government debt) and target (annual borrowing plan)



Source: National Treasury, BCB, Barclays Research

FIGURE 8

Debt composition



Source: National Treasury, BCB, Barclays Research

The Brazilian Treasury 2014 financing program had a focus on decreasing the share of Selic-linked debt (LFT) by increasing the share of both fixed-rate bonds and linkers, and also to increase the duration of the federal debt. According to the financing plan, the total stock of outstanding debt in Brazil should raise to, at most, BRL2.32trn (the lower bound is BRL2.17trn from BRL2.12trn in 2013), of which the share of Selic-linked debt should fall to 14-19%, from 19.1% in 2013. Meanwhile, the sum of fixed-rate and inflation-linked debt should rise to 73-81% from 77% last year (inflation-linked bonds should reach 33-37% of the debt).

Taxation

Local residents in Brazil pay a withholding tax of 15-22.5% on the income from bonds, with the precise bracket depending on the holding period (22.5% if held for less than 180 days; 15% for periods above 720 days; and intermediate rates for holding periods in between).

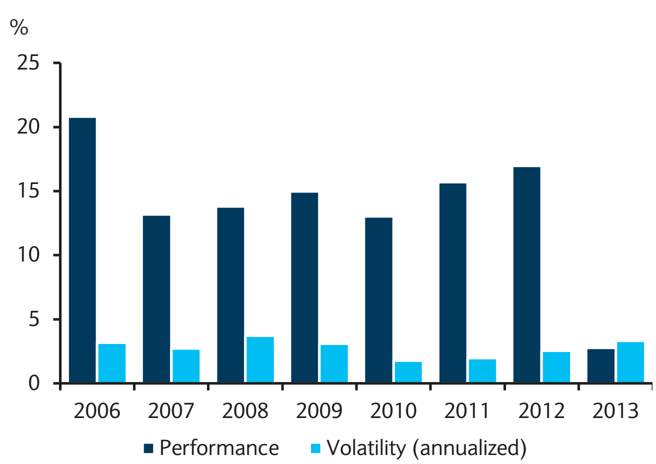
Since early 2006, the withholding income tax rate applicable to sovereign local bonds has been set to zero for foreign investors who are not in tax havens (see *www.receita.fazenda.gov.br* for a list of these). Thus, qualifying foreign investors are exempt from withholding taxes. Nonresident investors domiciled in tax havens are taxed at the same rates as local investors.

It is important to point out that a zero tax rate is different from a non-existent tax. Any new tax in Brazil has to be approved by the National Congress (both the Chamber of Deputies and the Senate), which entails political costs. Therefore, it is much simpler for the executive branch to raise the rate on a tax that already exists. The IOF tax on foreign capital flows is a good example. In October 2009, the government raised the IOF tax for fixed income to 2% from zero; in October 2010, it raised it to 4%, finally hiking it to 6% less than 30 days later. The tax is now zero again on all fixed-income inflows (except on external loans with a maturity of less than 180 days); foreign direct investment has always been exempt from the IOF tax. Also, in December 2011, the government reduced the IOF tax levied on foreign equity inflows to zero from 2.0%. There is no discrimination between long- and short-term flows.

In July 2011, the government also announced a new IOF tax on local USD derivatives markets. It was levied on all derivatives contracts with settlements that were influenced by FX changes (ie, USD options, futures and FRAs), so it was not applied to local deposit rates, commodities or other contracts. The 1% IOF was also levied on domestic investors to prevent increases in short USD positions, but the government has lowered it back to zero.

FIGURE 9

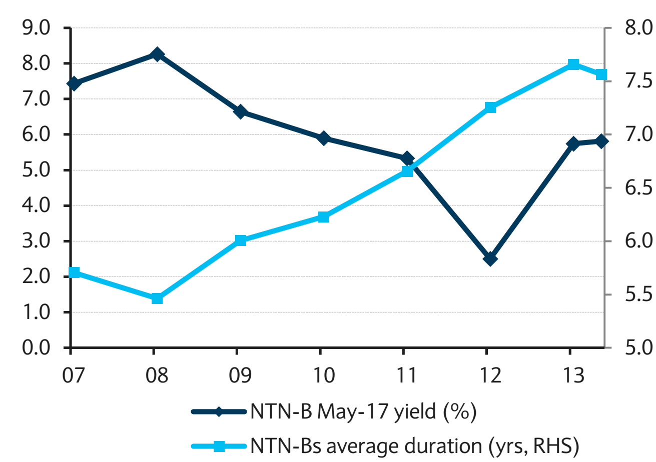
Performance and annual volatility of IMA-B 5*



Note: *IMA-B 5 is an index created by ANBIMA to value a portfolio of NTN-Bs with bonds maturing in up to 5y. Source: Bloomberg, Barclays Research

FIGURE 10

IPCA-linked debt duration and NTN-B May15 yield



Source: National Treasury, Bloomberg, Barclays Research

These measures were aimed at containing BRL's appreciation, given government concern with the industrial sector's performance and the country's overall growth rate. The government started to unwind theses measures when the market turmoil related to Fed tapering placed significant pressure on EM FX. But in any event, the taxation of foreign flows remains in the government's toolkit.

Other inflation-linked assets and derivatives

The market for corporate linkers in Brazil is still underdeveloped, with limited interest from foreign investors. This largely reflects low liquidity. Moreover, foreign investors do not enjoy the exemption from withholding taxes when purchasing private debt instruments (non-government inflation linkers are included here), which they benefited from when buying government debt.

In late 2010, however, the Brazilian government announced a set of measures to encourage long-term financing in Brazil, by basically creating incentives to foster investment projects in the country. The measures comprised two main parts: tax incentives for long-term corporate bonds earmarked for investment projects, and the creation of a fund to stimulate the liquidity of those bonds in the secondary market.

Households and foreign investors purchasing long-term fixed-rate or inflation-linked bonds that were linked to investment projects and had a minimum duration of 4y became exempt from withholding taxes. In December 2011, the government also cut the IOF tax on foreign inflows for infrastructure debentures to zero from 6%.

According to ANBIMA, the inflation-linked market (private and government) represents 21.6% of the total fixed income market. The government is by far the largest presence, accounting for 86% of the market, which leaves private issuance at 14%. Among the private fixed income market, inflation-linked assets accounts for only 6.16%

On the derivatives side, onshore inflation-linked swaps over IPCA and IGP-M are available, but with very limited liquidity and concentrated on short tenors (up to 2y). Longer tenors may be found with very large bid/ask spreads or coinciding with the maturity dates of bonds. These swaps can be registered in CETIP (OTC) or BM&F (the main local exchange) and are usually traded as zero coupon, but can also be coupon bearing. The leg of the swap linked to inflation pays the changes in the inflation index plus a real rate coupon that is quoted at the onset of the trade. The other leg of the swap is usually the accumulated overnight rate (CDI), as is also the case for the IPCA futures contract (WLA <Index> on Bloomberg), but it can also be fixed Libor plus spread or other formats.

Offshore total-return swaps are common for foreign investors looking to work around the burden of opening and managing local accounts in Brazil. Dealers with an onshore presence buy the bonds on their books and pass the total return to offshore investors though an ISDA swap. The funding leg of the swap may be CDI, the local overnight rate, or Libor, if the client wants to keep the FX exposure along with the local interest rate exposure. The reimplementation and subsequent increases in the IOF tax significantly increased international investors' interest in total-return swaps. Regular offshore swaps against CDI or Libor may also be found on a limited basis and with fairly wide bid/ask spreads. Since the local inflation swap market is not well developed, the few dealers quoting the offshore swap need duration hedges using the local linkers, leaving their books with basis risk and cash flow mismatches.

INFLATION MARKETS

Mexico

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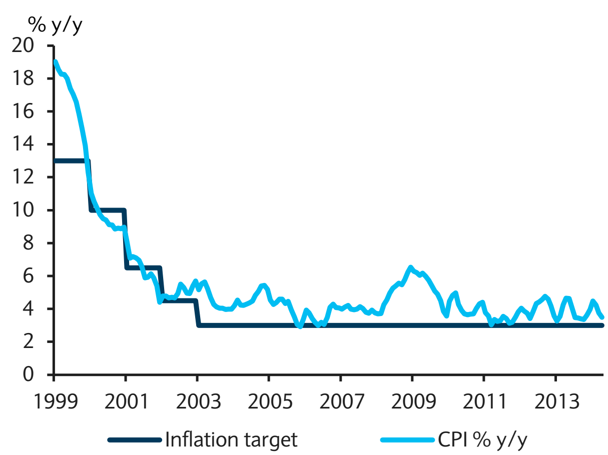
Mexico has been issuing inflation-linked bonds since 1996 with maturities up to 30 years. The inflation-linked securities (UDIBonos) represented 24.2% of the outstanding government domestic bond debt at the end of April 2014 (UDI189bn, c.USD75bn equivalent). The UDI is unusual in that it fixes off a CPI index that is published twice monthly rather than monthly. Pension funds are the largest holders of government UDIBonos, with foreigners holding about 9% at the end of May 2014, despite no restrictions or withholding tax for international investors.

Indexation

Mexico's current inflation-linked bond market started in May 1996 as a result of the 'Tequila crisis' in late 1994, as higher inflation led to accelerated amortisation of loans in real terms. The incentive was created to issue credit in UDI ("investment units" in Spanish) to preserve its real value. The central bank (Banxico) adopted the inflation targeting (IT) regime in 1999 with an initial 13% target for that year, but with the objective of bringing inflation down to 3% by 2003 and beyond. The latter has remained the target with a tolerance range of +/- 1%. As seen in Figure 1, Banxico has been fairly successful not only in obtaining the desired disinflationary path, but also in keeping inflation within the tolerance band over the past few years.

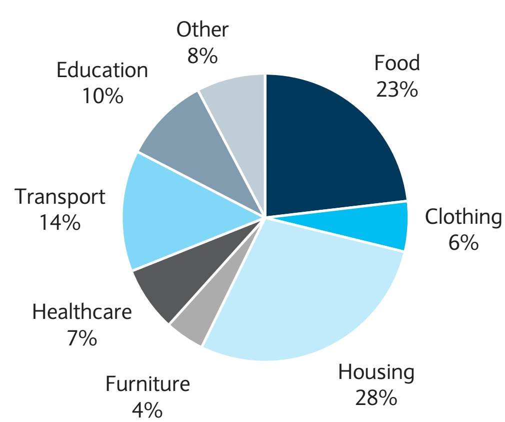
Mexico CPI (Indice Nacional de Precios al Consumidor – INPC), which was previously released by the Banco de Mexico, is currently calculated bi-weekly by the National Statistics Institute (INEGI), which releases the data on its webpage (www.inegi.org.mx) according to an annual calendar. The release occurs close to the 10th and 25th days of each month for the previous fortnight period. The CPI considers fixed weights, and the current survey is based on a representative consumption basket from 2010. Price information is collected in 46 cities and metropolitan areas. As seen in Figure 2, the housing component has the heaviest weight in the index (28.5%), followed by food (23.1%). INEGI also reports a breakdown of the headline index into core (77.4% of the total) and non-core (22.6% of the total) items. While core inflation is fairly stable over time, non-core prices inject considerable volatility into the index, particularly those of perishable food items.

FIGURE 1
Inflation dynamics



Source: INEGI, Banxico, Barclays Research

FIGURE 2
CPI weights



Source: INEGI, Barclays Research

UDIBonos have a face value of 100 UDIs (one hundred investment units). The value of the UDI is adjusted according to observed inflation; it is currently 5.129219 MXN per UDI (value of June 4, 2014, MXUDI Index in Bloomberg; see Appendix for the UDI calculation).

UDIBonos can be issued for any term as long as it is a multiple of 182 days, since the securities pay interest in pesos every six months. The real interest rate that these securities pay is fixed by the federal government upon issuance and is specified to investors in the auction announcement. Interest is calculated given the days elapsed between payment dates, on the basis of a 360-day year, and paid at the end of each payment period.

$$I_J = VN * N_J * \frac{TC}{360}$$

Where:

I_J = Interest to be paid at the end of period J

TC = Annual coupon interest rate

VN = Face value of the security in investment units (UDIs)

N_J = Term in days of coupon J

The securities are placed through auctions in which participants submit their bids for the amount they desire to purchase at the price they are willing to pay denominated in UDIs. Often, in the primary auctions, the federal government offers securities originally issued prior to their auction date. In these cases, auctions are carried out at clean prices (with no accrued interest), which means that investors have to add the accrued interest of the current coupon to the allotted price according to the following formula:

$$I_{accJ} = VN * d * \frac{TC}{360}$$

Where:

I_{accJ}= Accrued interest (rounded up to 12 decimal points and in UDIs) during period J

d= Days elapsed between the issue date or the last interest rate period (J – 1), whichever applies, and the valuation date.

For the purposes of the placement, interest payments, and amortization, the conversion to domestic currency is made at the value of the UDI on the day that the corresponding payments are made. The UDI Index (MXUDI Index <Go> in Bloomberg) is released twice a month by Banxico. It is a function of the bi-weekly inflation index and dates back to 4 April 1995. By day 10 of each month, Banxico publishes index values for the period between days 11 and 25 of that month. On day 25, it publishes values for the period between days 26 of the month and day 10 of the next month. In each period, the UDI Index changes by the daily geometric equivalent of the corresponding bi-weekly inflation rate according to:

$$UDI_t = UDI_{t-1} \times (1+\pi)^{1/n},$$

where π is the most recent reported bi-weekly inflation rate and n is the number of days between the releases (see Appendix for details).

The UDIBonos market

The UDIBonos are UDI-denominated, euro-clearable, semi-annual (182-day), coupon-bearing bonds auctioned by Banxico as agent of the Treasury (MUDI Govt <Go> in Bloomberg). As of end-2013, c.UDI183bn notional (approximately MXN924bn or USD71bn) of these bonds were outstanding. UDIBonos represent 24.2% of the c.MXN4.012trn (USD309bn) of the Mexican government domestic bond debt (ie, Cetes, MBonos, UDIBonos, and Bondes D) outstanding, a proportion that declined to 8% in 2004 from the 30% peak in the mid-1990s and recently has recovered some ground. That said, the government remains interested in developing the UDI market in light of pension funds' need to hedge future inflation-linked liabilities.

UDIBonos are quoted in real yields, with a typical bid-ask spread of 3bp, with liquidity as of May 2014 concentrated in the on-the-run Jun16 and Nov40 issues. The average trade ticket is MXN50mn. Given the 'bullet' structures of UDIBonos, the real yield calculation is simply the yield-to-maturity of the bond quoted in UDI. The total return will depend on the realisation of the UDI Index, which will affect the interest accrued and principal of the bond. Hence, other than the half-monthly inflation periods and short lag, the calculations are conceptually similar to those of the Canadian model.

FIGURE 3

UDIBonos issued

Maturity date	Issue date	Coupon	Coupon freq.	Day count	Issued (UDI bn)	% of total
Dec-14	Jan-05	4.50	Semi-annual	act/360	22.5	12.3
Jun-16	Jul-06	5.00	Semi-annual	act/360	26.3	14.4
Dec-17	Jan-08	3.50	Semi-annual	act/360	12.4	6.8
Jun-19	Jul-09	4.00	Semi-annual	act/360	11.2	6.1
Dec-20	Feb-11	2.50	Semi-annual	act/360	17.1	9.4
Jun-22	Aug-12	2.00	Semi-annual	act/360	18.5	10.1
Dec-25	Dec-05	4.50	Semi-annual	act/360	8.1	4.4
Nov-35	Dec-05	4.50	Semi-annual	act/360	21.5	11.8
Nov-40	Mar-10	4.00	Semi-annual	act/360	45.0	24.6

Source: Bloomberg, Barclays Research

As of May 2014, domestic investors hold 91% of the total outstanding amount of UDIBonos, with local pension funds the single key holders (44% of the total). Foreign investors, who are not subject to withholding taxes or any other local Mexican taxes on purchasing government securities, hold just 9.0% of the outstanding amount of these bonds.

Inflation derivatives and non-government UDI debt

OTC inflation-linked swaps are traded in both UDI/Libor and UDI/TIIE formats. The former are offshore fixed real-for-floating cross-currency swaps, with one counterparty paying/receiving a fixed UDI rate (semi-annual, Act/360) and the other receiving/paying a six-month USD Libor floating rate. Cross-currency basis risk is present in this type of swap. UDI/TIIE swaps are fixed-for-floating real rate swaps, in which one counterparty pays/receives a fixed UDI (real) rate and the other receives/pays the 28-day TIIE floating nominal rate. In both formats, the notional amount is exchanged at the start of the contract. In general, liquidity is lower than in the UDIBonos market, with typical bid/ask spreads of 10/15bp and average ticket size of MXN100m. 5y and 10y maturities exhibit the most liquidity, while 30k/50k DV01 are traded weekly.

Private sector issuance of medium-term and long-term UDI-denominated securities has been on the rise since 2003; nonetheless, it has a fairly stable participation rate in relation to other instruments, constituting 2% of total private sector issuance on average (Figure 4). UDI-denominated debt gained momentum between 2006 and 2008, but much of this acceleration came from issuance securitised against inflation-linked mortgages, and this flow fell away as global credit conditions deteriorated in the second half of 2008. Momentum returned from late 2009 to mid-2010 – while historical average monthly issuance was UDI0.5bn during that period, the monthly average reached UDI0.8bn. In the past four years (2010-2013), the monthly average issuance has stabilized around UDI0.5bn.

Appendix: UDI calculation

The UDI is calculated as follows:

$$UDI_{d,m} = UDI_{d-1,m} * \sqrt[n]{\frac{CPI_q}{CPI_{q-1}}}$$

Where:

d= Number of the day of the month “m”

m=month corresponding to “d”

$UDI_{d,m}$ =UDI value at day “d” month “m”

Depending on the number of day “d”, the formula it is adjusted and considers different CPIs:

1) For days between the 11th and 25th day of the month “m”

n=15

CPI_q=Consumer Price Index of the second fortnight of the month immediately previous to month “m”.

CPI_{q-1}=Consumer price index of the first fortnight of the month immediately previous to month “m”.

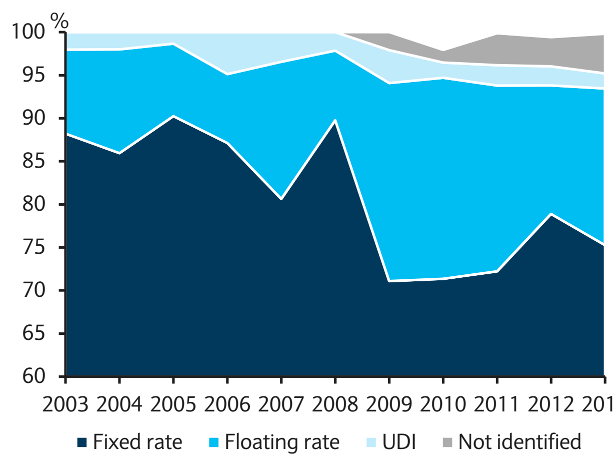
2) For days between the 26th of month “m” and the 10th day of month “m + 1”

n=Number of days between the 26th day of month “m” until the 10th day of the month “m + 1”.

CPI_q=Consumer Price Index of the first fortnight of the month “m”.

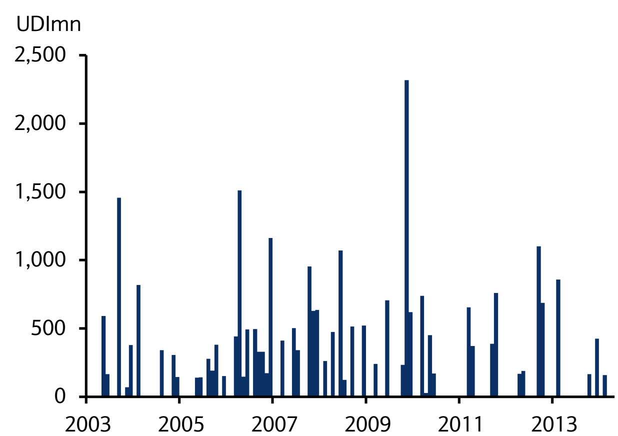
CPI_{q-1}=Consumer price index of the second fortnight of the immediate previous month to month “m”.

FIGURE 4
Private sector debt by instruments



Source: Banxico, Barclays Research

FIGURE 5
Monthly private UDI debt issuance



Source: Banxico, Barclays Research

3) For days between the 1st day and the 10th day of month “m”.

n=Number of days between the 1st day and the 10th day of month “m”.

CPI_q=Consumer Price Index of the first fortnight of the month immediately previous to month “m”.

CPI_{q-1}=Consumer price index of the second fortnight of the second month before month “m”.

Argentina

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The release of a new, more credible CPI in February 2014 has renewed interest in inflation linkers. However, a long period of inflation under-reporting has significantly reduced liquidity, and the government no longer issues in this market. A series of swaps in 2009 aimed at extending maturity and switching to nominal bonds also reduced the amount outstanding. We expect higher demand for inflation linkers as the new CPI recovers credibility and investor scars are healed.

CER Inflation-linked Index

Inflation-linked bonds issued were first issued in 2002 and linked to consumer prices via the Coeficiente de Estabilización de Referencia Index (CER). This index, launched in February 2002, is published daily by the central bank and calculated using the geometric mean of the changes in the consumer price index (CPI), with a one-month lag. CPI is calculated by the Instituto Nacional de Estadistica y Censos (INDEC), while the CER is calculated by the central bank.

The CPI methodology was changed in May 2008 to introduce a new CPI (base 2008) to replace the old CPI (base 1999). The change occurred amid controversy over inflation under-reporting by INDEC. The chosen basket is intended to represent the expenditures structure of the population considered in the National Survey of Household Expenditure (ENGH) of 2004-05. Yet despite the government's efforts, the new method was unable to restore confidence in the CPI, as the gap between private inflation gauges and official CPI inflation remains significant. In February 2014, the authorities launched a new CPI that has restored confidence in CPI statistics. The IMF is reviewing new CPI and new GDP statistics.

The index is broken down into the following nine groups (weights in parentheses): food and beverages (33.2%); transportation and communications (18.6%); housing and basic services (12.1%); medical attention and healthcare expenses (5.6%); leisure (8.3%); household equipment and maintenance (7.3%); apparel (8.7%); other goods and services (5.2%); and education (2.9%). In the first 10 working days of each month, the INDEC makes public the index corresponding to the previous month.

The CER-linked bond market

As of June 2013, government CER-linked debt totaled USD33.2bn (including loans and other non-marketable debt), or approximately 17% of Argentina's total outstanding debt. These bonds are quoted on broker screens in ARS and USD (quotes in USD use an implicit parallel exchange rate). The bid-offer spread is typically 5-10bp in real yield terms. Argentinean bonds comprise 10.4% of the Barclays EM Government Inflation-linked Bond Index.

The Argentine government stopped issuing inflation-linked debt in 2005. Coupled with the controversy over the measurement of the CPI, this has eroded the appeal of this market to institutional and other long-term investors, at whom these assets were originally targeted. In addition, the nationalisation of pension funds in October 2008 will potentially reduce the traditional demand for this kind of instruments. As well, two swaps performed in 2008 to extend maturity and switch currency denomination (to nominal bonds) have further reduced the amount outstanding of CER-denominated debt. The release of a new CPI could mean an increase of CER paper demand over time.

The structure of the marketable inflation-linked debt can be summarised as follows:

1. Bonos de reestructuración (par/discount/quasi par)

2. Bonos de Consolidación (BOCON)

3. Bonos Garantizados (BOGAR)

Bonos de reestructuración (par/discounts/quasi par)

In February 2005, Argentina extended a global exchange offer to holders of its defaulted debt. Of the USD82bn of eligible debt, about 76% was tendered by holders, who, in exchange, received par, discount, or quasi-par bonds denominated in ARS, USD, EUR or JPY. Discount and quasi-par bonds carried haircuts of 66.3% and 30.1%, respectively. All of these bonds incorporated a GDP-linked unit (or GDP warrant, as it is usually called in the market), which began to trade separately in November 2005. The government also issued par/discounts and quasi-pars regulated by Argentine local law and linked to inflation. The pars and quasi-pars were targeted at long-term local investors. As a result, trading in those bonds is less liquid than in the DISC (particularly in the quasi-par, which was customised for buy-and-hold private pension funds). Figure 2 summarises the structure of these bonds.

FIGURE 1

Par/discount and quasi-par bond structure

Bond	CCY	Issue date	Maturity	Type	Coupon	Amortisation
Par	CER	31 Dec 03	31 Dec 38	Step-up cpn/ sinking fund	0.63% first 5y, 1.18% 6-15y, 1.77% 16-25y, 2.48% thereafter*. S/A; 30/360	Am: 20 equal S/A installments starting June 30, 2029
Discount	CER	31 Dec 03	31 Dec 33	Step-up cpn/sinking fund/capitalised	2.79% first 5y, 4.06% 6-10y, 5.83% thereafter*. S/A; 30/360*	Am: 20 equal S/A installments, starting September 30, 2024 - Cap: 3.04% first 5y, 1.77% 6-10y, 0% thereafter
Quasi-par	CER	31 Dec 03	31 Dec 45	Step-up cpn/sinking fund/capitalised	0% in the first 10y, 3.31% thereafter*. S/A; 30/360	Am: 20 equal S/A installments, starting June 30, 2034. - Cap: interest fully capitalised in the first 10y

Note: *Principal is adjusted for inflation using CER Index (T-10 business days)/Initial CER (1.4549). Source: Mecon

FIGURE 2

BOCONs structure

Bond	CCY	Issue date	Maturity	Type	Coupon	Amortisation
PRE 09	CER	15 Mar 04	15 Mar 14	Sinking fund	2%* monthly; 30/360	Am: 72 equal monthly installments of 1.35% except the last two of 2.75%, starting April 15, 2008
PRO 12	CER	3 Feb 02	3 Jan 16	Sinking fund/ capitalised	2%* monthly; 30/360	Am: 120 equal installments. The first 119 of 0.84% the last one of 0.04% - Cap thru January 3, 2016
PRO 13	CER	15 Mar 04	15 Mar 24	Sinking fund	2%* monthly; 30/360	Am: 120 equal monthly installments of 0,83% except the last one of 1.23%, starting April 15, 2014

Note: *Principal is adjusted for inflation using CER index (T-10 business days). Source: Mecon

Bonos de Consolidación (BOCON)

Bonos de Consolidación (BOCON) were issued by the national government to restructure its obligations to pensioners and suppliers. They are divided into Bocones de Deudas Previsionales (Pre 8 and Pre 9) and Proveedores (Pro 11, Pro 13 and Pro 12). The Pre 08 and Pro 12 are the most liquid BOCON bonds.

An earlier series of BOCON was issued as reparation to families of victims who were jailed or "disappeared" during the military dictatorship. Re-openings of BOCON have taken place opportunistically over the past few years for amounts within those originally authorised in 2002 or for additional amounts authorised through new decrees. Individual re-openings are not reported. Figure 2 summarises the structure of some of the most liquid BOCON issues.

Bonos Garantizados (BOGAR)

Issued by the Fondo Fiduciario de Desarrollo Provincial (a trust), BOGAR bonds were used to restructure the debt of a number of provinces. Payment is secured by government guarantee, which, in turn, is secured by a pledge of up to 15% of the province's portion of shared tax revenues. Beyond that, payment is guaranteed by central government, the financial intermediation tax and remaining fiscal resources (net of what corresponds to the state-managed social security system).

FIGURE 3

BOGAR structure

Bond	CCY	Issue date	Maturity	Type	Coupon	Amortisation
BOGAR18	ARS	4 Feb 02	4 Feb 18	Sinking fund	2%* monthly; Actual/365	Am: 156 monthly rising payments, starting March 4, 2005, capitalised thru September 4, 2002
BOGAR20	ARS	4 Feb 02	4 Oct 20	Partially capitalised	2%* monthly; Actual/365	Partially capitalised: first 3y of the 2% cpn: 60% will be paid in cash, 10% will be capitalised and 30% represents the haircut. From February 4, 2005-August 4, 2005, the 2% coupon was capitalised. Paid in cash thereafter.

Note: *Principal is adjusted for inflation using CER index (T-5 business days)/Initial CER (0.9999). Source: Mecon

CER and real yield calculations

CER calculation

CER are units of account, whose value in pesos is indexed to the Argentine CPI. The CER index was fixed at 1 ARS on 2 February 2002 and tracks the Argentine CPI with a one-month lag:

$CER_t = F_t * CER_{t-1}$ where F_t is Daily CER factor

The Daily CER factor F_t is calculated as follows:

a) $F_t = \left(CPI_{j-2} / CPI_{j-3}\right)^{1/k}$ for days 1-6 of each month, the CER is based on the geometric mean of CPI variation, between the second and third month previous to the current month;

b) $F_t = \left(CPI_{j-1} / CPI_{j-2}\right)^{1/k}$ for day 7 to the last day of each month, the CER is based on the geometric mean of CPI variation during the previous month,

where *k* is the number of days in the current month and *j* is the current month.

The CER time series may be viewed on Bloomberg using the code ACERCER <Index>.

Real yield-to-maturity calculation

To calculate the real yield to maturity for CER-linked bonds, the first step is to set up the entire real cash flows structure (including amortisation and capitalisation). Since these real cash flows are essentially deterministic, to calculate the real yield to maturity, it is sufficient to solve for R in the equation:

$$\Pr ice = \sum_{t=1}^{n} \frac{c(t)}{(1 + R/q)^{qt}}$$

Where $c(t)$ is the cash flow at time t (in years) and R is the real yield to maturity q -compounded.

The only complication in this formula is adjusting the quoted all-in peso market price to take into account the change in the CER Index since inception:

$$Price = \frac{Mkt\,Price}{CER_{T-d} / CER_0}$$

where $Mkt\,Price$ is the peso price quoted, CER_{T-d} is the index level for T-d (where T is the payment and d specific number of days) and CER_0 is the base index level, fixed at inception of the specific bond. Figure 4 summarises $\frac{CER_{T-d}}{CER_0}$ for the most liquid CER-linked bonds:

FIGURE 4

Change in CER Index adjustment

Bond	CER Index at issuance	Settlement convention
BODEN 14	1.5178	T-10
par, DISC	1.4549	T-10
PRO 12	1.0000	T-10
BOGAR 18	0.9999	T-5

Note: T= payment date, d number of days. Source: Mecon, Bloomberg, Barclays Research

Taxation and capital controls

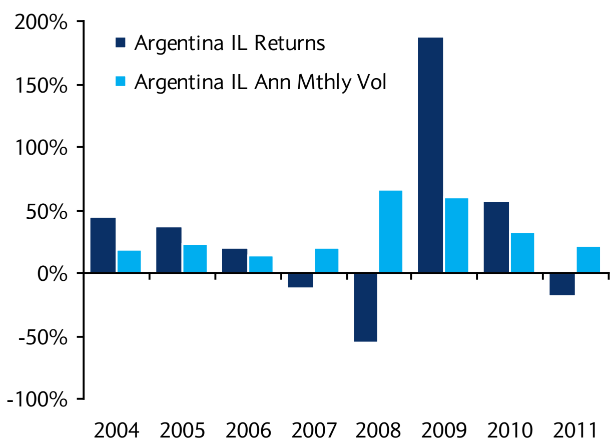
In Argentina, government and central bank bonds are subject to neither withholding tax nor income tax. However, the country has capital controls for short-term capital flows. The purchase of securities in the secondary market requires investors to deposit 30% of the total amount brought into the country, at a 0% rate.

Non-government CER debt and derivatives

There has been almost no significant non-government issuance linked to the CER Index. CER swaps have traded versus USD Libor, but activity has dried up since controversy over CPI measurements developed.

FIGURE 5

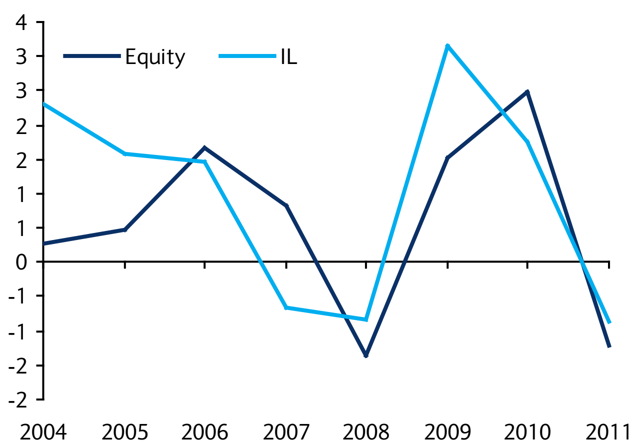
Argentinian linkers – historical performance and risk



Source: Barclays Research

FIGURE 6

Return/risk of linkers versus nominals and equities



Source: Thomson Datastream, Barclays Research

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The use of inflation-indexation is widespread in the Chilean economy. Since the introduction of the unidad de fomento (UF) in the 1960s, the role of the UF as a unit of account has grown consistently: Domestic debt instruments are mostly UF-denominated, and there is a liquid market for UF-linked derivatives. In terms of government debt, both the Chilean Central Bank (BCCh) and the Treasury issue inflation-linked debt; linkers amount to 65.3% of the more than USD56bn outstanding in debt securities issued by either the government or the BCCh.

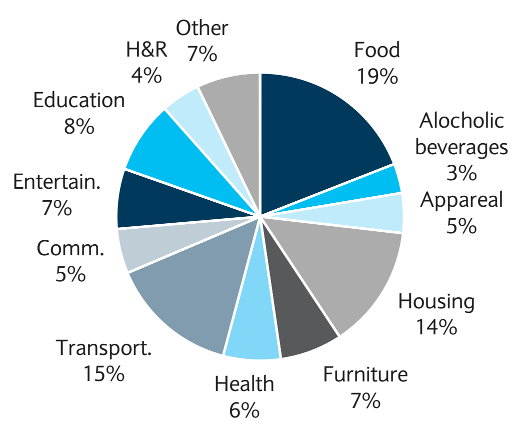
Indexation: An inflation-linked product pioneer

In 1959, Chile's economy underwent an ambitious liberalization program that included, among other measures, the deregulation of the financial sector. Interest rate ceilings and high inflation resulting in years of negative real rates had a negative effect on Chileans' propensity to save. Policies such as the indexation of savings accounts by the state-owned bank, the issuance of inflation-indexed bonds, and crucially, the creation of the "unidad de fomento" (UF), the world's first successful indexed unit of account[12], made the recovery of savings possible; private financial savings grew from less than 1% of GDP in 1965 to 2% in 1971.

Since the 1960s, the role of the UF as a unit of account in Chile's economy has consistently expanded with more than 80% of wages negotiated by unions being indexed. In addition, mortgages, car loans, taxes, pension payments, real estate, and even child support payments are UF denominated; the majority of 90-day bank deposits in Chile offer rates in terms of UF and close to 91% of non-dollar corporate bond issuances were UF-linked during 2013. Finally, approximately 65% of government debt outstanding is UF-linked.

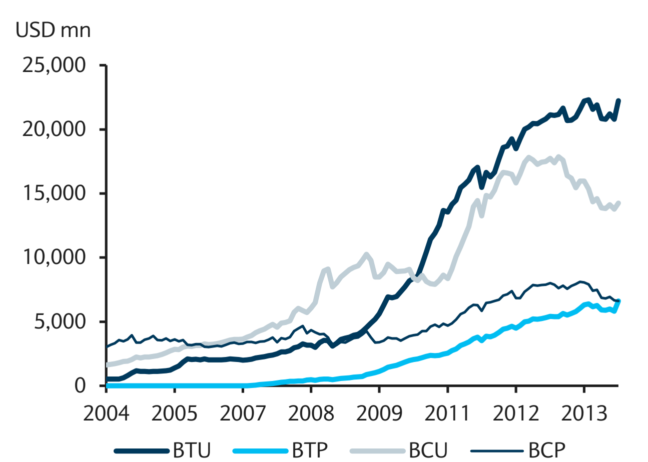
The widespread use of CPI indexation in Chile was the result of hyperinflation and powerless monetary policy. Today, the Central Bank of Chile (BCCh) sets monetary policy targeting a 3% inflation target (+/-1%) over a two-year horizon. Moreover, while domestic prices are fully flexible, Chile's openness to international movements of goods and capital and its floating exchange rate regime exposes its economy to fluctuations of commodity prices. Oil

FIGURE 1
CPI weights



Source: INE, Barclays Research

FIGURE 2
Cumulative BCCh and government bond issuances (USD mn)



Source: BCCh, Barclays Research

12 Shiller, Robert J. (1998). "Indexed Units of Account: Theory and Assessment of Historical Experience," *Cowles Foundation Discussion Paper No. 1171*.

and agricultural commodity price movements quickly pass through into the domestic economy, generating considerable CPI volatility via fuel and food prices. However, the BCCh's ample credibility is reflected in inflation expectations, which are firmly anchored at 3% over the 2y policy horizon.

The CPI is calculated by the National Institute of Statistics (INE). During the first eight days of each month, and following a pre-set calendar, INE releases the previous month's CPI. To measure CPI, INE calculates a weighted average of price changes of a set of products. Each product's price is weighted by its relative importance in a basket of goods and services chosen to reflect the consumption of the typical urban household in 2013. The average price of the basket during 2013 is set at 100, and CPI releases are not subject to revisions.

Since 1967, inflation indexation has been based almost exclusively on the UF. The UF is a lagged interpolation of the monthly CPI, and it is subject to daily adjustments since 1977. The UF Index (CHUF Index <go> in Bloomberg) is calculated and published by the central bank. The formula for computation of the UF on day *t* is:

$$UF_t = UF_{t-1} \times (1+\pi)^{1/d}$$

where π is the inflation rate for the second calendar month preceding the calendar month in which *t* falls if *t* is between the first and the ninth day of the month, and the calendar month preceding the calendar month in which *t* falls if *t* falls between the tenth and last day of the month. *d* is the number of days in the calendar month in which *t* falls, and the inflation rate is rounded to the first decimal. Note that because the inflation rate for a calendar month depends on the CPI for that month and the preceding month, during a calendar month, the UF will depend on the CPI of each of the three preceding months.

The UF-linked bond market

In Chile, both the Treasury and the BCCh issue inflation-linked debt. Although the BCCh has historically been the largest issuer of inflation-linked bonds, since 2009 the Treasury has become the country's main indexed bond issuer. Since August 2002, the BCCh has been actively seeking to re-profile domestic public debt, and since 2009, it has almost exclusively issued CLP-denominated debt such as BCPs and avoided issuing instruments such as inflation-linked PRBCs (5y, zero-coupon 'pagares'), PTFs (floating rate 'pagares'), and PRCs (coupon-bearing 4y/20y 'pagares'). However, when the BCCh has sought to influence the FX market via sterilized interventions, it has issued inflation-linked bonds or BCUs ('Bonos del Banco Central de Chile'; BCUCL Govt <go> in Bloomberg). These bonds are standard bullet bonds with semi-annual interest payments that issued in tenors of 5y, 10y, and 20y. As of May 2014, UF-linked debt amounted to 53% of the BCCh's USD27.6bn total debt.

As mentioned above, the Chilean government issues BTUs ('Bonos de la Tesoreria General de la Republica en UF'; CHILBT Govt <go> on Bloomberg) using the BCCh as its agent. BTUs are UF-denominated standard bullet bonds. The issuance of BTUs is not as regular as the BCCh's issuance of BCUs: the government's supply of debt depends on Chile's fiscal situation and is contingent on the 'structural balance' rule. In a nutshell, fiscal policy in Chile is bound by a rule that requires the government to run a cyclical (temporary) deficit (surplus) when economic activity expands below (above) its potential, which then requires higher (lower) net issuance of debt (mainly in the form of nominal BTPs and BTUs). The 2008 financial crisis increased the financing needs of the Chilean government and thus brought on an increased supply of Treasury bonds (BTPs and BTUs). However, beyond the rapid, unexpected expansion of government issued bonds during 2008 and 2009, Figure 2 shows that that over the past 10 years, the stock of inflation-linked bond issues (BCUs and BTUs) has been significantly higher than the issuance of non-indexed bonds (BTPs and BCPs) over the 2004-14 period.

Of the two main types of inflation-linked bonds, historically BCUs have been more liquid than BTUs, although in 2014 the BCCh is auctioning 10y, 20y, and 30y BTUs on a monthly basis. On the demand side, the market for inflation-linked bonds is dominated by local pension funds, which own more than half of the outstanding stock of linkers. Foreign investors do not participate much due to taxation issues and the complexity of trading them (a local custodian account is needed).

FIGURE 3

BCUs and BTUs outstanding

Maturity date	Issue date	Coupon	Coupon frequency	Day count	Outstanding UF (mn)	% total
BCUs						
Oct-15	Oct-10	3.00	Semi-annual	act/365	8.00	2.4
Jan-16	Jan-06	5.00	Semi-annual	act/365	10.37	3.2
Feb-16	Feb-11	3.00	Semi-annual	act/365	33.00	10.1
Aug-16	Sep-11	3.00	Semi-annual	act/365	22.00	6.7
Mar-17	Mar-12	3.00	Semi-annual	act/365	12.60	3.9
May-17	May-07	3.00	Semi-annual	act/365	7.70	2.4
Jul-17	Jul-12	3.00	Semi-annual	act/365	15.90	4.9
Jan-18	Jan-08	3.00	Semi-annual	act/365	13.17	4.0
Mar-18	Mar-13	3.00	Semi-annual	act/365	24.40	7.5
Jul-18	Jul-08	3.00	Semi-annual	act/365	16.63	5.1
Aug-18	Aug-13	3.00	Semi-annual	act/365	8.10	2.5
Oct-18	Oct-08	3.00	Semi-annual	act/365	5.57	1.7
May-19	May-09	3.00	Semi-annual	act/365	0.96	0.3
Feb-21	Feb-11	3.00	Semi-annual	act/365	41.30	12.6
Mar-22	Mar-12	3.00	Semi-annual	act/365	23.65	7.2
Sep-22	Sep-02	5.00	Semi-annual	act/365	8.35	2.6
Mar-23	Mar-13	3.00	Semi-annual	act/365	12.40	3.8
May-28	May-08	3.00	Semi-annual	act/365	11.48	3.5
Feb-31	Feb-11	3.00	Semi-annual	act/365	25.25	7.7
Feb-41	Feb-11	3.00	Semi-annual	act/365	25.75	7.9
				TOTAL	326.58	
Maturity date	**Issue date**	**Coupon**	**Coupon frequency**	**Day count**	**Outstanding UF (mn)**	**% total**
BTUs						
Jul-14	Jul-09	3.00	Semi-annual	act/365	13.50	3.5
Jan-15	Jan-10	3.00	Semi-annual	act/365	34.00	8.7
Sep-15	Sep-05	2.10	Semi-annual	act/365	11.00	2.8
Jan-17	Mar-12	3.00	Semi-annual	act/365	9.76	2.5
Jul-17	Jul-10	3.00	Semi-annual	act/365	42.00	10.7
Jan-19	Mar-12	3.00	Semi-annual	act/365	4.80	1.2
Jul-19	Jul-09	3.00	Semi-annual	act/365	25.00	6.4
Jan-20	Jan-10	3.00	Semi-annual	act/365	58.23	14.9
Jan-22	Jan-12	3.00	Semi-annual	act/365	27.17	7.0
Oct-23	Oct-03	4.50	Semi-annual	act/365	19.86	5.1
Jan-24	May-14	3.00	Semi-annual	act/365	5.00	1.3
May-24	May-14	3.00	Semi-annual	act/365	2.49	0.6
Aug-24	Sep-04	4.50	Semi-annual	act/365	18.00	4.6
Sep-25	Sep-05	2.60	Semi-annual	act/365	11.00	2.8
Mar-27	Mar-07	3.00	Semi-annual	act/365	10.01	2.6
Mar-28	Mar-08	3.00	Semi-annual	act/365	20.17	5.2
Mar-29	Mar-09	3.00	Semi-annual	act/365	7.95	2.0
Jan-30	Jan-10	3.00	Semi-annual	act/365	44.00	11.3
Jan-32	Jan-12	3.00	Semi-annual	act/365	22.57	5.8
Jan-34	May-14	3.00	Semi-annual	act/365	4.30	1.1
				TOTAL	390.81	

Source: Bloomberg, Barclays Research

Taxation

Chile has a general flat 4% tax rate for interest earned by foreigners in the domestic market. This rate applies to the BCU rate, not to earnings due to indexation (in general, the Chilean tax system considers tax bases that are CPI deflated). Capital gains, however, have a more cumbersome treatment. The general rule for bonds is that they pay the general income tax, which is 35% for foreigners. However, if the investor is domiciled in a country with which Chile has a double-taxation treaty, the tax is zero.

Non-government UF debt and derivatives

More than 88% of the 408 corporate bonds outstanding at the end of April 2014 were UF-denominated; in the government bond market, local pension funds and insurance companies are the largest holders.

Linkers also have a presence among derivatives. In particular, there are two swaps traded OTC that involve inflation linked instruments: the UF/Camara swap; and the UF/Libor swap. The UF/Camara swap is a fixed-for-floating contract in which one of the counterparties pays/receives a fixed UF rate, while the other counterparty receives/pays a floating nominal rate that depends on the 'Indice de Camara Promedio' (ICP). The ICP Index reflects the funding cost incurred by local financial institutions and is published every day by Chile's banking association (*www.abif.cl*). The index depends on the 'Tasa Camara Interbancaria Promedio', which is the average O/N interbank interest rate set by the central bank. The UF/Libor swap is an offshore, fixed-for-floating cross-currency swap. The swap requires one of the counterparties to pay/receive a fixed UF rate, while the other receives/pays the 6m USD Libor floating rate.

In both of the swaps described above, coupons are exchanged semi-annually and proper accounting follows an ACT/360-day count convention, with notional amounts exchanged at the start of the swaps. Note that it is also possible to trade the floating real rate against fixed real rate swaps, where the nominal ICP deflated by the UF index pins down the floating real rate. These swaps are mostly traded in the interbank market, whereas foreign hedge funds are more active in the nominal swap market. Local corporations use these markets for liability management.

Finally, there is also a liquid market of inflation rate forwards (up to 1y) in which investors can directly express their views on inflation rates. These forwards, combined with a nominal-swap position, can span the instruments necessary to trade UF-denominated swaps synthetically.

INFLATION MARKETS

Colombia

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Inflation-linked bonds were first issued in 1967, and the market has grown steadily since then. About a quarter of government debt is linked to CPI via the UVR indexing unit. Taxation has been an issue limiting non-residents investment in these instruments, but recent tax reforms have increased the interest from international investors.

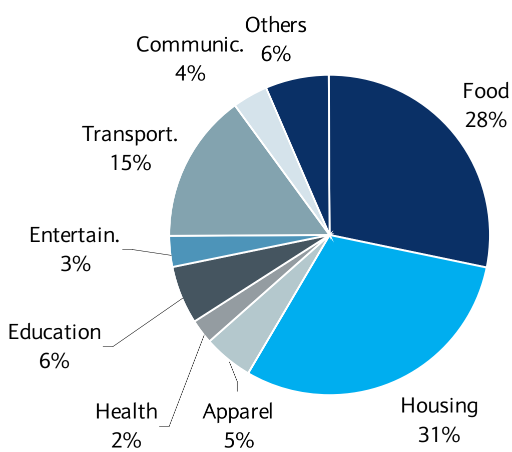
Indexation

Colombia's central bank (Banrep) conducts monetary policy within an inflation-targeting framework. In October 2009, Banrep set the 2010 inflation target in line with its long-term goal of 3% (in a +/-1% tolerance range), culminating in successful gradual target reductions and inflation convergence, in place since the inception of the inflation-targeting regime. Banrep has tended to adopt one of the most hawkish monetary policies in Latin America. Even with still-benign inflation and limited risks of GDP growing beyond its potential, Banrep has decided to normalize interest rates and start an early hiking cycle, showing a strong commitment to keep inflation in line with its target. Recent appreciation of the COP should help keep inflation around the target in the coming months; however, a reversion of this trend in the FX market, as US monetary policy becomes less expansionary, would put upside risks in the medium term. Energy prices are regulated relatively heavily and typically reflect international prices more smoothly and with a lag.

CPI inflation is calculated monthly by the statistics office ('Departamento Administrativo Nacional de Estadistica' – DANE). The CPI has December 2008 as its base, with the consumption basket weights fixed and representing the consumption survey of 2006-07. Geographical coverage includes the urban population of 24 cities. The CPI represents average monthly prices and is released by the fifth day of the following month.

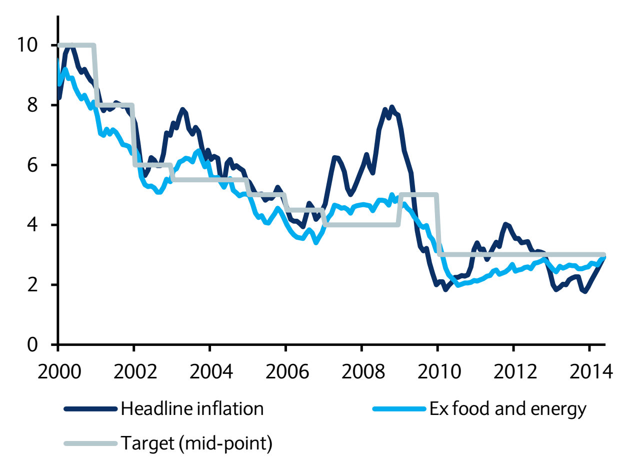
Since August 2000, the inflation indexing unit has been the 'Unidad de Valor Real' (UVR Index <go> in Bloomberg), which is calculated/published by Banrep based on DANE's CPI inflation rate for the previous month. The UVR Index is adjusted daily between the 16th day of the current month and the 15th day of the following month. For any day t within this period, the UVR is given by:

FIGURE 1
CPI weights



Source: DANE, Barclays Research

FIGURE 2
Inflation dynamics



Source: DANE, Banrep, Barclays Research

$$UVR_t = UVR_{15} \times (1 + \pi_{m-1},1)^{t/d}$$

where UVR_{15} is the index value in day 15 of the previous month, π_{m-1} is the previous month's m/m inflation rate and d is the number of days in the period.

The UVR-linked market

While there are two types of linkers, the UVR-denominated are the most liquid (SENC1 <go>, second page in Bloomberg). These are fixed-rate, coupon-bearing bonds. As of end-April 2014, total gross domestic debt was COP202trn (USD107bn), out of which coupon-bearing TES bonds (nominal and UVR-linked) represented 94%. Fixed-rate, UVR-denominated debt represented nearly 23% of the aforementioned total.

Liquidity varies significantly depending on market sentiment. In a rallying market, the typical bid/ask spread is 5bp for the most liquid paper and 10bp for their illiquid counterparts. When the market is under pressure, the liquid bonds' bid/ask spread widens to 10bp, while quotes for other bonds are practically non-existent. The average ticket size is UVR20mn, and many days can pass without activity in this market.

The UVR/Libor OTC is a swap that used to trade but is now practically non-existent. This swap was an offshore fix-for-floating cross-currency swap in which a counterparty pays/receives a fixed UVR rate (semi-annual, Act/360) and the other receives/pays 6mth USD Libor floating. When and if prices are provided, bid/ask spreads are very wide. When inflation-linked corporate deals occur, activity in this market rises, although this is sporadic.

Taxation

Taxation issues have been a limiting factor for foreign investor participation in the UVR-linked bond market because they were subject to withholding tax on income and capital gains, in addition to being subject to a 0.4% financial transaction tax. Nonetheless, the most recent tax reform reduced the income tax (from 25% to 14%) on profits derived by foreign portfolio investors who do not reside in the jurisdiction identified as tax haven by the Colombian government. This has been an incentive that has increase the participation of foreign investors in the local bond market, more than doubling it from 4% at the beginning of 2013 to about 9% as of May 2014.

Uruguay

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Uruguay resorted to an inflation index after the 2002 financial crisis, to create a local currency market in light of widespread financial dollarisation and high, uncertain inflation expectations. Owing to the government's effort, the market expansion has been sustained.

The inflation-linked bond market was created as part of a consistent effort to provide a dollar substitute and is continuing at a growing speed. To foster this market, in 2002, the Uruguayan government replaced the old Unidad Reajustable (UR), which was adjusted with a wage index, with a newly created Unidad Indexada (UI), which was adjusted with the CPI.

CPI and the Unidad Indexada (UI)

The CPI is calculated by the national statistics agency, INE, on monthly basis and is released over the first five days of each calendar month, covering the period of the previous month. The index is based on March 1999 and prices are collected in Montevideo.

The UI was introduced in June 2002, with its level set at 1 Uruguayan peso per UI, and is calculated and published by the INE. The level of UI is calculated on a daily basis from the sixth day of the month up to the fifth day of the following month, using CPI levels from the previous month. Specifically, the daily factor $UI_{d,,M}$ is computed according to the following formulas:

a) $UI_{d,M} = UI_{5,M-1}\left(\frac{CPI_{M-2}}{CPI_{M-3}}\right)^{\frac{d+D_{M-1}-5}{D_{M-1}}}$ from the first day of month M up to the fifth day;

b) $UI_{d,M} = UI_{5,M}\left(\frac{CPI_{M-1}}{CPI_{M-2}}\right)^{\frac{d-5}{D_M}}$ from the sixth day of month M to the end of the month,

where D_M represents the amount of calendar days in month M and CPI_M corresponds to the CPI level in month M.

Inflation-linked bonds

Since the creation of the UI, the government has issued several types of bonds linked to the index – in particular, Letras, Notas BCU and Notas del Tesoro – with initial maturities ranging between three year and 10 years. Recently, there has been a notably larger supply in UI-denominated global bonds in maturities that go up to 2025.

INFLATION MARKETS

India

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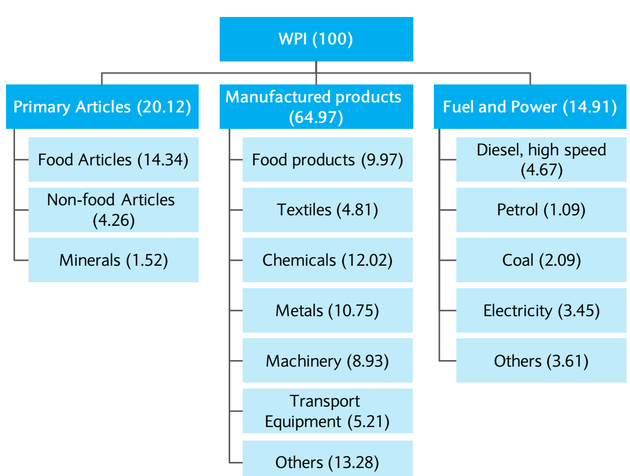
India issued its first 10y ILB in June 2013 using a standard Canadian format linked to WPI inflation, but with a four month lag. The current amount outstanding is USD1bn; the government has not re-opened the bond since January 2014 and market liquidity remains poor. The RBI issued a CPI-linked ILB in 2014, but only for retail investors.

The wholesale price index (WPI) and its major constituents

India's wholesale price index (WPI) is compiled and published by the Ministry of Commerce and Industry. The WPI basket is broadly divided in three segments: primary articles (weight ~20%); fuel and power (~15%); and manufactured products (~65%). Looking more closely at the basket, we highlight that:

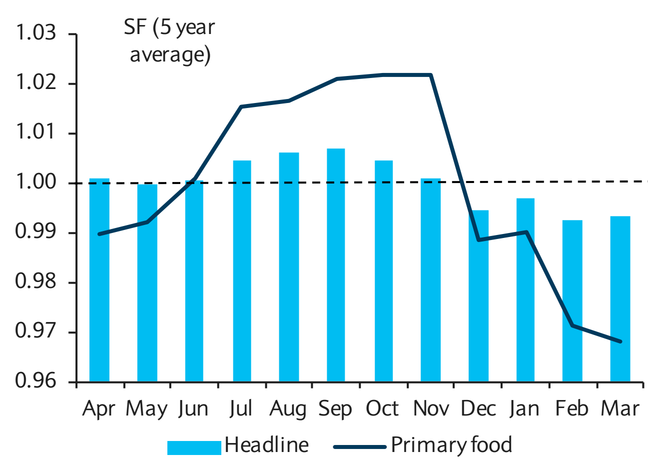
- The primary articles group comprises food, non-food articles (eg, fibres, oilseeds), and minerals. Prices of food/agriculture commodities exhibit strong seasonality and generally reflect downward rigidities. In recent years, increases in minimum support prices (MSP) of agricultural commodities have been a key source of upside on commodity prices, even during years of good harvests.
- Diesel, electricity and coal are three key constituents of the fuel and power group. Within the fuel group, prices of several commodities, including diesel (weight 4.67%), LPG (0.91%), kerosene (0.74%) and electricity (3.45%), are administered.
- On the other hand, prices of aviation fuel, naphtha and bitumen are not administered. Also, prices for bulk purchases of diesel fuel, which account for 15-20% of overall diesel demand, have been linked to market prices since January 2013. Officially, the price of petrol (weight 1.09%) is not administered, but the government owned companies set prices on a bi-weekly basis.
- Manufactured products have the largest weight of the WPI basket. The trend in prices in this segment, excluding food products – commonly referred to as non-food manufacturing products (weight ~55% of overall WPI) – is considered the measure of

FIGURE 1
WPI and its major constituents



Source: GoI, Barclays Research

FIGURE 2
Seasonality remains high in case of WPI; food items the key source of seasonality



Note: SF – Seasonal factor. Source: Haver Analytics, Barclays Research "core" inflation in India. Among the various commodities included in the manufactured products segment, textiles, chemicals, metals and machinery remain the key drivers.

- The WPI does not reflect prices of services or assets.
- Seasonality is strong in case of WPI. Primary articles, which account for ~20% of the WPI basket has the strongest seasonality.

The WPI is released monthly; typically, the provisional data for a given month are released around the 14th day of the following month. Usually, the provisional figure is revised two months after it is released. The WPI basket is modified periodically. However, the time between revisions is not rigid. The base year for the current basket is FY 04-05.

Government bonds

Market development

The Indian government started issuing a 10y WPI linked inflation-linked bond (ILB) in June 2013, and has re-opened it seven times, taking the total amount outstanding to INR65bn (USD1bn). The government's main motivation for issuing linkers, however, was to offer Indian retail investors an inflation-protected savings vehicle as an alternative to gold. Gold imports were one of the main drivers behind the 2011-13 spike in India's current account deficit. However, as the RBI's emphasis on WPI reduced, the government has stopped issuing the WPI inflation linked bonds, and the market volumes of the existing bond have become negligible.

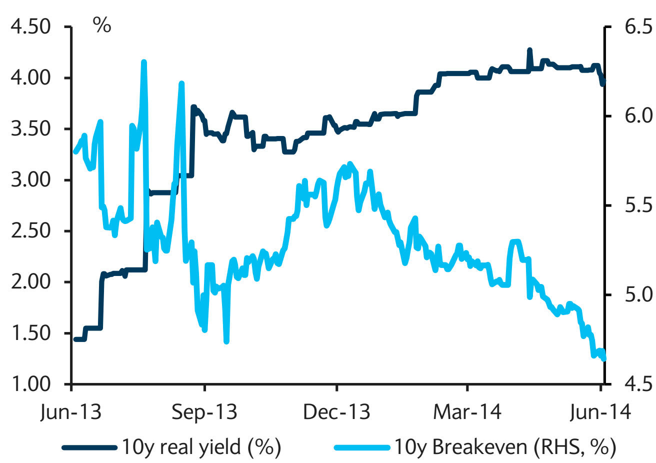
In fact, since late 2013, the CPI has become the key inflation metric tracked by the RBI, and the government issued a CPI linked inflation linked bond for retail investors. Institutional investors were not allowed to invest in such bonds. Going forward, if the government starts issuing ILBs for institutional investors at all, they are likely to be linked to CPI, and the WPI linked ILB may never be re-opened again.

Calculations

The tenor of issuance was 10y (2023 bond). The bond's structure is a standard Canadian model, with principal linked to the WPI and with a four-month lag. The bond has a semi-annual and T+1 settlement. The detailed circular on the RBI's website indicates that there will be a floor on the principal at par. For more details, please visit the RBI's Web site – *click here*.

FIGURE 3

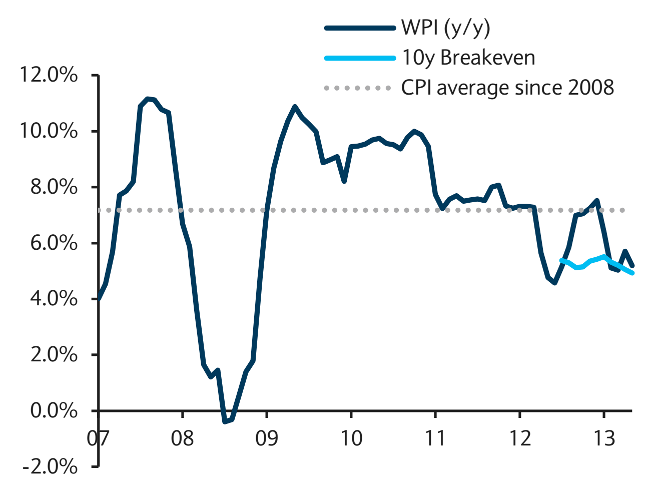
10y ILB has cheapened after it's 'rich' inaugural issuance



Source: Bloomberg, Barclays Research

FIGURE 4

Historical WPI and Breakeven



Source: Barclays Research, Bloomberg

For settlement on the first day of any calendar month, the WPI from four months previously is the reference WPI for that date. A reference WPI value is calculated for every day based on the WPI values for four months and three months prior to the month containing the settlement date. The reference WPI for any day during the month is calculated by linear interpolation.

Reference CPI for day d of month t:

$$\frac{(d-1)}{m}\left(CPI_{t-3} - CPI_{t-4}\right) + CPI_{t-4}$$

d = day of the month – eg, 1st implies d=1
m = number of days in that month

The indexation factor is the reference WPI for the settlement date divided by the reference WPI for the base date. Coupons are accrued on an actual/actual basis and paid semi-annually.

Foreign participation

According to the RBI's call with analysts on 20 May 2013, foreign participants can purchase ILBs through the regular FII quota route.

Tax implications

According to the RBI's call with analysts on 20 May 2013, ILBs will be taxed similarly to nominal IGBs and there will be no special treatment for the bonds. Based on the rules announced by the government in 2013, the withholding tax on government bonds was eased to 5% effective 1 June 2013. A short-term (one-year holding period or less) capital gains tax of 30% or a long-term capital gains tax of 10% are imposed. Given that higher-coupon bonds are likely to outperform lower-coupon bonds in this tax regime, inflation-linked bonds are likely to face higher capital gains taxes than nominals. This should also imply a slightly higher tax premium in the real yield, from a foreign investor's perspective.

Eligibility for SLR securities

Under the statutory liquidity ratio (SLR), Indian commercial banks are required to keep some portion of their total NDTL (liabilities) in liquid instruments, in order to control the expansion of bank credit. Since government bonds and bills already qualify as SLR securities, the government-issued ILBs will also qualify as SLR securities.

Israel

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In Israel's domestic bond market, the CPI-linked bonds issued by the sovereign and corporates are in the majority. However, the share of bonds linked to CPI has been falling, as the sovereign issuer has been reducing the issuance of linkers and floating rate bonds in favour of shekel (unlinked) bonds.

CPI calculation

The inflation reference for linked bonds in Israel is the consumer price index (CPI). This is calculated and published on the 15th of each month by Israel's Central Bureau of Statistics. CPI is calculated from a monthly survey of about 1,300 goods and services, by surveys or by phone, of c.3,000 stores, business and households in c.100 localities. The weightings in the basket are based on the household expenditure survey and are changed every few years. No schedule has been given for the next change, but revisions tend to be modest. Housing and house maintenance costs have increased in the share of the index.

FIGURE 1
Israel's CPI basket (weights of different components)

	2003	2008	2013
Food	16.99%	17.06%	16.55%
Housing and house maintenance	32.91%	31.56%	34.89%
Furniture and home equipment	4.75%	3.83%	3.74%
Clothing & footwear	2.90%	3.42%	3.05%
Health	4.85%	5.18%	5.22%
Education & culture	12.93%	12.94%	11.68%
Transport	20.26%	21.11%	20.62%
Miscellaneous	4.41%	4.90%	4.25%

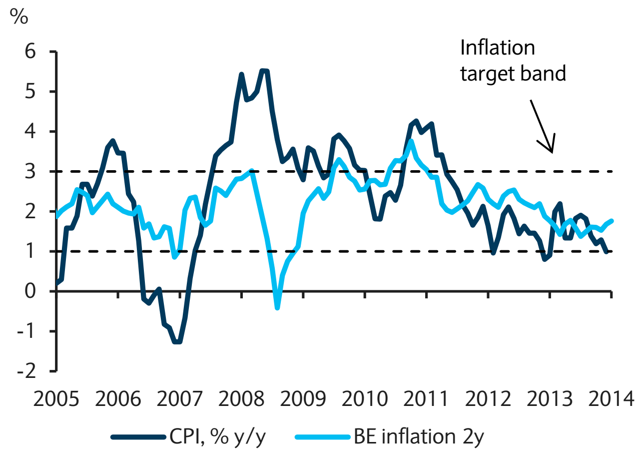
Source: Central Bureau of Statistics

Formal inflation-targeting regime

The central bank law formally entrenches the inflation target as the monetary regime. This has been in place since 2012. The inflation target is 1-3% annual CPI growth. The monetary policy council meets on a monthly basis to decide on policy rates and exchange rate policy as well. The central bank's exchange rate policy decisions are also framed around the inflation target. As Figures 2 and 3 illustrate, Israel's trend inflation has been within the 1-3% target since early 2005, and the time spent outside the band has been short lived. The anti-inflation credibility of the central bank is high, even though formal inflation targeting is a recent development.

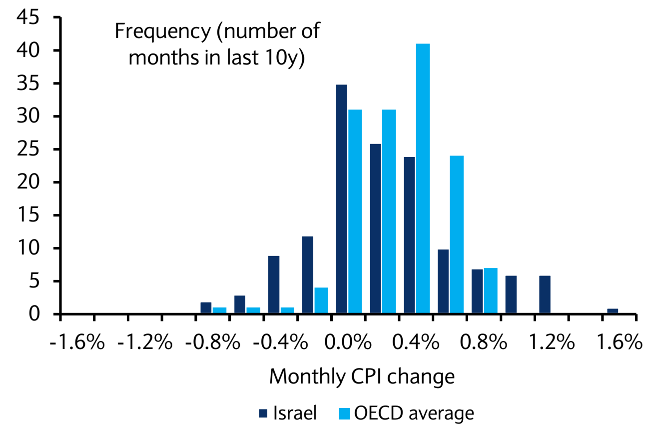
The very subdued inflation trend in Israel in the past two years has been a function of global factors (which we expect to gradually subside), as well as more persistent domestic developments. The major downward pressure has come from strong government scrutiny on competitive practices by service providers. This has dovetailed with considerable downward pressure on local energy costs, which have kept service prices contained. In our assessment, the increased gas production capacity in Israel is likely to keep energy costs subdued for the foreseeable future, which should offset cyclical upward pressures. The central bank has kept interest rates low for a long period due to these price forces and while this stance may eventually feed through to fast credit and price growth somewhere in the economy, we do not see a need for a policy reversal in 2014. As a result, the low real yield levels in Israel can persist and breakevens can similarly be lower for longer, in our view.

FIGURE 2
Inflation has kept within the target range…



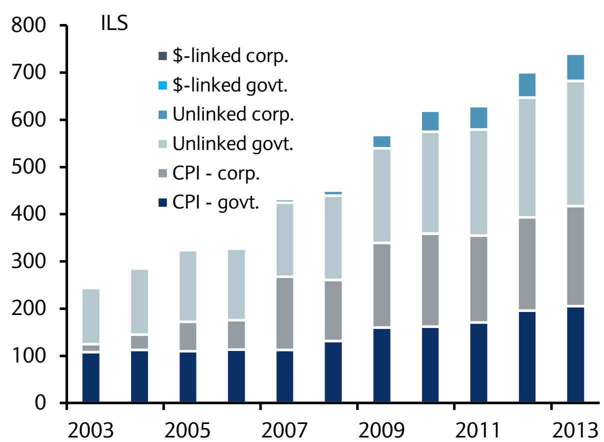
Source: Barclays Research

FIGURE 3
… but the tails on monthly changes are still greater than the CPI changes in other economies



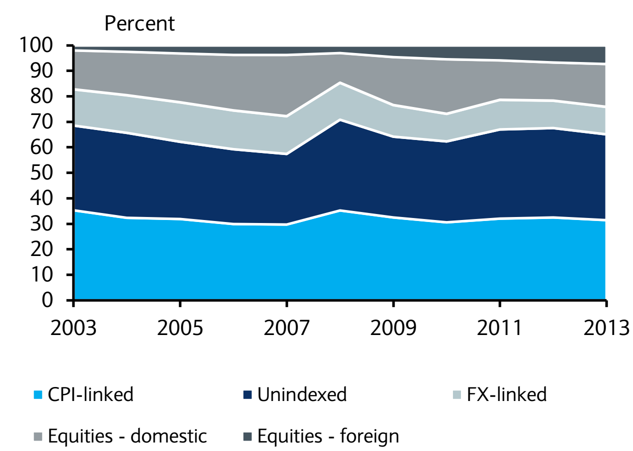
Source: Barclays Research

FIGURE 4
Distribution of tradable debt by type (%)



Source: Ministry of Finance, Barclays Research

FIGURE 5
Israel's private sector financial asset holdings (%)



Source: Ministry of Finance, Barclays Research

Large and stable linker market

At the end of 2013, the total amount outstanding of CPI-linked bonds in Israel was ILS417bn, comprising ILS205bn in government linkers and ILS202bn in corporate linkers. CPI linkers were 43% of tradeable government bonds and 78% of domestic corporate bonds. The sovereign linker market comprises the traditional 'Galil' bonds and a more conventional type of CPI-linked bond. The latter was issued from 2006 onwards, and the main difference from the Galil bonds is the absence of a deflation floor for the value of the bond's principal and coupon. This can have pricing implications during downturns in inflation, particularly because the positive and negative tail risks on CPI changes have been large in Israel historically (Figure 3). With the low inflation prints in the past few years, we expect the old style 'Galil' bonds to command a small premia over the new instruments.

The newer inflation-linked bonds have a longer maturity (out to 30y) than the Galil bonds, which were originally up to 30y but now have a remaining maturity of only about 10y. The newer CPI-linked bonds are tapped on a monthly basis. While the sovereign linker market is still very large, the nominal curve has caught up in terms of depth and breadth. The sovereign nominal curve is now longer in maturity than the CPI linkers and in most maturity buckets is traded more actively than the linkers as well. The exception is at the longer end, where the linker is still more liquid. We think the build-up of the nominal sovereign curve will continue, and the target of the ministry of finance is, in our opinion, to reduce the share of CPI-linked and floating bonds in sovereign debt and increase the shekel (non-linked) share.

Calculations

The annual coupons on Galil bonds are fixed real rates, while the value of principal is enlarged by the rate at which CPI has increased between the base date and the latest inflation observation. Indexation has a one- to a one-and-a-half-month lag; for example, the base CPI for a Galil bond issued on 20 August 2001 is the CPI for July 2001. Both the coupon and redemption value of Galil bonds in Israel have implicit floors against deflation. By contrast, the value of the principal of the new inflation-linked bonds can rise and fall with the change in CPI relative to the base CPI (ie, the latest CPI when the bond was first issued). Another difference between Galil bonds and the new CPI-linked bonds is the method of computing interest payments. For Galil bonds, a multiplicative formula is used:

$$R = \{ (1+ r/100) ^\wedge (T/365) -1 \} * 100$$

Where R = interest rate for the interest period; r = the fixed interest rate and T= number of days in the interest period.

For the new CPI-linked bonds, the interest payment is computed more simply as:

$$R = r*T/365$$

The key difference between Israeli inflation-linked bonds and those of most other markets is that there is no official daily referenced index, so the principal and coupon can have step moves according to the release of the latest CPI report.

The format of the linkage is as follows:

Principal payment = (M 1 / M 0) * 100

Coupon payment = (M 1 / M 0) * 100 * Real Coupon

Where M 1 = latest CPI at the time of payment and M 0 = base CPI, or CPI known when the bond was first issued.

The quoting convention is to use full uplifted prices. The latest CPI report is used to compute the index ratio from time of issue; this index is used to deflate the uplifted price and, hence, derive the implied real yield. As mentioned above, this induces volatility in the yield levels around CPI release dates.

Non-government bonds and derivatives

It is possible to trade inflation swaps on request, and much of the current activity in this sphere is undertaken by Israeli corporates hedging their balance sheet exposures. One of the more common products is real rate swaps in which the floating leg is 3m Telbor and the fixed leg is the real rate uplifted again by the ratio of the most recent CPI index over the CPI index at start. This market is likely to grow over the coming months and years as local corporates and banks adopt more sophisticated approaches to liability management and foreign interest in creating global inflation exposure increases.

INFLATION MARKETS

Turkey

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The Treasury of Turkey has consistently supported the linker market. CPI-linked instruments have been issued regularly and are likely to remain one of the benchmark linker markets in the foreseeable future. The Treasury tends to auction 5-10y linkers every two to three months. As a result of the consistent sovereign issuance program, the linker market now has capitalisation of about TRY107bn (USD51bn) in notional size as of the end of April 2014, dominated by government bonds.

Consumer price inflation

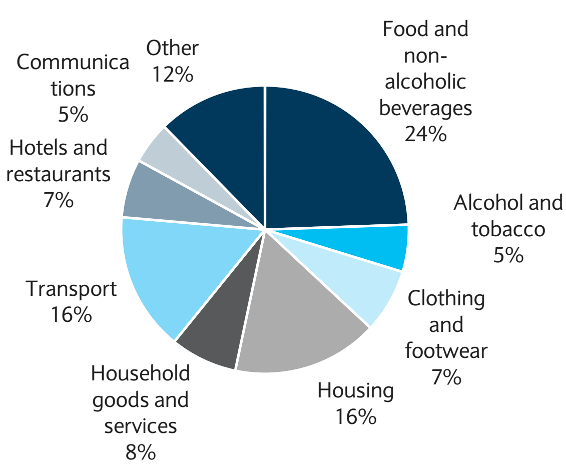
The reference price index for linker bonds in Turkey is based on CPI, which in turn is calculated and published by the Turkish Statistical Institute. The CPI is published on the third day after the reference month and covers 26 regions, 81 provinces and 447 items. Generally, prices are collected twice each month (four times each month for vegetables, fruits, and petroleum products), and prices include any relevant taxes. Weightings and the item basket are updated annually using continuous household budget surveys. The data are seasonally unadjusted.

Turkey's CPI seasonality pattern is strong and largely related to harvest-dependent patterns in unprocessed, locally produced, food prices. As a result, inflation tends to fall below the trend in June-August after a fall in food prices, while in October, there is usually an upward swing. Although this pattern is relatively stable, the distribution of monthly inflation changes is far from being a normal distribution and has been skewed to the right. The fat tails of the distribution are caused not only by the strong seasonality of food prices, but also by tax hikes and discrete changes in controlled prices (mainly from energy-related items). Finally, in the month of Ramadan, food prices pressure tends to be pushed upwards by strong household consumption. The applicable month varies by year (June-July in 2014), which means uncertainty regarding the related peak in food prices.

Central bank and monetary policy

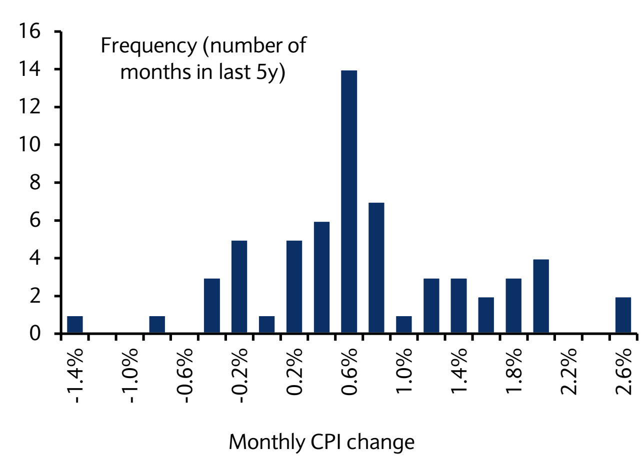
Inflation targeting by the central bank formally began at the start of 2006. However, the inflation targets have been overshot repeatedly; since the inflation-targeting regime began, the central bank has met its target only twice. The target for the 2014 is 5%, and the CBT

FIGURE 1
Composition of Turkey's CPI basket



Source: Turkish Statistical Institute

FIGURE 2
M/m inflation distribution, April 2009 – May 2014



Source: Turkish Statistical Institute, Bloomberg, Barclays Research has indicated that this target would be kept for the foreseeable future. The target applies for December of each year with a formal +/-2% tolerance band. The tolerance band is of low relevance for investors, as there is no formal sanction if the target is missed. Furthermore, since 2011, the CBT has included 'financial stability' as an additional goal of policy. Inflation is still the formal target, but the CBT has tended to place significant weight on financial stability and considers the effect of cross-border capital flows on financial stability in its monetary policy and FX management decisions.

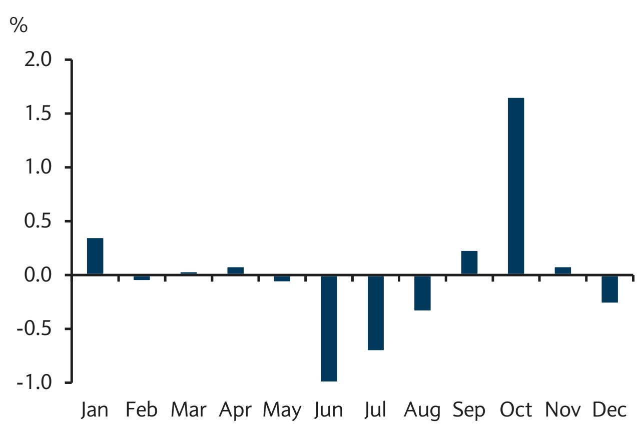
Turkish financial markets (FX and bonds) have been more prone to high volatility, in our assessment, because of the central bank's additional objectives. Simplifying somewhat, periods of strong border capital inflows and currency appreciation pressure in Turkey tend to be met with interest rate cuts and FX buying by the central bank. The reverse has been true during periods of outflows. Inflation in Turkey continues to suffer from significant FX pass-through: the CBT estimates a 15% pass-through from changes in the trade-weighted value of the nominal exchange rate to CPI inflation, with most coming through in six months (two-thirds) and the full effect twelve months. The pass-through coefficient is a little bit less than in the past (we estimated about a 20% pass-through in 2012), but the relationship between FX and CPI does mean that during periods of strong capital inflows, short-term real yields and implied BE can move in synch (ie, pulled down by interest rate cuts and headline inflation declines). The reverse is applicable during periods of strong capital outflows.

Market development

The Turkish Treasury re-entered the linker market in February 2007 with a new instrument that followed the international standard for CPI linkers (see below). A small amount of inflation-linked bonds (importantly, in a different format) had been issued in the 1990s, but were redeemed in 2000 and never enjoyed great popularity. The initial launch of the February 2012 10% CPI-linked bond (TRY4.0bn, ~US$3.0bn sold) was met with strong demand, and quarterly taps of the 2012 issue raised the nominal amount outstanding to USD5.4bn by end-2007. In 2008, the Treasury held three auctions of 2012 and 2013 bonds for a total of TRY2.4bn. Initially, local banks were sceptical about the new instruments, perhaps based on the negative experience from the 1990s, yet seemed to gain more interest in the product as a consequence of the 2008-09 crises. But as the linker market has grown in size and TRY-floating rate bonds have been scarcer, banks have become active participants in the linker market.

FIGURE 3

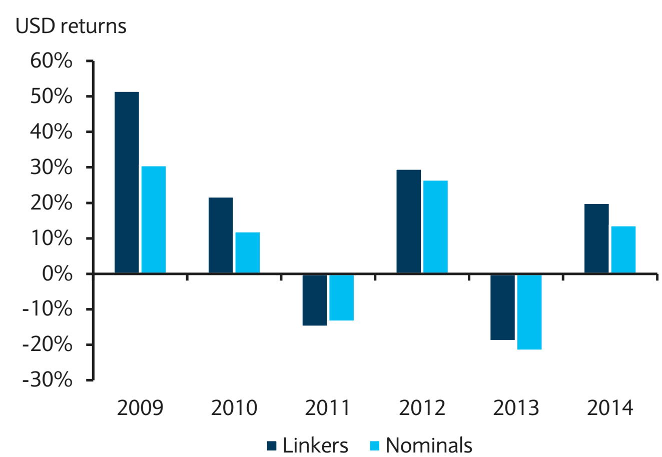
CPI Inflation Seasonality 2009-13 average divergence from trend



Source: Turkish Statistical Institute

FIGURE 4

Performance of Turkey in Barclays local government bond indices (USD total returns)



Source: Bloomberg

Since 2007, when the new linkers program started, the Treasury has placed TRY107bn of linkers, amounting to 18% of outstanding domestic government debt. The TRY linker market is still less liquid than the nominal bond market, but the linker price swings have decreased considerably, even amid local market stress (during the global financial crisis in 2008, linker real yields rose to above 20% in line with nominal yields but implying a somewhat untenable zero BE). The real yield swings since 2008 have been moderating, and, importantly, the resulting BE have continued to hold about +/-3 percentage points around the prevailing inflation target.

It is difficult for investors to express a pure inflation view through the linkers because their repo market is not developed enough to accommodate sizeable short positions. Synthetic/structured inflation investment positions are possible by using cross-currency swaps, but these too are illiquid, and investors would also need to assume the asset swap spread risk. As yet, there has been no significant activity in inflation swaps.

Calculations

Inflation-linked bonds in Turkey follow a Canadian format: a fixed annual coupon bond, with the principal value changing by the reference index, linked to CPI with a two- to three-month lag. The Treasury updates the daily reference series for linkers after a new CPI report is published. Turkish linkers are protected against deflation by a par floor.

The format of the bond is as follows:

*Principal value = (Reference index maturity/Reference index issue data) * 100*

Existing bonds have a coupon of 10% in real terms paid semi-annually. They are indexed against inflation as outlined below:

*Coupon payment = (Reference index coupon date/Reference index issue date) * 100 * Real coupon rate;*

Daily reference index = CPI a-3 + (G-1 / AG) * (CPI a-2 – CPI a-3);

Where CPI a-2 = CPI of (a-2) month and G = number of past days in month “a”;

Where CPI a-3 = CPI of (a-3) month and AG = number of total days in month “a”.

Notably, the market convention in Turkey has changed, and CPI bonds are now quoted on a clean price basis, similar to other markets.

South Africa

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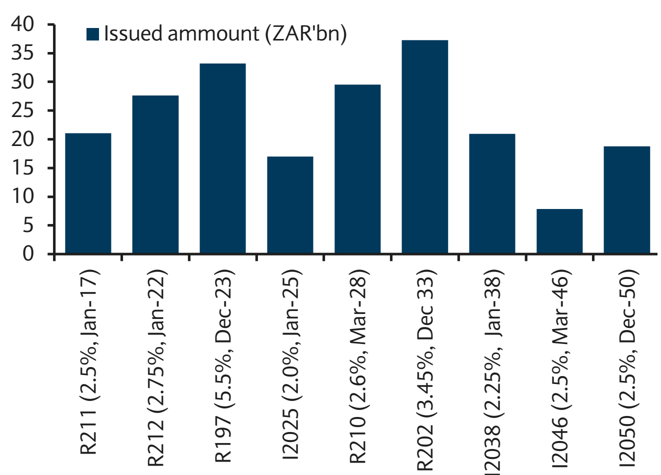
The South African inflation bond market has one of the best-represented curves within the emerging market arena, consisting of nine bonds that extend to 2050. Liquidity continues to improve as a result of regular issuance from the National Treasury, while activity in the non-government and derivatives segments is still gaining traction. Even though the Reserve Bank remains a vigilant inflation fighting central bank, the volatile nature of the exchange rate means that inflationary risks persist. Moreover, the prevailing breakeven yields imply that SA inflation will average 7% over the coming year, while market surveys expect inflation to hover around the upper limit of the target band, ie, 6%.

Market depth

As a result of consistent issuance, inflation-linked bonds now represent 18% of the total government bond market

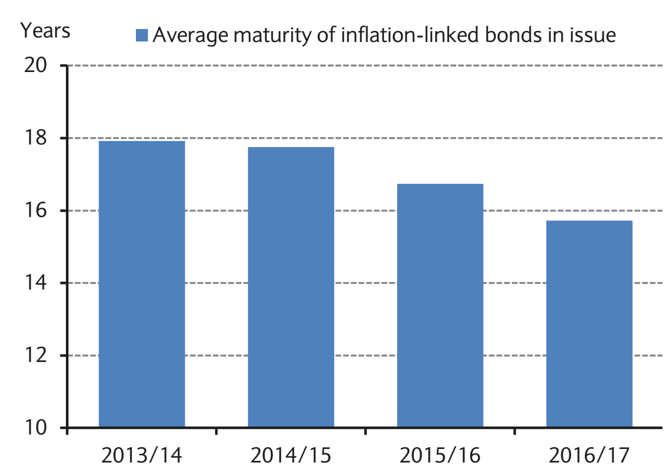
South Africa first issued inflation-linked bonds in March 2000, launching the CPI-linked 6.25% March 2013, known as the R189, and underlining a policy commitment to low and stable inflation over the medium term. Linker turnover pales in comparison to nominal bonds, and market conditions can be especially illiquid in between auction days. In terms of bid-offer spreads, linkers normally trade within a 5-10bp range - wider than the 3bp enjoyed by the nominals. Over the past decade, the Treasury has increased the pace and the magnitude of issuance. Initially, the Treasury only conducted monthly linker auctions, but weekly allotments became the norm after 20004. The size of the weekly allotments were very erratic between 2004 and 2009 (between ZAR100mn and ZAR600mn), before becoming a consistent ZAR600mn between 2009 and 2011 and ZAR800mn per week since then. As a result, the amount of government-backed inflation-linked paper currently in issue stands at $21bn, which represents 18% of the total SA government bond market. The National Treasury has indicated that it would ideally like linkers to constitute between 20% and 25% of total debt. Hence, the pace of linker issuance theoretically could intensify over the coming years. However, for the time being, there is no evidence to suggest that the Treasury will allot more than ZAR800mn per week.

FIGURE 1
SA linker market



Source: JSE, Barclays Research

FIGURE 2
Average maturity of inflation linked bond



Source: National Treasury, Barclays Research

Linker curve increasingly has become more representative across the maturity spectrum...

…with most of this scrip is held by local pension funds and banks

The Treasury has also indicated that the average term-to-maturity of linkers should not range between 14 and 17 years in duration. At present, the average duration stands at 15 years, which implies that the Treasury theoretically can afford to issue more longer-dated scrip and still remain within these issuance guidelines. There are currently nine inflation-linked government bonds in issue. The bulk of inflation-linked bonds are held by the local pension fund community and domestic monetary institutions, with combined holdings of around 80% of the total market. Pension funds buy linkers to guard their assets against rising inflation while banks use linkers to match their inflation-linked liabilities. Insurance companies own about 6% of the linker market, while foreign ownership stands at a mere 3%.

Non-government bonds

Banks and Parastatals are also notable linker issuers

As of May 2014, the Johannesburg Stock Exchange listed 77 non-government inflation-linked bonds, with an outstanding value of ZAR66bn. Local banks are responsible for roughly half of this scrip, with the balance of the allotments stemming from domestic parastatsls (Eskom, Trans-Caledon Tunnel Authority, South Africa Roads Agency, Airports Company SA). In more recent years most of the issuance has stemmed from the banks. The non-government linker market remains highly illiquid, with most trading periods being characterised by decent bids but few offers.

Real rate and inflation derivatives

The inflation-linked derivatives market has only taken off since 2003, as banks became willing to facilitate corporate hedging in the form of real rates and pension fund investment via annuities. Currently, it consists mainly of zero-coupon real-rate swaps and zero-coupon breakeven inflation swaps, with the former being more frequently traded. While a few option trades have occurred, they are not a regular feature. As in other global sectors, inflation pricing in the derivative and cash markets moved significantly out of line in late 2008, with cash bonds quoted relatively cheaply, and this discrepancy remains today. Such pricing prompted the first significant volume of asset swap buying of government linkers, and this trading has continued, allowing swaps to benefit from the improved liquidity of the expanding bond market.

When swap trading began, it quickly developed into a more liquid market than bonds, as it was mainly an inter-bank market, rather than a buy-and-hold one. While the swaps market does not have the consistent weekly liquidity injection of auctions, these do create activity if there is asset swap flow. In recent years, liquidity has dried up, with more frequent trading in the bonds. There is less of a structural constraint on taking long/paid real yield positions in the swap market – but the repo market is developing, with aid from the SARB's reverse repo facility enabling investors to take on short positions in the bonds to some degree. Liquidity is notably worse than the nominal swaps market. Even though the size of underlying flows has grown significantly as the curve has become better defined, it is still mostly a market between five market-making banks. For this reason, bid-offer spreads remain quite wide, at 10-20bp.

Inflationary trends

South African inflation has generally been lower since the SARB was explicitly given a price stability mandate in 2000

South Africa's Finance Minister Trevor Manuel announced the introduction of an inflation-targeting regime in 2000, in which the South African Reserve Bank (SARB) was mandated to keep consumer inflation within a within a 3-6% target band. Between 2000 and 2009 the SARB targeted a CPIX measure (headline inflation less mortgage rate costs), while all inflation linked products referenced the headline inflation measure instead. However, since 2009, both the reference rate and the target rate now refer to the headline measure. Since the adoption of this inflation targeting, consumer inflation has been between below the upper limit of target range 60% of the time. In the decade prior to the introduction of inflationary targeting, consumer inflation was only below 6% only 20% of the time. Hence, even though the monetary authorities have managed to contain price pressures in more recent years, inflationary risks clearly still exist.

Inflation remains particularly susceptible to exchange rate movements

The consumer inflation basket is reviewed every five years by Statistics South Africa, soon after the household spending patterns survey has been conducted. The basket was last updated in 2012 and it was noticeable that the authorities gave a higher weighting to services categories. In South Africa services inflation is typically less volatile than good inflation, which implies that the current basket is slightly less susceptible to shifts in the exchange rate and/or international food and energy prices in comparison to the previous baskets. We expect services categories to continue gaining in importance over the coming decades as the economy becomes increasingly more developed in nature. SA inflation is typically highly sensitive to the performance of the ZAR, with the long-term pass through coefficient of 20%. Since the adoption of inflation targeting, the real effective exchange rate and the consumer inflation rate have tended to move in lockstep and only the latest episode of ZAR weakness has yet to translate into a commensurate uptick in inflationary pressures.

Food prices and inflationary expectations also need to be closely monitored

Food and fuel prices also tend to have a significant bearing on overall inflationary pressures, because collectively these items normally constitute roughly one-third of the overall basket, not to mention that both are also heavily influenced by global prices. Inflationary expectations also can have a significant bearing on price setting, wage demands and monetary policy decision making. In this regard, the SARB and market participants closely track the performance of break even yields and the market survey such as the one conducted by the Bureau for Economic Research. Break-even yields tend to be higher than the inflation levels published in surveys, because the former can be influenced by market forces and demand/supply dynamics that influence the linker market. Accordingly, the SARB places more weight on the survey because the respondents are actually responsible for setting prices within the economy.

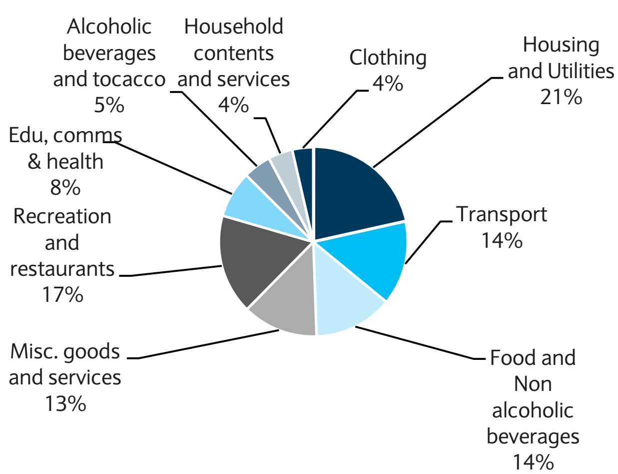
Calculations

South African government inflation-linked bonds carry a principal deflation floor and are quoted on a real yield basis; with inflation indexation calculated using a slightly augmented Canadian methodology. For settlement on the first day of any calendar month, the CPI from four months previous is the reference CPI for that date. This means that South African linkers have a lag that is a month longer than those in Canada, the US or the euro area.

Each day has its own distinct reference index. The first day of each month has a reference index equal to that of the CPI of four calendar months earlier – eg, for 1 December 2014, the CPI is for August 2013 and for 1 January 2014 the CPI is for September 2013. Reference indices for intervening days are calculated by straight-line interpolation.

FIGURE 3

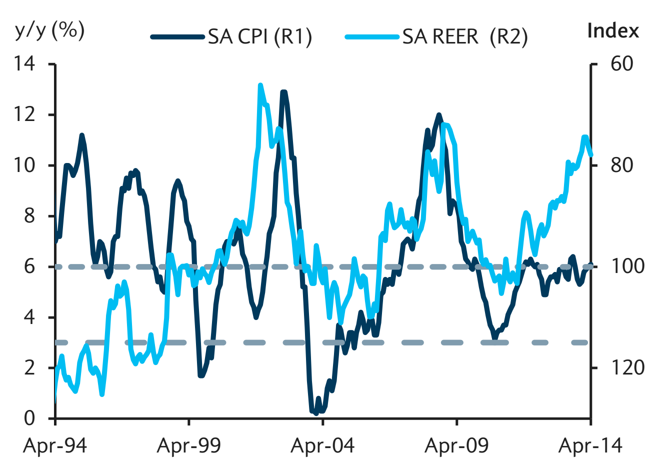
The latest consumer inflation basket has proportionately more weight for the services categories



Source: Stats SA, Barclays Research

FIGURE 4

The real trade-weighted ZAR tends to track consumer inflation closely



Source: Bloomberg, Barclays Research

This formula is used to calculate a reference CPI for the official original issue date, or "Base Reference index". For settlement date or cash flow payment date "t", a reference CPI is then calculated. The reference index and the base index are rounded to 15 decimal places. These provide an index ratio for the value date:

Index Ratio Rate = Reference CPIt/Reference CPIBase

For settlement amounts, real accrued interest is calculated as for ordinary South African bonds. Dirty price and accrued are each multiplied by the index ratio to arrive at a cash settlement amount. For coupons paid, the (real) semi-annual coupon rate is multiplied by the index ratio, and likewise for the par redemption amount (with the cash value subject to the par floor).

Taxation

South African inflation-linked bonds pay interest on a semi-annual basis, with a 10-day "books closed" ex-dividend period. However, international investors are not subject to withholding tax, making investment relatively straightforward. For domestic investors, such bonds fall under section 24J of the Income Tax Act of 1962. Interest on bonds is taxed on a yield-to-maturity basis. Coupon payments and the difference between the acquisition cost and the nominal value of the bond are defined as interest and are liable for income tax. Basically, inflation-linked bonds are treated like floating-rate instruments. The tax liability is determined and paid annually, taking into account any adjustments in the principal amount and the coupon payments as a result of changes in the CPI.

INFLATION MARKETS

Poland

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Poland's inflation-linked bond market has shrunk significantly, from around PLN30bn outstanding (at the end of 2013) to PLN8bn. Structural changes in the domestic pension fund industry caused this drop, and Polish linkers risk becoming a 'peripheral' part of the global linker market because of this.

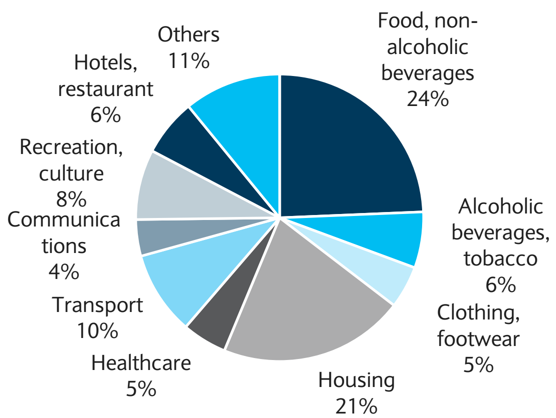
CPI: Down but not out

Inflation-linked bonds in Poland are referenced off non-seasonally adjusted m/m CPI, which is published by Poland's central statistical office around the middle of the following month. CPI is calculated using data gathered from 209 research regions (ie, towns or parts of large cities) across the country. The prices of 1,800 consumer goods and services are surveyed between the first and the 25th day of each month, collecting about 292,000 individual prices in total each month. Since 1990, the weighting system has been based on a household budget survey. The weightings are revised annually.

The long-term trend of inflation in Poland has been downwards, reflecting fast historical productivity growth rates, competition pressure from regional trade, and pass-through from low prices in the euro area into imported goods. Inflation has also been kept down by past central bank actions, which have focused on bringing it down to 2.5% and the willingness to sacrifice growth to achieve this goal. Additional downward pressure on inflation has come from the zloty exchange rate: we estimate that the pass-through from changes in the exchange rate to CPI inflation is still significant at around 10%. Furthermore, the zloty exchange rate has been steady against the EUR since 2009, reflecting consistent foreign investor buying of local bonds. This FX path has helped anchor prices in Poland.

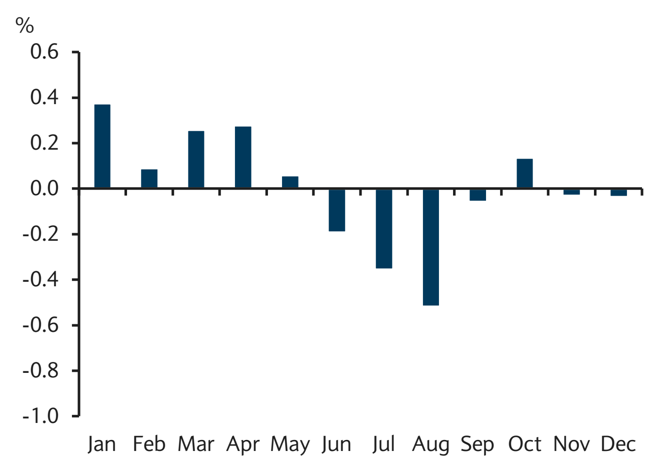
Inflation in Poland in early 2014 has been subdued, at rates of growth similar to the euro area average. This does not, however, portend deflationary risks, in our view: the economy has consistently been in stronger shape than the euro area average, with the secondary (manufacturing) and tertiary (private sector services activity) sectors improving steadily. This should mean stronger labour market trends than in the euro area on a persistent basis.

FIGURE 1
The key components of Polish CPI…



Source: National Statistics Office, Barclays Research

FIGURE 2
…and the seasonality of CPI changes (average deviation from trend during 2009 to 2014)



Source: Barclays Research

From a medium-sized linker market to a peripheral one

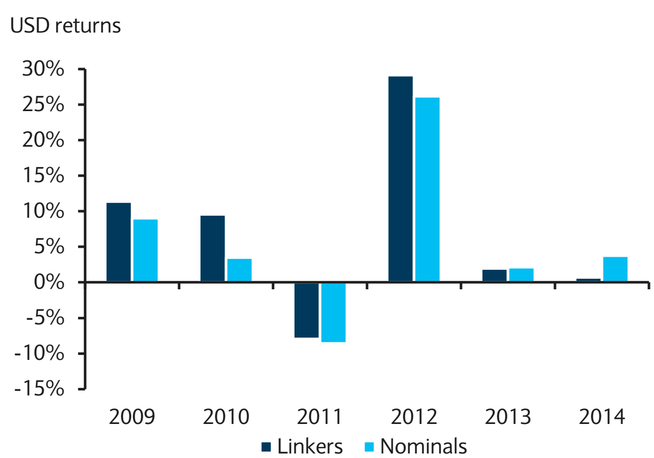
The linker market in Poland has faced repeated challenges that have stunted its growth. CPI-linked bonds were introduced in Poland only after inflation had fallen to low levels, which meant they were launched when demand for real assets was already moderating. The 2016 bond was first auctioned on 18 August 2004. The 2023 linker was issued in July 2008.

In 2004, the Ministry of Finance supplied the market with PLN2.6bn of 2016 CPI-linked bonds, but they were taken mainly by foreign investors in the absence of strong domestic interest. In subsequent years, supply declined gradually, to about PLN1.5bn per annum, as local pension funds, for which the instruments were targeted, started to show interest. From 2010 to 2012, the linker market in Poland enjoyed a growth spurt and decent investor sponsorship. In that period, global real and nominal global rates fell, and the persistent overshooting of inflation targets since 2008 pulled investors towards the Polish linkers.

The linker market was significantly affected by structural changes in the Polish pension funds industry in 2014: at the beginning of February 2014, privately managed state-mandated pension funds transferred a large part of their assets back to the government. They were holding local government nominal and linker bonds. These bonds were subsequently retired, which meant that gross public debt levels fell and the amount outstanding of the bonds they were holding fell also. This includes both the 2016 and 2023 CPI-linked bonds. At the end of 2013 – before the changes – the amount outstanding of the linker bonds was PLN30bn. As of end April 2014, the amount outstanding had fallen to PLN8bn. The ownership structure of these bonds also shifted significantly. Prior to the change, local pension funds were the major holders of the bonds. After the changes, foreign investors hold around 56% of the amount outstanding, followed by local investment funds (17%), insurance companies (15%), and local banks plus others (12%). Foreign investors are now the dominant holder of a smaller market, which means greater risk of price disruptions if they decide to take profits or to scale up their holdings. Trading market liquidity can be negatively affected, with an associated premium required for the risk of greater price volatility in the future. The Polish government can help alleviate these risks by issuing more regularly and in larger sizes, but there seems little indication from the government that this will happen any time soon. The Polish linkers enjoy rarity value in the Central and Eastern European region, but have gone from being a benchmark market to potentially a small peripheral one.

FIGURE 3

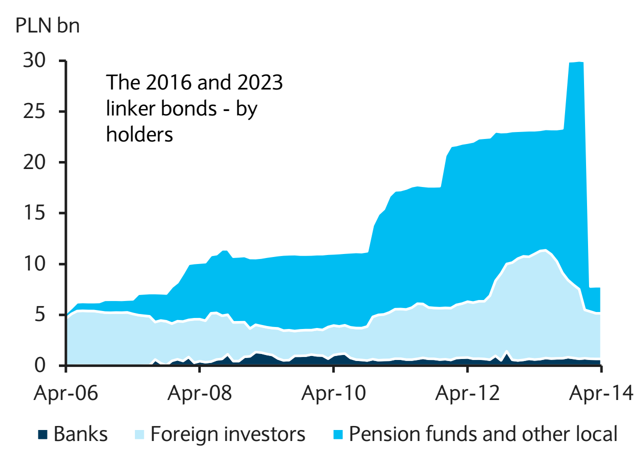
Performance of Poland in Barclays local government bond indices (USD total returns)



Source: Barclays Research

FIGURE 4

Large shifts in ownership structure after the transfer-cancellation of government bonds in 2014



Source: Haver Analytics, Barclays Research

Technical characteristics – Indexation and supply

The Polish government's 2016 and 2023 inflation-linked bonds carry a principal deflation floor and are quoted on a price basis, with inflation indexation calculated according to the Canadian method. The only difference from the standard Canadian method is that there is no CPI index, so the month-over-month CPI changes are combined to calculate an index that is based to July 2003. For settlement on the first day of any calendar month, the implied CPI index from three months previous is the reference CPI for that date, with linear interpolation during the month. The reference coefficient for month "T" is published to five decimal places, which in the case of the August 2016 linker bond is 100 times the product of the monthly changes. For settlement amounts, real accrued interest is calculated, with coupons paid annually.

The supply calendar for the next quarter and month are published on the last working day of quarter or month at the MinFin webpage (*www.mofnet.gov.pl*). The final offer and supply are announced two days before the auction. T-bond auctions take place once a week, usually on Thursdays. Although there is no fixed rule, the MinFin usually offers linkers at 3-4 regular auctions annually. Also, during the course of the year, linkers are offered at switch auctions.

INFLATION MARKETS

Thailand

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Thailand started issuing ILBs in 2011 and currently has two bonds outstanding (2021 and 2028), with a total market capitalization of USD 5.4bn. It uses a standard Canadian format, with a floor on principal at par. Both the bonds are linked to headline CPI, which has high seasonality in April and negative seasonality in November-December.

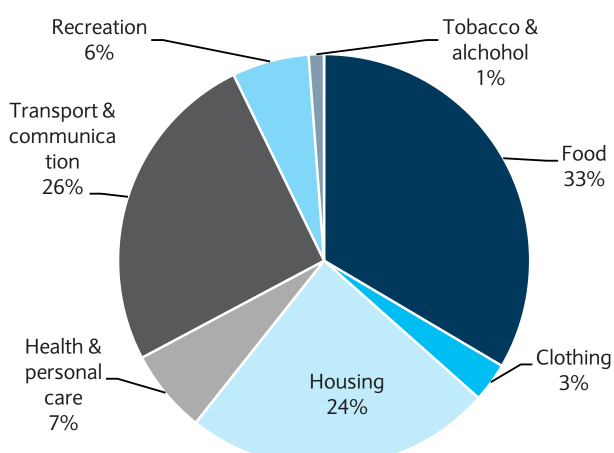
CPI

The inflation index used is the headline CPI, calculated and published by the Ministry of Commerce. The inflation index is broadly divided into three sections: raw food, energy, and core inflation. Looking closely at the basket, raw food has a weight of 15.5% and roughly comprises cereals, meat, proteins and seasonal items, such as vegetables & fruits. Energy is heavily dominated by fuel prices and is loosely regulated by the government. Core inflation represents roughly 73% of the basket, and is comprised mainly of services. CPI data are usually released on the first working day of the month and are seldom revised. The weights of the basket are changed every five years.

Inflation targeting: The BoT has conducted monetary policy under a flexible inflation targeting framework since May 2000. Core inflation (ex food and energy prices) has been BoT's key target variable, with a current target range of 0.5-3%. The target band width is defined every December as per the BoT Act 2008, and needs to be approved by the cabinet. The central bank plans to switch to headline inflation as the key policy target, but it has not effected that change. The Monetary Policy Committee (MPC) has been saying that it will monitor both core and headline inflation, and will communicate policy deliberations with increasing emphasis on headline inflation, even though it is not the benchmark target now. If inflation breaches the target, the MPC must explain why and what policy action it is taking in response, and the period within which it expects inflation to return to target.

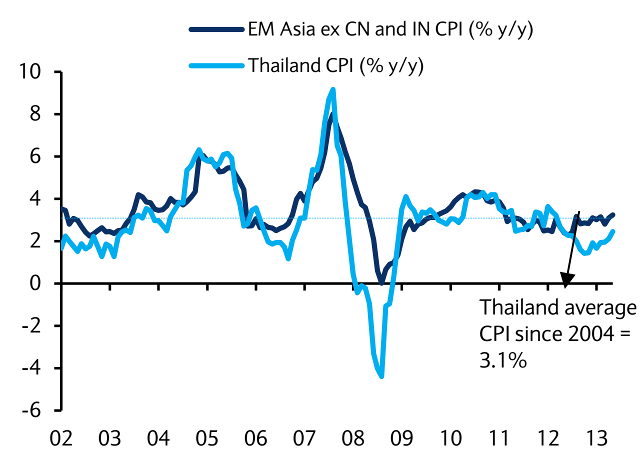
Thailand linker as regional and oil hedge: Thailand's inflation linker offers a hedge not only to inflation in Thailand, but also a partial hedge to regional inflation (Figure 2), which is mostly due to the higher energy weight in Thailand's CPI basket. For Thailand, we estimate that the pass-through from a 20% increase in oil prices would lead to an approximate 1% increase in headline CPI, which is one of the highest pass-throughs for regional CPI (ex India

FIGURE 1
Breakdown of CPI by major category



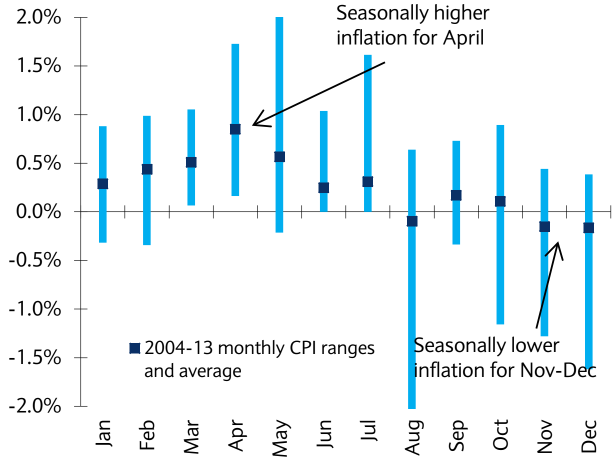
Source: Bloomberg, Barclays Research

FIGURE 2
Thailand linker as a hedge to regional CPI



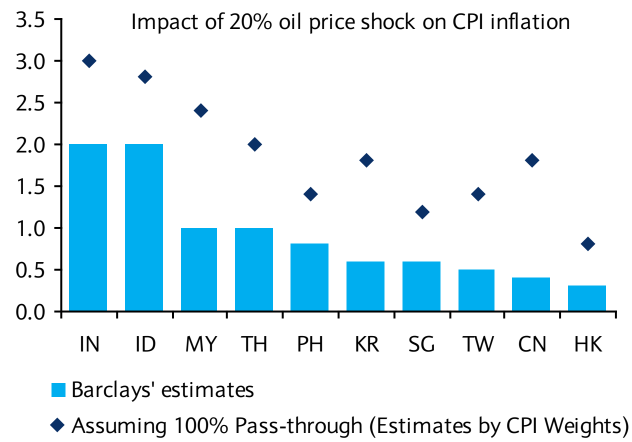
Source: Bloomberg, Barclays Research

FIGURE 3
Seasonal patterns for Thailand CPI



Source: Bloomberg, Barclays Research

FIGURE 4
Oil impact on CPI



Source: Bloomberg, Barclays Research

and Indonesia).

High Seasonality for April CPI: Similar to other linker markets, performance is subject to seasonal fluctuations, which has implications for carry trades. As shown in Figure 3, clearly there is strong seasonality for a higher inflation bias in April, with m/m April inflation during 2004-13 averaging 0.81%, compared with average monthly inflation of 0.26%. This coincides with the Songkran festival, which is the celebration of the Thai New Year, as a result of which, generally, the retail sales and prices pick up over the month.

Government bond

Market development: The first and only ILB was issued in July 2011 with a 10y tenor and a semi-annual real rate coupon, in order to expand the Treasury bond market base to resident investors and foreigners. The inaugural bond was re-opened at quarterly auctions until the amount outstanding reached THB 100bn (USD 3.3bn). In 2013, the Debt management office auctioned a new 15y bond (2083) to develop an ILB curve. Currently, the 2083 ILB is being auctioned regularly at quarterly auctions.

Liquidity and trading pattern: The secondary market liquidity of linkers since the issuance has been relatively low. As shown in Figure 6, the monthly turnover ratio has been below 10%, with the exception of the re-open months. The average monthly trading volume for the 2021, 2028 ILBs since inception (i.e., July 2011, March 2013, respectively) has been USD0.18bn, USD 0.08bn, respectively, and the average monthly turnover ratio has been 7.1%, 4.7%, respectively. Given the thin secondary market liquidity, the best opportunity to buy the bond is at re-openings, in our view.

Amount outstanding: The current amount outstanding of the latest linker (ILB283A – March 2028 expiry) is only THB69bn (~USD2.1bn.), while the amount outstanding of old (inaugural) linker is THB 100bn (~USD 3.3bn). The PDMO plans to issue a further THB30bn, which would take the amount outstanding to THB100bn (i.e., approximately USD3.3bn).

Calculations

- Similar to global linkers, Thailand linkers are also quoted using a standard Canadian model, with a floor on the principal at par. The cash flows are based on the headline inflation index, with a three-month lag.

- For inflation-linked bonds, the principal is indexed to inflation and subsequent coupons reflect adjusted principal. The factor by which to adjust interest and principal payments is known as the index ratio.

- $$IndexRatio = \frac{CPI_t}{CPI_{IssueDate}}$$

- **Coupon Payments**: Subsequent coupon payments are made by multiplying the fixed real coupon by the monthly index ratio, and likewise for final redemption value. Similar to the normal Canadian model, the coupon payments are quantified only after the start of the accrual period when the reference CPI is released (the reference date is three months before the payment date).

- **Accrued Interest**: Accrued interest is paid on the linearly interpolated CPI between the second and thirrd month-back-CPI, as shown in the index below.

$$Index = CPI_{m-3} + \frac{(t-1)}{D_m} \times (CPI_{m-2} - CPI_{m-3})$$

Where CPI_{m-x} is the CPI index x months back of settlement month m; D_m is the number of days in month m; t is the day of the month on which settlement takes place.

- **Index Rebasing:** While the inflation basket is adjusted after five years, the rebasing or index rebalancing would not have any impact on the retrospective index ratios, and would only affect the forward-looking inflation ratio.

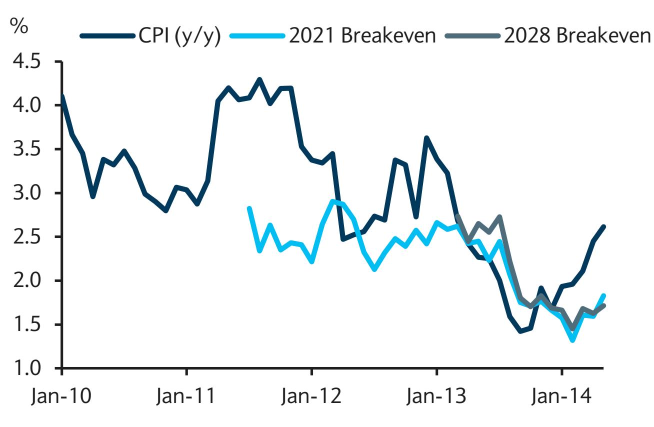
Taxation

- **Interest income:** There is no withholding tax on interest income from Thailand government bonds for foreign investors.

- **Capital gains:** The capital gains tax is 15%, unless exempted. As per Stock Exchange of Thailand regulations, institutional investors from 28 countries are exempt from capital

FIGURE 5

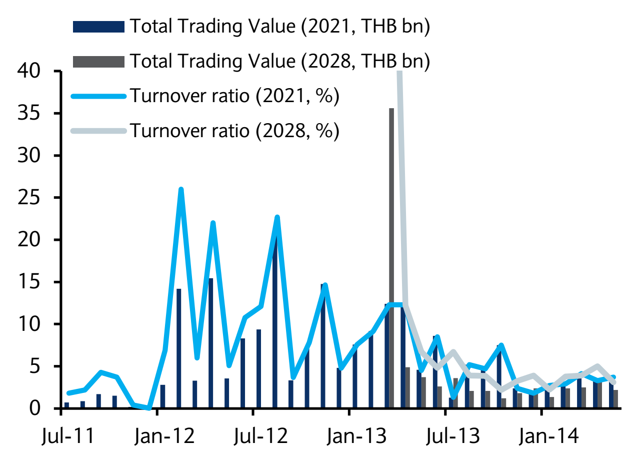
Breakeven yields and historical CPI



Source: Bloomberg, Barclays Research

FIGURE 6

Trading volumes low except the re-open months



Source: Thailand Bond Market Association, Barclays Research gains taxes. These countries include Canada, France, Germany, Hong Kong, Italy, Singapore, Switzerland and the UK. Institutional investors from the US are taxed at 15% on capital gains. However, if the US investor is a US bank operating out of the US, the gains would qualify as business profits and would likely be exempt from Thai tax.

Settlement

- The BoT is responsible for the settlement of government bonds and uses a Real-Time Gross Settlement (RTGS) system that provides DvP (delivery vs. payment) facilities. Settlement convention is T+2 but can vary by bilateral agreement.

- Foreign investors can settle the bond via Euroclear and Clearstream. Investors with Euroclear accounts can trade with dealers that also have Euroclear accounts, and the same holds true for Clearstream. However, access through a Euroclear-Clearstream bridge is not possible.

Hong Kong

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The HK government has issued HKD30bn (USD3.9bn) of retail inflation-linked bonds. Three 3y bonds, USD1.3bn each, were issued in 2011, 2012 and 2013. Each works like a FRN, with only the coupon, and not principal, linked to the 2009-10 composite CPI. The annual coupon is the average of y/y CPI for the past six months, with a floor of 1%.

CPI

The Consumer Price Index (CPI) is compiled and published by the Census and Statistics Department of HKSAR Government (C&SD). Different series of CPIs are compiled to reflect the impact of consumer price changes on households in different expenditure ranges. The CPI(A), CPI(B) and CPI(C) are compiled based on the expenditure patterns of households in the relatively low, medium and relatively high expenditure ranges, respectively. The Composite Consumer Price Index – which is the floating-rate index – is compiled based on the overall expenditure pattern of all the above households taken together to reflect the impact of consumer price changes on the household sector as a whole. Different expenditure weightings are used to compile the different CPI series. These weightings are determined every five years based on the results of a new Household Expenditure Survey (HES). The period in which a HES is conducted forms the "base" of a CPI series. The most recent HES was conducted in 2009-10, and the CPI is now being compiled and published based on that survey. The outstanding inflation linked bonds use 2009-10-based CPI for the coupon calculations.

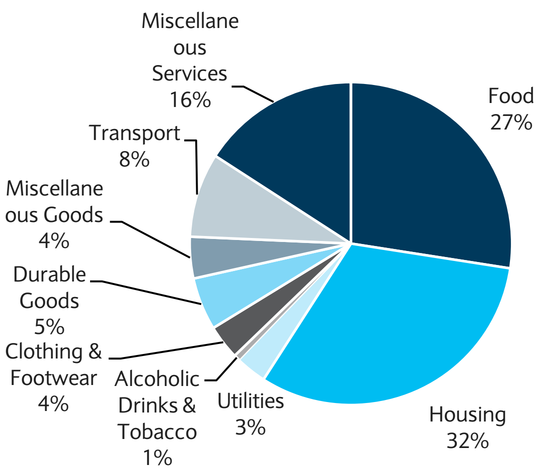
Government bond

Market development

In July 2011, Hong Kong issued HKD10bn of 3y inflation-linked bonds (July 14), its first inflation-linked bond, which was offered only to domestic retail investors. This was followed by two similarly sized 3y bond issues, one in 2012 and another in 2013.

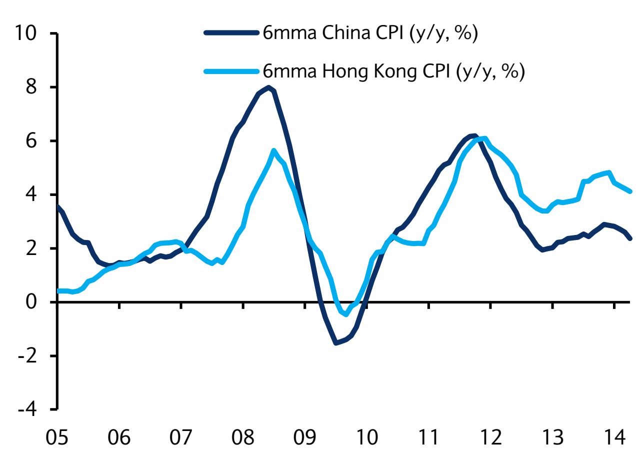
- **Amount Outstanding:** The above mentioned bonds were issued at three auctions, with current total amount outstanding of HKD30bn (USD3.9bn), only for retail investors.

FIGURE 1
Breakdown of CPI by major category



Source: CEIC, Barclays Research

FIGURE 2
HK CPI and China CPI



Source: Bloomberg, Barclays Research

- **Trading patterns:** The bonds are traded on the Hong Kong Exchange. The most recent issue, the 2016 maturity, is the most liquid, with approximately ~73k lots (100 units of HKD100 in principal) traded daily (monthly average); trading volumes of the previous two issues dropped after the sale of the 2016 iBonds. Currently, the average monthly trading volume for the 2014 iBond is 14k lots and for the 2015 iBond it is 27k lots. The 2014 iBond currently yields 1.07% to maturity, the 2015 2.12%, and the 2016 2.45%.

Calculations

- **Principal:** Only the coupon – not the principal – is linked to the headline inflation rate. The HKSAR government will repay 100% of the principal amount of the retail bonds at maturity.

- **Coupons:** The 2009-10 based Composite Consumer Price Index will be used in determining the annual interest rate. The interest paid every six months is based on the following formula and is fixed 10 days ahead of the coupon date (rounded to two decimal places, with a day-count convention of actual/365).

Annual Interest Rate = Max (Average (y/y CPI for the six recent months), 1%)

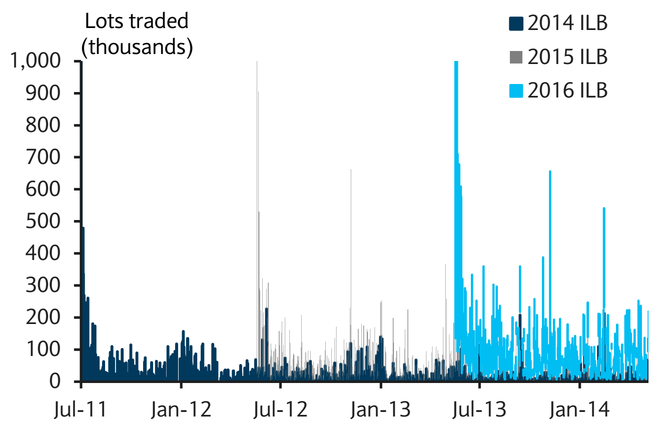
- **Accrued interest:** This is calculated in the same way as for a normal FRN.

Taxation

- No capital gains tax, profits tax or withholding tax or stamp duty is payable in Hong Kong on capital gains from the resale of a retail bonds.

FIGURE 3

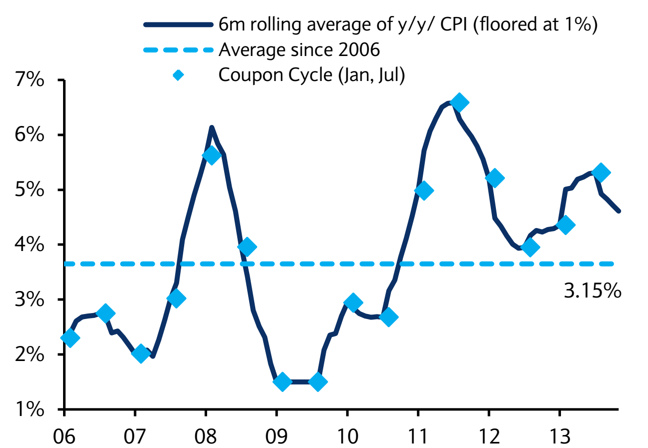
Daily exchange traded volumes of the bond



Source: Hong Kong Exchange

FIGURE 4

Rolling 6m average inflation



Source: Bloomberg, Barclays Research

South Korea

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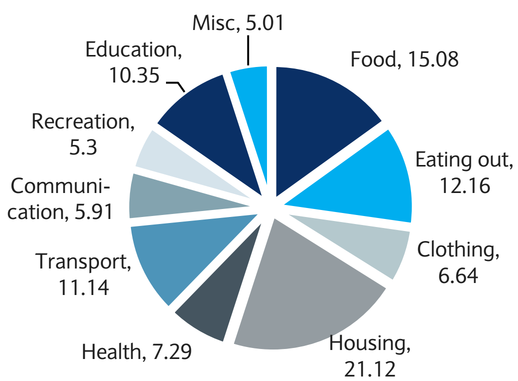
South Korea issued its first 10y inflation-linked bond in March 2007 using a standard Canadian format, linked to the headline CPI rate. In order to increase demand, the MoSF introduced a par floor on bond principal starting from June 2010. As of May 2014, the KTBi market amounted to KRW8.19trn (2.0% of KTBs). The BoK's target for headline CPI is 2.5-3.5%.

CPI

The reference index for computing the inflation adjustment factor for South Korea's first linker bond is the Headline Consumer Price Index (CPI), which is not seasonally adjusted. Since 1998, the Bank of Korea (BoK) has applied inflation targeting, with a target set in consultation with the government. The inflation target range for the 2013 to 2015 period is 2.5-3.5%, in terms of the 12-month rate of change in the consumer price index. The band was wider at 2.0-4.0% over 2010 to 2012 to provide the central bank with room for policy support amid higher volatility in the index. The BoK reviews the performance of its inflation targeting policy annually and the results are published. The target horizon is three years. Since inflation targeting was adopted, inflation in Korea has been both better contained and more stable. For example, inflation averaged 6.2% in the past 30 years, compared with 3.2% in the past 10 years – with a standard deviation of 0.9%. The Korean National Statistics Office publishes CPI data on a month basis, usually on the first working day of the following month.

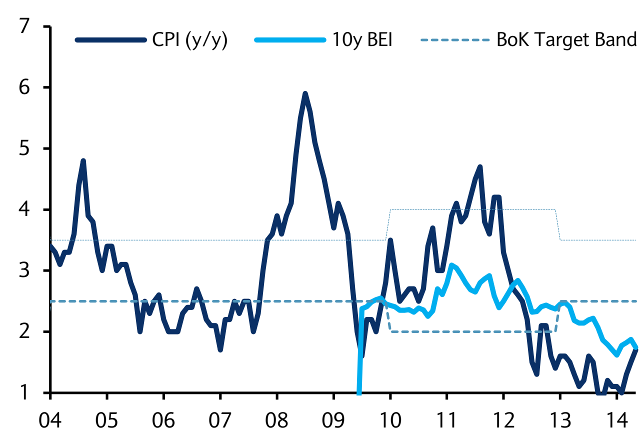
Although the CPI has been used as a measure of inflation in South Korea since 1936, the country's economy has experienced considerable change since that time. These changes largely reflect the national shift from agriculture to heavy industry in the 1970s and 1980s, and the subsequent growth of the service sector in the 1990s. The major categories of goods and services and their weights in the CPI basket are shown in Figure 1. Major revisions to the index are made every five years to reflect changes in the consumption structure of urban households, while additional updates to weights are made two years after the main revision. In December 2013, the results of the updated weights based on 2012 data were released by Statistics Korea.

FIGURE 1
Breakdown of CPI by major category



Source: Korea National Statistic Office

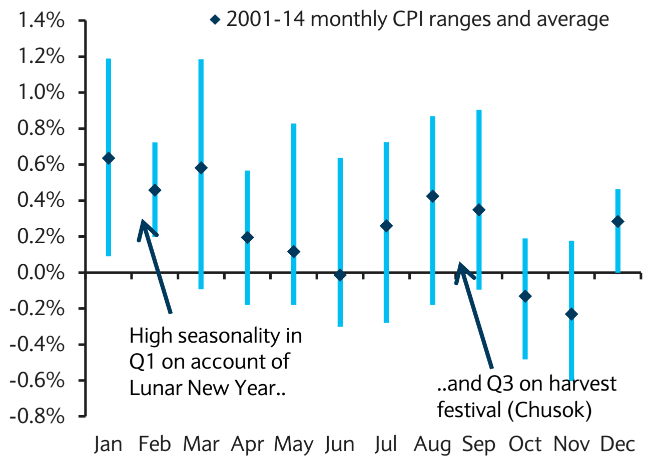
FIGURE 2
Historical CPI and breakevens (on the run)



Source: Bloomberg, Bank of Korea, Barclays Research

FIGURE 3

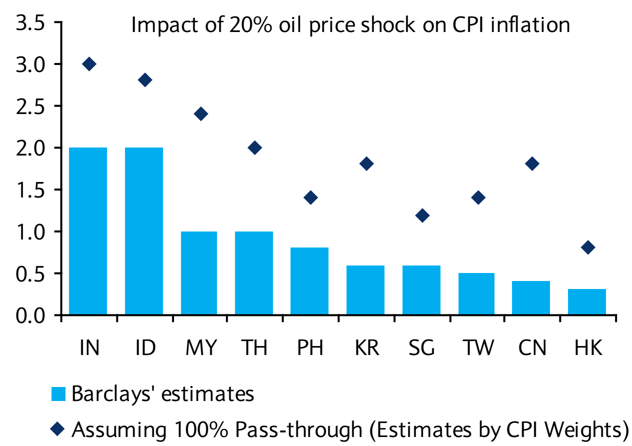
CPI seasonality



Source: Bloomberg, Barclays Research

FIGURE 4

CPI sensitivity to oil prices, %



Source: Bloomberg, Barclays Research

There is strong seasonality of inflation in Korea. Usually, Q1 and Q3 have relatively high inflation due to Lunar New Year and Independence Day, and the “Chuseok” festival.

Government bonds

Market development

The Korean government first issued inflation-linked bonds in March 2007, when it launched the 10y CPI-linked 2.75% March 2017, known as a KTBi, in order to: 1) reduce interest expenses; 2) secure a stable funding base; 3) provide a benchmark for issuance of inflation-linked notes by the private sector; and 4) demonstrate the government’s commitment to maintain stable prices. The government continues to express a commitment to expand the country’s bond markets, including the KTBi segment; however, the global financial crisis led to a pause in issuance of linkers. The last auction of the 2017 series was in July 2008 which raised KRW61bn (c.USD61mn as of July 2008). A new issue scheduled for September 2008 was postponed due to the financial crisis, and KRW900bn of the existing issue was bought back by the Treasury in Q4 08.

The Ministry of Strategy and Finance (MOSF) resumed 10y KTBi issuance in 2010 by introducing a new benchmark in June 2010. Two other new benchmarks, June 2021s and June 2013s, were subsequently introduced, and the latter has been the on-the-run linker bond since then. To enhance the liquidity of on-the-run KTBis, the MOSF increased the fungible bond issuance period from 1-year to 2-years. This means the next new benchmark issuance will be in June 2015. To make linkers more attractive, the government put a guarantee on the principal amount of such bonds issued from 2010 onwards. Incentives to retail investors were provided by lowering the minimum auction bid to KRW100k from KRW1mn and allowing them to request the official quote level from primary dealers (PDs), unlike previously, when the offer rate was subject to a margin imposed by PDs. Tax incentives to retail investors have also been provided to support demand, but only for paper issued until 2014.

Nevertheless, secondary market liquidity for KTBis remains poor. As of the end of May 2014, KTBis outstanding totalled KRW8.19trn, equivalent to just 2.0% of the total KTB market. The investor base has also tended to be domestic and foreign buy-and-hold institutional investors, rather than trading accounts, which has limited the amount of secondary trading. For reference, bid-ask spreads for linkers are 5-10bp, compared with 1-3bp for 5y and 10y KTBs. In effort to boost liquidity, the MoSF has instituted regular buybacks of KTBis.

Therefore, positioning through the primary market generally provides better entry levels. After 10y KTB auctions, which are typically held on the third Monday of each month, the 10y KTBi is allotted through a non-competitive allocation to each primary dealer up to 25% of their allocation at the 10y KTB auction. The BEI rate for the 10y KTBi is announced by the MoSF before the allocation.

Calculations

South Korean government inflation-linked bonds are quoted using the standard Canadian model. For settlement on the first day of any calendar month, the CPI from three months previously is the reference CPI for that date. A reference CPI value is calculated for every day based on the CPI values for three months and two months prior to the month containing the settlement date. The reference CPI for any day during the month is calculated by linear interpolation.

Reference CPI for day d of month t:

$$\frac{(d-1)}{m}\left(CPI_{t-2} - CPI_{t-3}\right) + CPI_{t-3}$$

d = day of the month – eg, 1st implies d=1
m = number of days in that month

The indexation factor is the reference CPI for the settlement date divided by the reference CPI for the base date. Coupons are accrued on an actual/actual basis and paid semi-annually.

The principal amount of KTBi is linked to inflation. The first KTBi issue did not include a par floor on the principal amount, unlike the next two issues which included this feature. The principal of a KTBi is calculated by multiplying the principal amount at the time of issuance by the coefficient of price fluctuations – ie, index ratio (CPI on the payment date/CPI on the issuance date). The calculation of interest is also adjusted accordingly.

Taxation

In general, foreign investors are subject to three taxes: a 14% withholding tax on interest income; a 20% capital gains tax; and an additional 10% “resident tax”. The latter effectively raises the withholding tax to 15.4% and capital gains tax to 22%. These taxes only apply to bonds purchased since 13 November 2010. Interest income earned by non-residents on KTBs and MSBs settled on or before 12 November 2010 remains exempt. The tax treatment for KTBi is the same as that for KTB.

Foreign investors need to obtain approval (ie, Investment Registration Certificate) from the Financial Supervisory Service (FSS) to invest in the Korean bond market. To invest, IRC holders are required to open an exclusive KRW/foreign currency cash account with their FX bank. A local custodian account is also required, as ominibus accounts of Euroclear and Clearstream have not been available since 1 January 2011.

Inflation Themes

INFLATION THEMES

Modeling the end of a trend

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We illustrate how real yields can be modelled using time series decomposition as a means of spotting significant structural breaks. This can be helpful in building fair value models, and also for spotting potential cross-market trade opportunities.

Recent market volatility makes spotting changes in underlying trends difficult. However, time series analysis techniques can help separate the 'noise' from the statistical trend. Simple cross-sectional regression models can be used to estimate fair value for 10y real yields, as discussed in *Inflation Products: Real Yield and Breakeven Fair Value Models*. However, this class of models generally performs poorly around regime changes. An alternative way of modelling market time series is using the Kalman filter, for which we use the STAMP function in Oxmetrics, a statistical software package. This involves decomposing a time series into a series of components, the structure of which is user specified. We specify a smooth level (or trend), with a stochastic slope and an irregular component (ie, residual). The model takes the form:

$$RY_t = \mu_t + \varepsilon_t, \varepsilon_t \sim NID(0, \sigma_\varepsilon^2), t = 1 \ldots T$$

μ represents the trend component and ε the irregular (or residual/random noise). The model specifies that the residual should be normally and independently distributed. The trend is defined by the following equations:

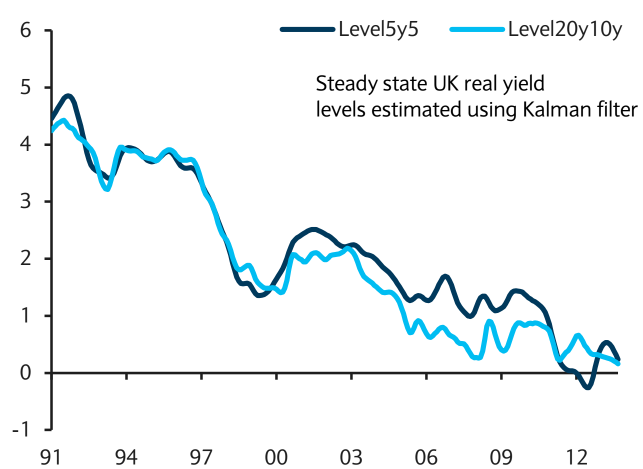
$$\mu_t = \mu_{t-1} + \beta_{t-1}$$
$$\beta_t = \beta_{t-1} + \xi_t$$
$$\xi_t \sim NID(0, \sigma_\xi^2)$$

In the above series of equations, β represents the stochastic slope term in the model. The intuition underlying this model is that forward real yields can be modelled using a stable, slow-moving component that is equivalent to equilibrium real yield expectations, and a more volatile slope or risk premium, which captures the change of the trend.

The model draws on a concept known as State Space Form (SSF). The mathematics and algorithms underpinning this are somewhat complicated, but the broad concept is simple. Essentially, SSF allows a complicated process to be deconstructed into basic components,

FIGURE 1

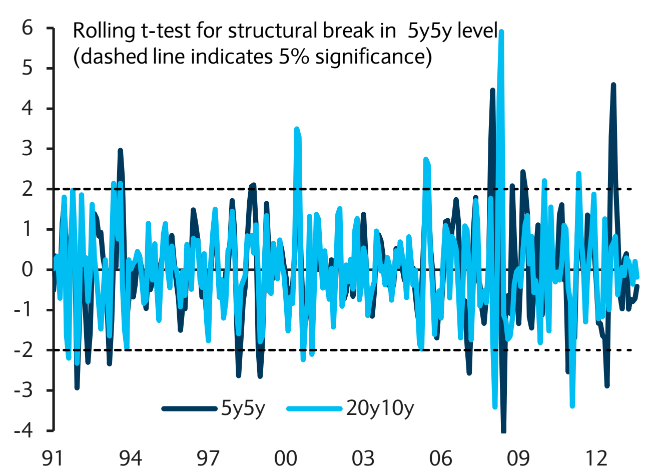
Is the 20y downtrend in 5y5y UK real yields over?



Source: Oxmetrics STAMP, Barclays Research

FIGURE 2

2013 saw a significant structural break, but stability since



Source: Oxmetrics STAMP, Barclays Research even if the process driving the data is neither stable nor directly observable. This makes it an ideal technique to apply to financial market variables, where there can be any number of factors driving movement at any one time and also the risk of autocorrelation between explanatory variables in a model. The time series model is estimated recursively using the Kalman filter, which extracts a trend and slope using maximum likelihood estimation (MLE). This derives the statistically *most probable* trend and slope based on minimising forecast errors, which should be normally and independently distributed. The Kalman filter is effectively the equivalent of an ordinary linear regression in SSF, but with time-varying components instead of fixed coefficients. The technique has practical applications beyond econometric time series analysis, for example in missile guidance and navigation systems.

Figure 1 plots the modelled trend for 5y5y and 20y10y real yields. This trend is calculated as a smoothed variable, with the filter using all available observations, past, present and future, to derive the best fit. Although the UK linker market has existed since 1981, our constant maturity series for 5y, 10y and 30y real yields start in 1991 as the curve was until then insufficiently populated to produce meaningful constant maturity series. For the 5y5y forward, there have been three distinct phases since 1991. In tandem with most major rate markets, the forward fell consistently through the late 1990s. A period of stability followed during the so-called ‘great moderation,’ which was characterised by relatively low inflation and macroeconomic stability. After the financial crisis, 5y5y real yields started to trend lower into late 2011, when all UK linker real yields briefly first turned negative. The lows in real yield were most likely struck in March 2013, after which markets started to react to the possibility of less accommodative central bank policy. Another striking feature of Figure 1 is the extent to which 5y5y and 20y10y forward real yields were correlated prior to the early 2000s. The decoupling, after which longer-dated forwards tended to trade structurally richer, coincided with changes in the pensions landscape, which skewed pension demand toward liability hedging using fixed income assets and linkers in particular.

Figure 2 shows the results of rolling ‘t-tests’ for the level (or trend) computed by the model. T-tests are most commonly used to assess the significance of components in an ordinary regression, with a value of +/-2 indicating significance at a 5% confidence level. In SSF models, the rolling t-stats serve to highlight structural breaks in the individual components calculated. Equivalently, a value above 2% indicates a potential change in trend. The most recent structural break found by this analysis was in 2013, following the sharp sell-off in the 5y5y forward. By contrast, longer-dated forwards have been markedly more stable. The breakdown in correlation between short- and long-dated forwards has been clear anecdotally, but the model provides rigorous statistical validation that this has been the case. From a fundamental perspective, we think that improving growth prospects are likely to bias 5y5y forward real yields higher over the long run. Longer forwards may prove more stable, in our view, as the sell-off in outright real yields is likely to have improved pension solvency ratios, which could prompt demand.

FIGURE 3

Stability of longer forwards leads to more volatile slope

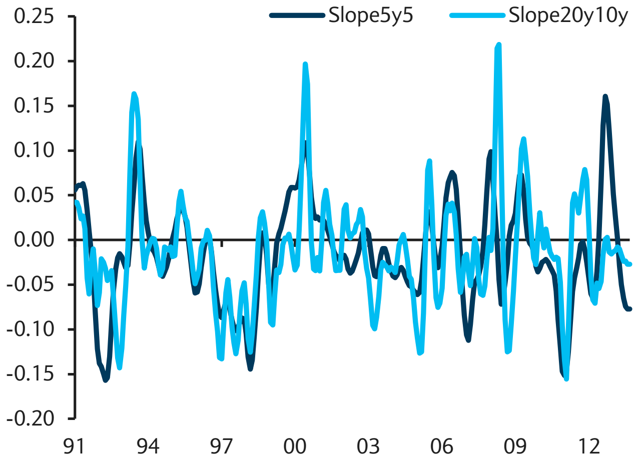


FIGURE 4

Sizeable structural break recently in 5y5y real yield slope

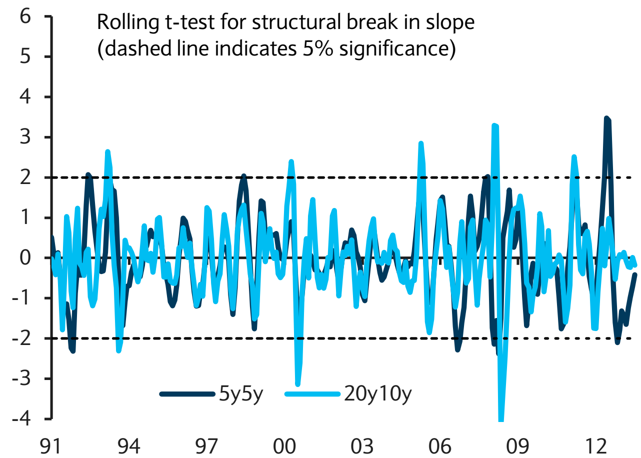


FIGURE 5

5y5y model residual

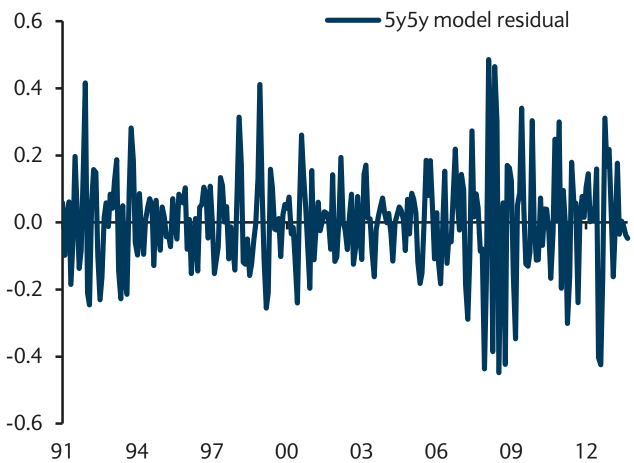


FIGURE 6

5y5y residual t-tests

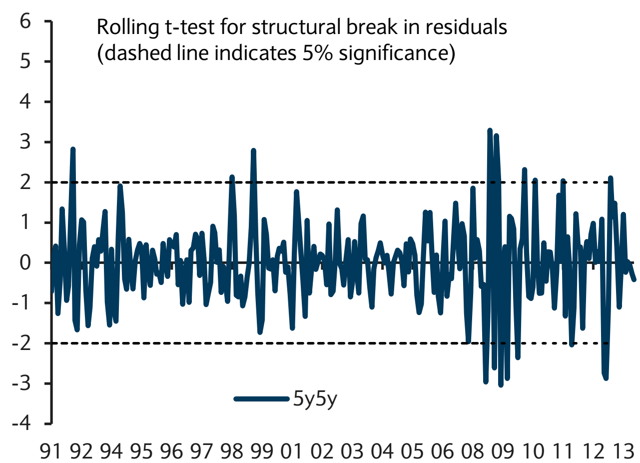


FIGURE 7

20y10y residual

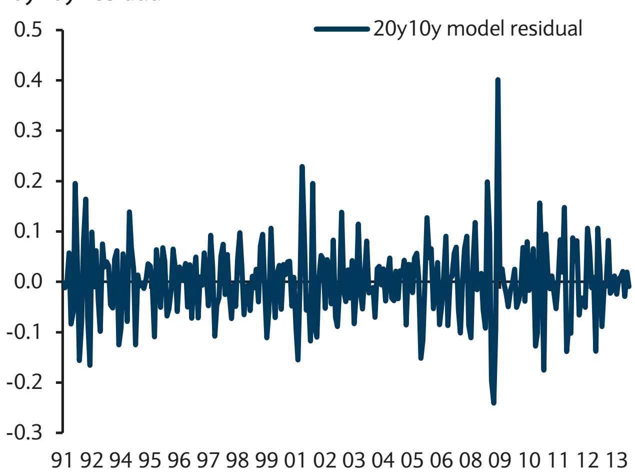
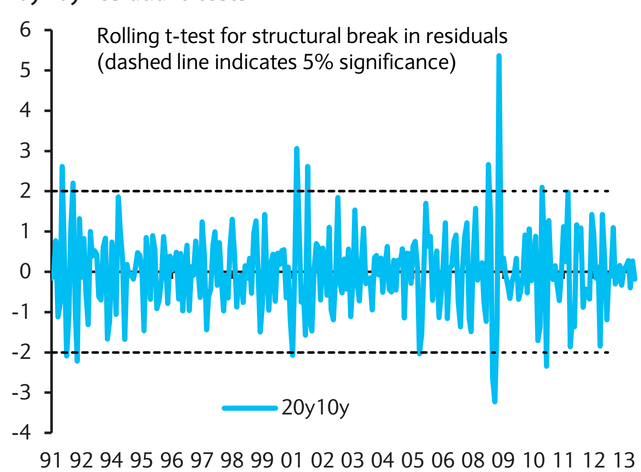


FIGURE 8

20y10y residual t-tests



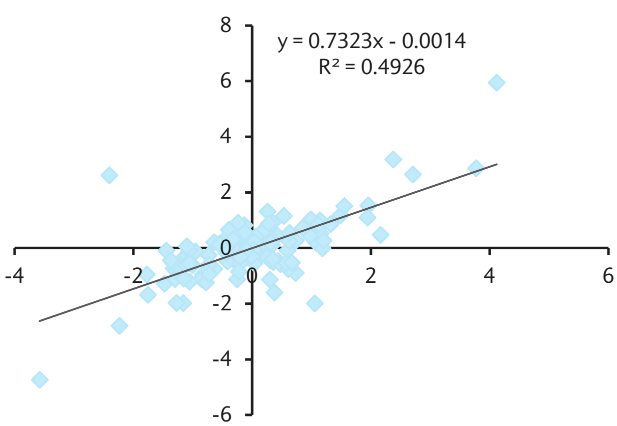
Source for all figures: Oxmetrics STAMP, Barclays Research

Figures 3 and 4 plot the estimated value of the model slope for 5y5y and 20y10y fwd real yields, and the rolling t-stats for these variables, respectively. Residuals for the 5y5y and 20y10y models and t-stats are shown in the subsequent figures. Our interpretation of the slope is of a risk premium embedded within the term structure. The slope for 20y10y fwd real yields is much more volatile than for 5y5y, most likely because of the greater relative stability of long-dated forwards. The consequence of this is a more stable trend, but more volatile slope. The greater volatility of 5y5y forward real yields also makes for larger, more volatile residuals relative to the longer forward. In other words, the model performs less well in characterising moves in the 5y5y forward. This is where the t-tests are a useful guide to model performance. These indicate a significant structural break in the 5y5y model slope, which had previously been stable for much of the period back to 1991. A sizeable break is also seen in the 5y5y residual alongside the taper driven 2013 sell-off.

A statistically significant t-stat can either signal a structural break in a series or a statistical outlier. Most time series models suffer from a degree of 'endpoint bias,' where estimates at either end of a time series can be less accurate. However, the Kalman filter is notably less prone to such bias than less sophisticated methods. In interpreting the results, we think it best to 'let the data speak for themselves'. The sharp sell-off in 5y5y forwards in 2013 marked the largest structural break in this time series since the considerable financial distress of 2008. Additionally, the smoothed series illustrate that it has been comparably rare for shorter-dated forward to trade rich to longer-dated ones since the introduction of mandatory pension inflation indexation in 1997. This is consistent with the weight of linker demand being directed towards longer-dated linkers to match the duration of pension scheme liabilities. Ultimately, the modelling techniques described above are largely useful for historical analyses of real yields but do have some use in forecasting and other related exercises. Figures 9 and 10 show cross-plots of the real yield level intervention t-stats for TIPS vs. UK and EUR vs. UK real yields, respectively. These indicate that structural breaks in the level of US and UK real yields are more correlated than EUR and UK real yields. We interpret this as stemming to some extent from French spread widening during the euro crisis and also, more recently, from the diverging monetary policy outlooks between the euro zone and the UK, whereas the outlooks for the UK and US are more aligned. This could be used for spotting cross-market trade opportunities, for example, if there is evidence of opposing structural breaks in two different markets.

FIGURE 9

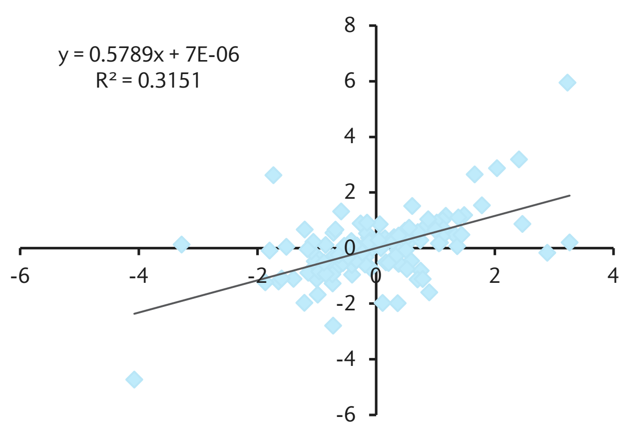
10y TIPS vs. UK real yield level intervention t-stats



Source: Oxmetrics STAMP, Barclays Research

FIGURE 10

10y EUR vs. UK real yield level intervention t-stats



Source: Oxmetrics STAMP, Barclays Research

INFLATION THEMES

After a storm, TIPS still pass the test

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Originally published in The Global Inflation-Linked Monthly, 13 March 2014.

We revisit our previously defined economic regimes framework and find that 2013 TIPS underperformance was in line with the previous regimes with similar characteristics. Given that we expect modestly higher inflation and a continued reduction in slack, real assets will likely outperform. We recommend being overweight in TIPS versus nominals in a structural allocation framework.

In frameworks by any name, they still smell sweet

Over the past six years, we have analyzed TIPS in various asset allocation frameworks, from efficient frontier analysis and Black-Litterman to asset correlations, risk parity and economic regimes. Regardless of the approach, we found that TIPS belong in a diversified portfolio. The methods we found most useful for forecasting TIPS performance are based on expected economic regimes and the Black-Litterman portfolio allocation approach. We also think it is worth highlighting the correlations of TIPS returns versus other asset classes. Here, we revisit some of our previous analysis and incorporate last year's return data.

One question we have received recently is whether these past results are still valid after the TIPS index had a negative return last year. Our findings indicate that on a relative basis, 2013 TIPS returns were consistent with the economic regimes of years past (Figure 1). Most of the negative returns in 2013 were explained by a rise in real rates as labor market slack was reduced. We expect realized inflation and growth to pick up and the Fed to remain on course with tapering. These factors lead us to believe that TIPS should outperform nominals on a duration-adjusted basis in 2014, although they are likely to post only slightly positive absolute returns. Given that TIPS have already earned 2% returns in first two months of the year, outright returns are likely to be negative for the rest of the year. In general, we expect real assets to fare better than they did in 2013, particularly on a relative basis.

Economic regimes and asset returns

2013 TIPS returns consistent with past economic regimes

In February 2013 (*The Global Inflation-Linked Monthly: Increase allocations, but not out of fear*), we provided a framework to look at asset returns and volatility under various economic scenarios. For a given economic forecast, we can then use previous economic regimes as a template for forecasting relative returns of various assets. We define five economic regimes separated by y/y changes in unemployment and inflation to identify average asset return/vol characteristics in those scenarios (Figure 1).

FIGURE 1

Historical economic regimes and average excess asset returns during that regime

Economic scenario	Unemployment	Inflation	Control for the level of unemployment	10y Tsy	TIPS	TIPS simulated returns*	MBS	Investment grade	Equities	Commodities
Growing/Overheating	Declining	Increasing		5.0	5.8	5.0	5.2	5.1	6.7	21.5
Goldilocks	Declining	Declining	Unemp<6	5.0	4.6	3.9	7.3	8.3	15.1	4.0
Recession Exit	Declining	Declining	Unemp>6	6.9	3.1	7.6	9.0	12.3	16.8	-0.7
Stagflation	Increasing	Increasing		4.6	11.4	11.3	6.1	3.9	-2.8	29.1
Entering Recession	Increasing	Declining		7.4	6.5	10.7	12.8	12.9	7.3	-2.8

Note: Please see pages 6-8 of *The real risk parity* for detailed definition of the aforementioned scenarios. * Simulated TIPS returns are model-driven TIPS returns going back to 1974. Source: BLS, Bloomberg, Barclays Research

2013 TIPS versus nominal and equities returns were quite consistent with the historical "Recession Exit" economic regime's returns

In early 2013, we expected the Fed to stay dovish and inflation expectations to remain relatively stable. As per Figure 1, we expected TIPS to outperform nominals. However, starting in May 2013, the Fed became hawkish and real rates led a sell-off, while the US dollar strengthened. During this period, headline inflation also declined, led by core goods and energy prices. At this surprise in Fed policy, we turned neutral on TIPS. However, most investors question whether TIPS underperformed significantly during this period relative to history. Specifically, in 2013, TIPS underperformed nominals by about 3.4%, which is quite consistent with the "recession exit" story noted in Figure 1 (row 3). In this scenario, when the unemployment rate is above full employment and the inflation and unemployment rates are declining, TIPS are likely to underperform nominals. Coincidentally, during similar episodes in the past, TIPS have underperformed nominals by more than three percentage points (see Figure 1, row 3). Also, equities were the best performing asset class during this period. Thus, the 2013 relative asset returns were quite consistent with those of the "Recession Exit" economic regime with declines in the unemployment rate and inflation.

In 2014, we expect a continued drop in the unemployment rate, which should result in an uptick in wage pressures since slack has already been reduced significantly. We believe NAIRU is higher now than before the financial crisis and, as argued in *The wages are coming, the wages are coming*, 7 March 2014, the recent pick-up in wage inflation supports this view. This will likely translate to higher realized inflation in the year (and years) ahead, in our view. In this setup, we are moving slowly toward the first economic regime (labeled "Growing/Overheating economy") in which the unemployment rate is below what is consistent with full employment. In the current environment, realized inflation is well below the Fed's mandate of 2% on PCE, but it should be moving higher. Thus, we would still characterise this economy as growing (lower unemployment and higher inflation) rather than overheating. In past scenarios, commodities, equities and TIPS have tended to outperform, while nominal fixed income assets have underperformed on a relative basis. As such, we maintain a breakeven widening view within this framework.

Black-Litterman type of portfolio allocation model indicates that in a growing economy regime (as defined in Figure 1), investors should allocate more to TIPS relative to nominals

With this view in mind, we employ a Black-Litterman model to figure out how much one should deploy in each asset class. This exercise is meant to be for guidance only. In it, we incorporated the approximate size for various fixed income markets (maturities greater than one year), US equities and commodities. Under the assumption that the market is in equilibrium, investors should have about 3% assets in TIPS, given the market size and volatility of TIPS returns. Expected excess returns for TIPS are higher because of their higher volatility than nominals. However, when we incorporate our view of outperformance in TIPS and other real assets (as discussed above) during a growing economy, the TIPS and commodities allocations increase significantly for an optimal portfolio.

FIGURE 2

Black-Litterman portfolio output suggests increased allocation to real assets

	Investable market size ($bn)	Market portfolio weights	Equilibrium excess returns	View based portfolio weights
Tsy	5.9	17%	0.68%	16%
TIPS	1.0	3%	1.25%	20%
MBS	4.9	14%	0.91%	20%
Corporate	3.8	11%	1.75%	20%
Equities	16.8	49%	6.47%	16%
Commodities	0.5	1%	3.55%	8%

Note: View based portfolio weights are derived from low confidence relative outperformance suggested by "Overheating economy" scenario. Portfolio is subjected to 20% limit in each asset class constraint.
Source: Barclays Research

2013 absolute and relative returns explained, and onto 2014 expectations

In years past, we have analyzed historical TIPS returns, volatility and correlations relative to other assets, along with relative correlations. Often, clients have also asked us for an update on this analysis. We start by explaining TIPS returns in 2013 and expected returns for 2014.

Why were 2013 returns so negative? TIPS have "real" duration

The significant rise in real rates in 2013 explains almost all of the negative return in TIPS, led by a hawkish change in Fed policy starting in May 2013

Recall our emphasis (*Linkers in an asset class of their own*, 22 May 2012) that TIPS are a real yield instrument and have significant exposure to real rates on an outright basis. It is via breakeven positions (long TIPS and short nominals) that investors gain exposure to expected inflation and the inflation risk premium. On a total return basis, TIPS returns are approximately equal to the change in real price (due to the change in real yield) plus the real coupon and realized inflation over the holding period. In 2013, real rates rose about 120bp (from -40bp to 80bp), while realized inflation averaged about 1.1% on a y/y 2m-3m lagged basis (from October-November 2012 to October-November 2013). Given TIPS duration of about 8.3, we show about -10% (-8.3*120bp) of real price returns plus a real coupon of -0.4% plus 1.1% of headline inflation. This adds up to a total return of about -9.3% for TIPS. Compared with a comparable nominal Treasury index (equivalent duration and similar maturity structure), TIPS underperformed by 3.4%.

For 2014, we expect 1.3% in positive return in 2014, but since real yields have rallied since late last year, we expect TIPS to deliver -1% from March 2014 to year-end

In 2014, we continue to expect a smaller rise in real rates…

… however, we expect a pick-up in realized inflation and TIPS to have a slightly positive return but -1% from March 2014 to year-end

From December 2013 to December 2014, we expect TIPS returns to be slightly positive because we foresee only a 20bp rise in 10y real yields from the year-end mark of 80bp. However, we also expect a rise in realized inflation (at about 2.1%) and a subsequent pick-up in inflation expectations. Thus, on a total return basis, we estimate TIPS will return about 1.3% (real price return: -1.6%, 0.80% real yield, plus 2.1% realized inflation) in 2014. As of March 13, 2014, TIPS real yields have declined to 55bp, and TIPS have returned 2.18% year-to-date. We expect real yields to rise to 100bp by the end of the year and therefore expect TIPS to deliver negative returns (from March 2014 to year-end) of about -1%. We expect them to outperform nominals on a duration-adjusted basis because we expect 10y breakevens to move from 220bp to 240-250bp by year-end. Thus, we expect a larger sell-off in nominal rates than in real rates.

Figure 3 shows that while 2013 was a difficult year for TIPS as real rates rose significantly, historically they have had a better return/risk profile than the US Agg index.

FIGURE 3
TIPS and other asset returns and risk over time

		Global Inf	TIPS	UK I/L	EUR I/L	EM I/L	Tsy	High Yield	FTSE 100	EURO Stoxx	S&P 500	GSCI	US Agg	Global Agg
Annualized Returns (%)	1y	-5.5	-9.3	0.3	-3.7	-10.7	-2.7	7.4	20.9	26.6	32.4	-1.2	-2.0	-2.6
	3y	3.5	3.5	6.3	1.8	1.9	2.9	9.3	10.6	8.2	16.2	-0.8	3.3	2.4
	5y	4.9	5.4	6.7	2.9	5.9	2.1	18.9	15.7	8.2	17.9	3.9	4.4	3.9
	10y	4.8	4.9	6.0	4.0	8.7	4.2	8.6	7.2	5.2	7.4	0.7	4.5	4.5
	Since Inception	6.1	6.1	6.2	5.9	8.7	5.5	7.3	6.2	6.1	7.1	2.3	5.7	5.4
Annualized Vol of monthly returns (%)	1y	6.0	6.3	8.6	4.6	6.0	2.7	4.6	10.9	17.9	8.1	10.8	16.9	4.6
	3y	4.6	5.5	7.7	6.2	10.6	3.3	6.2	15.2	27.8	32.6	17.1	14.2	4.2
	5y	9.0	5.8	7.3	9.5	8.5	3.9	8.8	18.4	29.2	31.2	19.3	11.1	5.5
	10y	7.4	6.2	7.0	7.5	7.6	4.2	10.0	17.0	24.2	24.3	23.2	8.2	5.6
	Since Inception	6.3	5.7	6.3	6.7	7.6	4.4	9.3	16.2	23.3	21.9	22.2	6.7	5.5
Return/ Risk	10y	0.65	0.78	0.85	0.53	1.14	1.01	0.86	0.42	0.22	0.30	0.03	0.55	0.80
	Since Inception	0.98	1.07	0.99	0.88	1.14	1.25	0.79	0.38	0.26	0.32	0.11	0.85	0.98

Note: Data since inception of the TIPS market to December 2013. Source: Bloomberg, Barclays Research

Correlations: TIPS continue to offer diversification benefit and the short end of the breakeven curve has a higher correlation with realized inflation

Given the above confirmation of significant real rate exposure in TIPS, we think it is worth diving into the correlation of TIPS and breakeven returns with other assets (Figure 4):

- On an outright basis, TIPS returns are generally reflective of other fixed income assets because all fixed income assets have real rate exposure. And as we saw earlier, real rate changes can explain the largest part of fixed income return (excluding credit/liquidity exposures) variations when inflation expectations are low and/or stable.
- Longer breakevens returns are not generally correlated with realized inflation over the previous year because longer breakevens reflect unrealized inflation expectations. This is a function of monetary policy and expected unemployment and broader inflation trends, rather than near-term headline inflation, which can be skewed by near-term changes in energy/food commodities.
- Front-end breakevens (1-3y) are more correlated with realized inflation (y/y) over the previous year because realized inflation trends are more likely to persist in the near future. For example, rental inflation tends to be sticky. Monetary policy cannot effectively control the path of very near-term inflation. Also, 1y realized inflation makes up a significant carry/return component of the 1-3y breakeven return index, while for 30y breakevens, it would make up very little of the inflation carry component.

FIGURE 4

Returns correlation of IL assets versus others, y/y

	World Govt IL	TIPS	UK IL	EURO IL	EM IL	1-3y TIPS	1-3y BE	1-10y BE	1-10y UK BE	1-10y EUR BE	Gold	Crude	CRB	GSCI	Food	S&P 500	Tsy	Global Agg	Case Shiller	UKRPI	EU HICPx	CPI NSA
World Govt IL	100	81	70	63	50	43	67	15	9	6	18	16	25	26	15	11	56	67	11	21	27	24
TIPS	81	100	32	55	41	50	61	34	15	9	37	25	43	42	38	-16	55	62	5	21	33	34
UK Govt IL	70	32	100	0	18	22	58	2	-1	2	12	9	1	4	1	37	25	36	-13	36	36	18
EURO Govt IL	63	55	0	100	56	14	35	29	13	-3	1	25	33	32	-2	-12	29	56	37	-29	-19	3
EM Govt IL	50	41	18	56	100	19	49	51	38	10	27	27	31	23	23	44	-13	26	47	9	1	19
1-3y TIPS	43	50	22	14	19	100	66	35	22	-2	28	41	34	43	32	4	32	19	-21	26	46	56
1-3y BE	67	61	58	35	49	66	100	98	55	17	45	78	79	72	48	69	-32	51	35	44	26	54
1-10y BE	15	34	2	29	51	35	98	100	59	24	37	74	72	66	44	42	-58	6	37	18	15	45
1-10y UK BE	9	15	-1	13	38	22	55	59	100	23	33	38	48	36	49	39	-38	16	19	33	10	24
1-10y EUR BE	6	9	2	-3	10	-2	17	24	23	100	22	28	45	44	50	22	-12	14	17	32	44	31
Gold	18	37	12	1	27	28	45	37	33	22	100	31	43	29	55	-7	-2	36	-26	29	36	32
Crude	16	25	9	25	27	41	78	74	38	28	31	100	83	86	41	27	-36	4	19	29	43	60
CRB	25	43	1	33	31	34	79	72	48	45	43	83	100	95	68	24	-23	22	34	44	42	65
GSCI	26	42	4	32	23	43	72	66	36	44	29	86	95	100	57	19	-16	10	32	42	56	73
Food	15	38	1	-2	23	32	48	44	49	50	55	41	68	57	100	24	-8	29	-4	60	47	44
S&P500	11	-16	37	-12	44	4	69	42	39	22	-7	27	24	19	24	100	-53	2	32	39	-3	11
Tsy	56	55	25	29	-13	32	-32	-58	-38	-12	-2	-36	-23	-16	-8	-53	100	45	-32	1	25	-3
Global Agg	67	62	36	56	26	19	51	6	16	14	36	4	22	10	29	2	45	100	-1	17	4	2
Case Shiller	11	5	-13	37	47	-21	35	37	19	17	-26	19	34	32	-4	32	-32	-1	100	-3	-11	15
UKRPI	21	21	36	-29	9	26	44	18	33	32	29	29	44	42	60	39	1	17	-3	100	65	56
EU HICPx	27	33	36	-19	1	46	26	15	10	44	36	43	42	56	47	-3	25	4	-11	65	100	81
CPI NSA	24	34	18	3	19	56	54	45	24	31	32	60	65	73	44	11	-3	2	15	56	81	100

Note: Data from February 1997 to December 2013. Source: Bloomberg, Barclays Research

INFLATION THEMES

Finding relative value

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We discuss our approach in finding micro relative value using our daily forwards and TIPS relative value reports, along with the analytics.

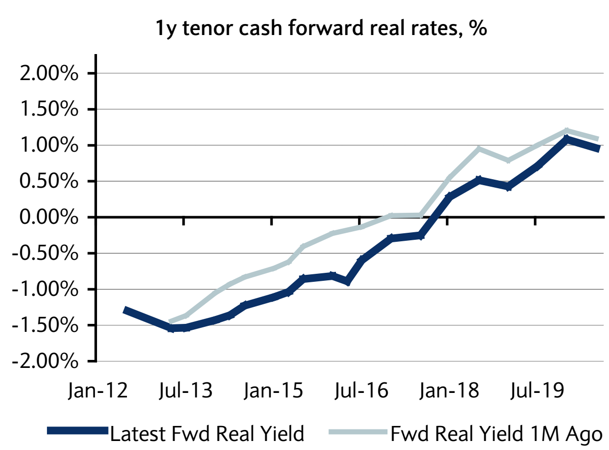
The framework

When evaluating TIPS, we look at fundamentals for asset class selection (TIPS versus nominals, portfolio diversification), tactical value (supply, demand) and micro relative value. Once we have decided on TIPS valuations from a macro perspective and a particular sector to invest in along the TIPS curve, we think investors can further add alpha by exploring micro relative value. We look at many tools to when evaluating rich/cheap along the curve including our *TIPS Pricing report*, *Inflation Linked Daily, inflation market volatility report*, and various analytical tools on Barclays Live. No one evaluation method drives our views and, instead, we look for a consistent signal from different approaches.

Example of finding micro relative value using the inflation forwards report

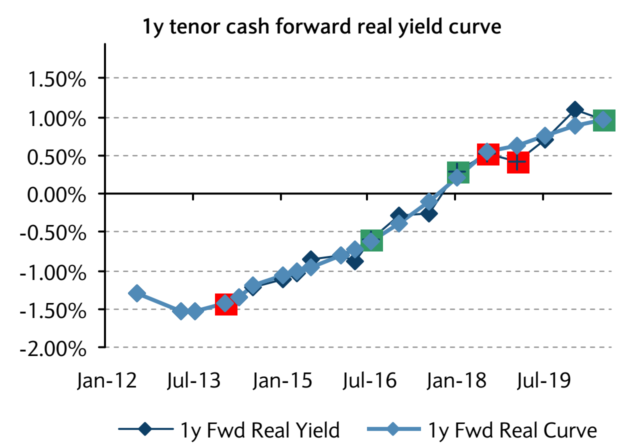
The *Inflation Linked Daily* displays a number of charts, including the path of forward real yields, breakevens, CPI swaps, and longer forwards (5y5y, 10y10y and 10y20y). The longer forwards can be used for relative sector richness or cheapness. The path of forward 1y real yields (Figure 1) can be used to find micro value. We have added z-score information on our forward 1y real and breakeven curves in order to further aid us in finding value. We use z-scores above 0.5 to identify cheap forwards, while we use z-score of less than -0.5 to identify rich forwards. In addition, we use consecutive pairs (Jul13-Jul14, Jul14-Jul15, Jul15-Jul16) to confirm whether a security is trading rich/cheap. For example, as of April 30, 2012, Jul18 and Jul19 forward real yields look rich (Figure 1 and Figure 2) in the 1y apart forwards real yield curve. If one can trade forwards and had a view that real rates were trading rich in this sector, we would recommend putting on a cash-neutral forward real-rate trade of selling Jul19 versus Jul18s. This rich Jul18-Jul19 forward rate, however, does not tell us whether Jul18s are trading cheap and/or whether Jul19s are trading rich. To further dissect what is happening in this sector, we look at several consecutive pairs of forwards. The prior pair, Jul17-Jul18, has a neutral z-score of -0.3, indicating Jul17 and Jul18s are of neutral status. The Jul19s and Jul20 forward pair also has a neutral z-score at 0.2, which marks

FIGURE 1
Jul18-Jul19 forward real yield standing out as rich



Note: Now available in Inflation-Linked Daily. Source: Barclays Research

FIGURE 2
Jul18-Jul19 forward real yield looks rich on a forward spline z-score basis as well



Source: Barclays Research

July19s and Jul20 as neutral. So we combine this information to formulate a view on Jul18s and Jul19. In our forward real curve z-score grading scheme, the following consecutive pairs status filters are applied to determine a security's status, ie, assuming two statuses are derived for a security from consecutive pairs.

1. neutral + Rich = Rich,
2. neutral + Cheap = Cheap,
3. Rich + Cheap = Neutral,
4. Rich + Rich = Rich,
5. Cheap + Cheap = Cheap.

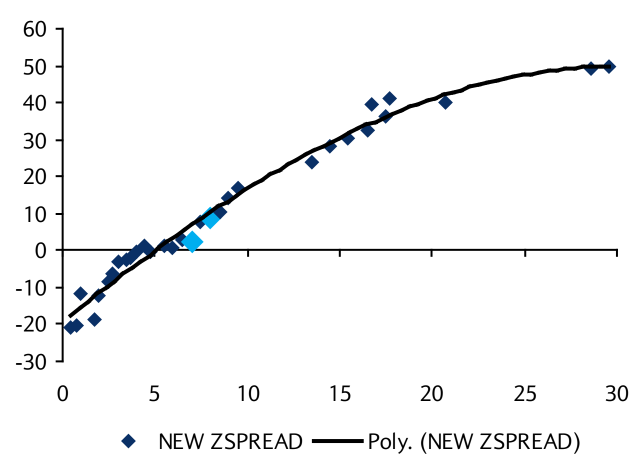
In this case, Jul18s are cheap because of neutral + cheap status via two consecutive pairs (Jul17-Jul18, which are neutrals; Jul18-Jul19 fwd, which is cheap-rich) while Jul19s are trading rich (Jul18-Jul19 (cheap-rich) marks Jul19s are rich, while Jul19-Jul20 pair marks Jul19s as neutral). We go through this exercise for each security and identify rich/cheap securities versus the forwards. One thing to keep in mind is that forward rate trades have a curve level risk; ie, if the broad level of real yields moves up, this forward rate trade can get hurt.

For the second measure, we look at the *TIPS Pricing Report* (Figure 4). Here we look at TIPS securities versus a real spline (the Barclays real spline is not floor or seasonality adjusted, as we expect these adjustments to change gradually) to determine rich/cheap on a 3m z-score basis of the current bond real yield versus matched-maturity curve real yield. As of April 30, 2012 the Jul18s in this relative value sheet have a 3m z-score of -1.3 indicating that Jul18s are trading rich versus the real spline. Jul19s have a z-score of -1.9 indicating it is also rich. Given that Jul18s are showing up as cheap in the forwards report, while rich versus the TIPS real spline curve, we mark this security as neutral or with a total TIPScore of zero. The Jul19s have appeared rich on the forwards as well as versus the real spline, indicating that the security is rich with a total score of -2.

Lastly (Figure 3), we look at z-spread ASWs curve (in the "curve" (search keyword on BCL tool in Barclays Live), the visual inspection versus fitted spline z-spread ASWs curve shows that both Jul18s and Jul19s are trading rich versus the z-spread ASWs curve. So in total,

FIGURE 3

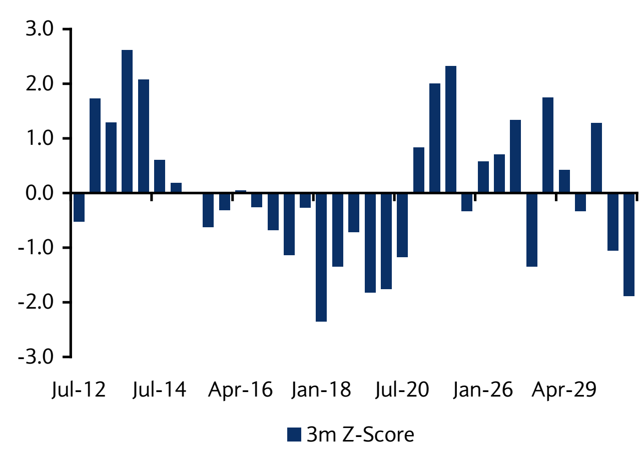
TIPS z-spread ASWs curve shows rich Jul18s and Jul19s



Note: Data available in Barclays Live Curve tool Source: Barclays Research

FIGURE 4

TIPS real yield spread (versus real spline) 3m z-score shows Jul18s are rich and Jul19s are rich



Note: Data extracted from the page 3 Inflation Linked Daily.
Source: Barclays Research

Jul18s have appeared rich on two measures (z-spread ASWs, z-score versus a real spline) while it is cheap on a forward real curve measure. We assign this security a total z-score of -1 (in rich territory). Meanwhile, Jul19s have appeared rich on only three measures; hence, this security has a total TIPScore of -3. Figure 5, shows the rich/cheap TIPScore card across all measures as of April 27, 2012.

A historical backtest of such a micro-relative value approach indicates a successful indication in identifying rich/cheap securities. See the "TIPScores" article for back-tested results of such an approach.

FIGURE 5

Rich/Cheap Scorecard as of April 27, 2012

Bond	Maturity	3m Z-Score	3m z-score vs TIPS real spline *	Z-Spread ASWs curve *	1y fwd real curve z-score ***	Total Score
TII 1.125% Jan 21	1/15/2021	0.8	Cheap	Cheap	Cheap	3
TII 0.625% Jul 21	7/15/2021	2.0	Cheap	Cheap	Cheap	3
TII 1.25% Apr 14	4/15/2014	2.1	Cheap	Neutral	Cheap	2
TII 2% Jul 14	7/15/2014	0.6	Cheap	Neutral	Cheap	2
TII 2% Jan 16	1/15/2016	-0.3	Neutral	Cheap	Cheap	2
TII 0.125% Apr 16	4/15/2016	0.1	Neutral	Cheap	Cheap	2
TII 0.125% Jan 22	1/15/2022	2.3	Cheap	Cheap	Neutral	2
TII 2.125% Feb 40	2/15/2040	1.3	Cheap	Cheap	Neutral	2
TII 1.875% Jul 13	7/15/2013	1.3	Cheap	Neutral	Neutral	1
TII 2% Jan 14	1/15/2014	2.6	Cheap	Neutral	Neutral	1
TII 1.625% Jan 15	1/15/2015	0.2	Neutral	Cheap	Neutral	1
TII 2.5% Jul 16	7/15/2016	-0.3	Neutral	Cheap	Neutral	1
TII 2.625% Jul 17	7/15/2017	-0.3	Neutral	Neutral	Cheap	1
TII 2% Jan 26	1/15/2026	0.6	Cheap	Neutral	Neutral	1
TII 2.375% Jan 27	1/15/2027	0.7	Cheap	Neutral	Neutral	1
TII 1.75% Jan 28	1/15/2028	1.3	Cheap	Neutral	Neutral	1
TII 2.5% Jan 29	1/15/2029	1.8	Cheap	Neutral	Neutral	1
TII 3.875% Apr 29	4/15/2029	0.4	Neutral	Cheap	Neutral	1
TII 0.625% Apr 13	4/15/2013	1.7	Cheap	Rich	Neutral	0
TII 0.5% Apr 15	4/15/2015	0.0	Neutral	Cheap	Rich	0
TII 0.125% Apr 17	4/15/2017	-1.1	Rich	Cheap	Neutral	0
TII 2.375% Jan 25	1/15/2025	-0.3	Neutral	Neutral	Neutral	0
TII 3.625% Apr 28	4/15/2028	-1.3	Rich	Cheap	Neutral	0
TII 3% Jul 12	7/15/2012	-0.5	Rich	Neutral	Neutral	-1
TII 1.875% Jul 15	7/15/2015	-0.6	Rich	Cheap	Rich	-1
TII 1.375% Jul 18	7/15/2018	-1.3	Rich	Rich	Cheap	-1
TII 2.125% Jan 19	1/15/2019	-0.7	Rich	Rich	Cheap	-1
TII 3.375% Apr 32	4/15/2032	-0.3	Neutral	Rich	Neutral	-1
TII 2.125% Feb 41	2/15/2041	-1.1	Rich	Neutral	Neutral	-1
TII 0.75% Feb 42	2/15/2042	-1.9	Rich	Neutral	Neutral	-1
TII 1.625% Jan 18	1/15/2018	-2.4	Rich	Rich	Neutral	-2
TII 2.375% Jan 17	1/15/2017	-0.7	Rich	Rich	Rich	-3
TII 1.875% Jul 19	7/15/2019	-1.8	Rich	Rich	Rich	-3
TII 1.375% Jan 20	1/15/2020	-1.8	Rich	Rich	Rich	-3
TII 1.25% Jul 20	7/15/2020	-1.2	Rich	Rich	Rich	-3

Note: 1y fwd real rate is calculated using a bond pair with maturities 1y apart. 1y fwd real rate = (RealRate2*ModDurationT2 - RealRate1 *ModDurationT1)/(ModDurationT2-ModDurationT1), where T2 = T1 + 1y. 1y fwd rate z-score is calculated for spreads between 1y fwd yield and 1y fwd curve, see Page7 "Market implied 1y tenor cash Forward Real Yield Curve" for more details. Source: Barclays Research

Relative value in European linkers

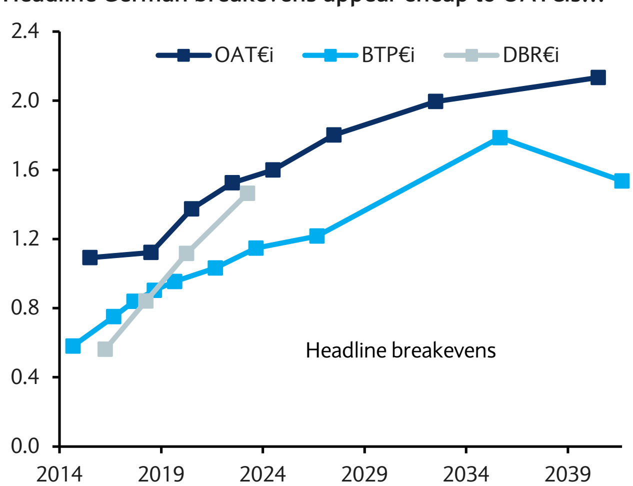
Identifying relative value in European linkers requires the isolation of country risk, which has become an increasingly important driver of valuations since the onset of the euro sovereign debt crisis. A comprehensive assessment of relative value opportunities across euro linkers can sometimes appear a cumbersome task. The multi-issuer aspect of the market, with each segment referencing a different point on the seasonality curve, clouds relative valuations between bonds. Furthermore, the euro linker market has been battered during the crisis years, more so than any other developed market, in our opinion. In that context, reduced dealer balance sheets and various sources of distortions (eg, exclusion of BTP€is from SMP) can trigger bond-specific moves that stand out as relative value opportunities but which are unlikely to see corrective momentum. As a result, to maximise the relevance of a signal as a tradable opportunity, relative value in euro linkers should be assessed using several indicators and preferably those that are commonly used in practice by market participants to identify opportunities. The analysis below is based on market levels as of 14 January 2014.

Adjusting for seasonality

The starting point for relative valuations in the euro linker market is finding a comparable breakeven measure that adjusts for the fact that bonds from the three sovereign issuers mature in different months. This difference means that real yields and breakevens between issuers are not directly comparable because the headlines measures for each issuer will be biased differently by inflation seasonality. In *Seasonality: Estimation and Adjustment*, later in this publication, we explain how to correct valuations for this seasonality bias. The output from such calculations will be subjective, as the seasonals used will user-dependent. However, we believe this is not a major issue because there is now sufficient consensus on monthly seasonality magnitudes across market participants. Figure 6 shows that headline breakevens on German linkers are notably lower than on their French counterparts, even though they reference the same price index. Adjusting for seasonals shows that their breakevens are, in fact, quite close. We note that BTP€i breakevens remain notably lower than for Germany and France even after seasonal adjustments. This highlights that valuation discrepancies can be large for other reasons. Here, for instance, the relatively low BTP€i breakeven valuations are explained by the fact that they are no longer part of major bond indices and, therefore, do not necessarily point towards relative value opportunities between issuers.

FIGURE 6

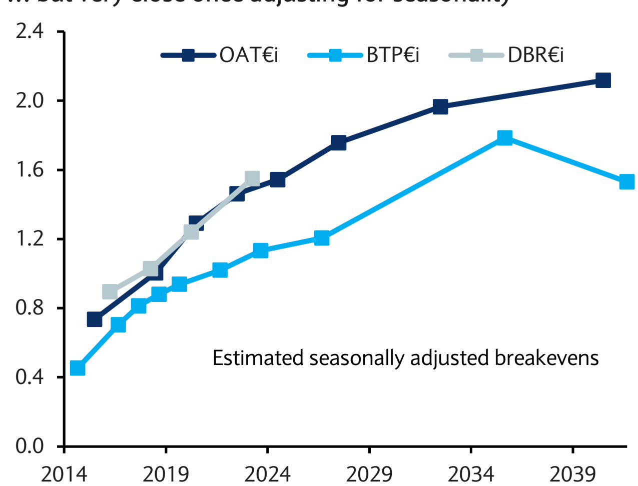
Headline German breakevens appear cheap to OAT€is…



Source: Barclays Research (14 January 2014 market levels)

FIGURE 7

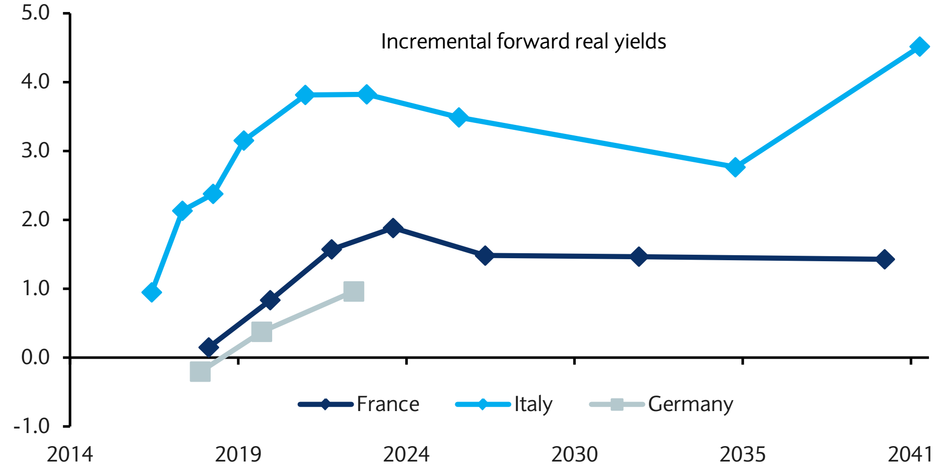
… but very close once adjusting for seasonality



Source: ECB data, Barclays Research (14 January 2014 market levels)

FIGURE 8

Incremental forward real yield curves relatively well defined



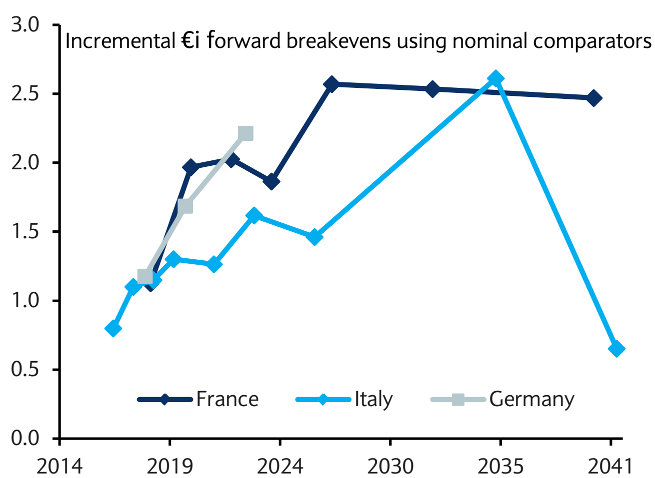
Source: Barclays Research (14 January 2014 market levels)

Incremental forward real yields and breakevens

When looking at relative value on the curve of a single issuer, more micro considerations come into play. One standard analysis here is to look at incremental forward curves of breakevens and real yields – ie, the forwards implied between a bond and the next bond shorter on the curve. Building the structure of forwards implicitly corrects the valuation of each bond for whatever the market is pricing in shorter maturities. What is calculated isolates micro relative value but nevertheless incorporates the directional element in valuations. Figure 8 shows, for instance, that the OAT€i24 is the cheapest issue on the OAT€i forward real yield curve. More generally, its shape can be interpreted as showing that the curve, in incremental terms, cheapens up to the 10y sector and richens thereafter. The relative value observation here means that the 10y sector could be the most attractive part to implement a long duration view. However, this is a static observation, and one needs to assess whether the cheapness of the 10y sector is a structural phenomenon before arriving at any conclusion from a relative value perspective.

FIGURE 9

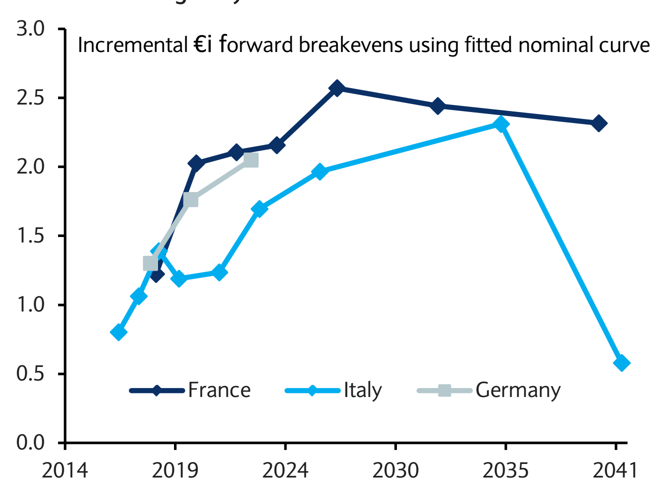
Forward breakevens curves not smooth



Source: Barclays Research (14 January 2014 market levels)

FIGURE 10

Distortions marginally reduced with fitted nominal curve



Source: Barclays Research (14 January 2014 market levels)

While forward curves are relatively well behaved in real yield, they tend to be all over the place in breakeven. This can be due to bond- or sector-specific distortions on the nominal curve, which are then reflected in breakeven and amplified on the forward curve. To smooth out such distortions, we can try maturity-matched nominal yields from a fitted curve (Figure 10). However, this does little to smooth out the forward breakeven curves in the example above.

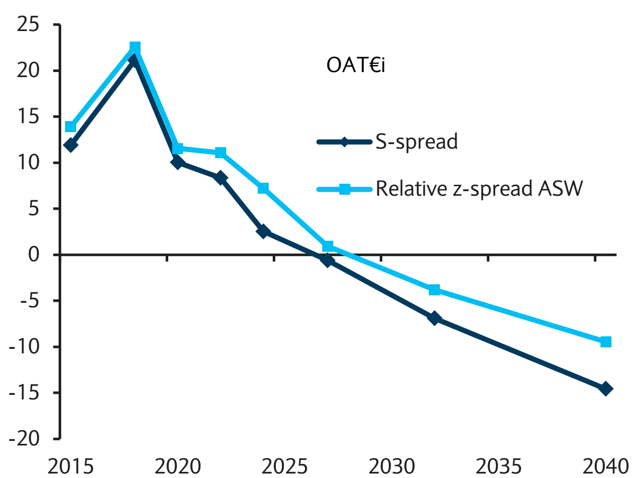
Refining asset swap measures – The S-spread

The most commonly used measures of relative value in linkers are related to asset swaps. Asset swaps are more comprehensive indicators of relative value because they integrate valuations versus the inflation swaps curve. Also, being spreads versus a nominal curve (versus Euribor for instance), asset swaps should be less directional (at least theoretically), and therefore are more appropriate to capture relative value. We typically use the z-spread asset swap. It is a purely theoretical analytical tool, but it circumvents many of the distortions inherent to tradable formats of asset swaps, such as par/par and proceeds asset swaps. For an explanation of asset swap calculations, including z-spreads, please see *Linker Asset Swaps* later in this publication. Z-spreads on linkers are also compared with those of nominals and, by construction, this relative z-spread is an expression of the relative valuation between the bond's breakeven and the corresponding inflation swaps curve.

However, the z-spread is calculated as a flat spread versus the Euribor curve and, as such, does not properly account for the credit component factored into the nominal curve. This implies that the relative z-spread asset swap would tend to be biased when credit considerations are significant. As a result, since the credit of sovereign linker issuers in the euro area (particularly Italy) has come to the forefront, a new measure has evolved. It is commonly referred to as the S-spread. As with the z-spread, it involves projecting the future cash flows of the linker using the corresponding inflation swaps curve (for instance euro HICPx). A nominal curve is then built using a set of nominal bonds from the issuer, preferably liquid issues and including (but not only) those that are normally used as nominal comparators. Nominal discount factors are then extracted from this constructed curve. The S-spread is the spread that needs to be applied to that curve such that the sum of projected linker cash flows discounted using the shifted curve is equal to the linker price. Given that it is calculated directly off a "stripped" nominal curve (hence the "S"), the S-spread measure isolates the relative bond breakeven valuation versus swaps from credit considerations. It is therefore a cleaner measure than the relative z-spread asset swap.

FIGURE 11

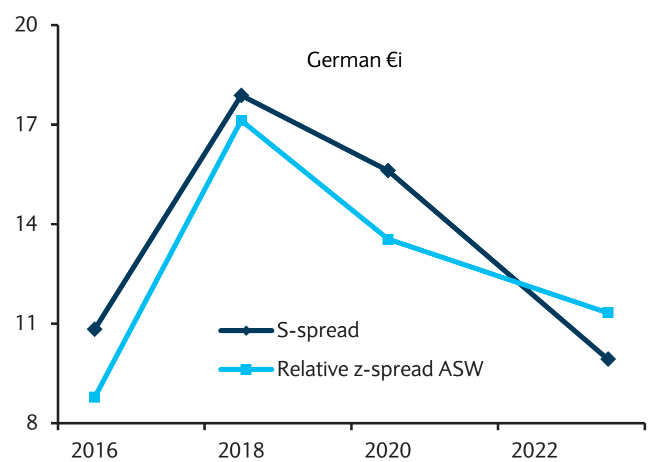
S-spread versus relative z-spreads for French €is



Source: Barclays Research (14 January 2014 market levels)

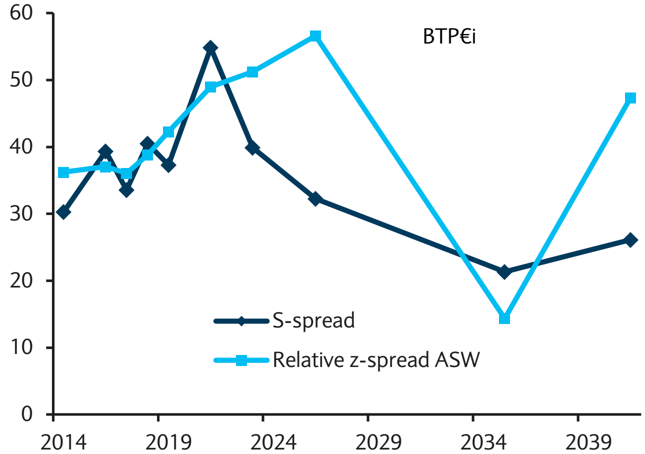
FIGURE 12

S-spread versus relative z-spreads for German €is



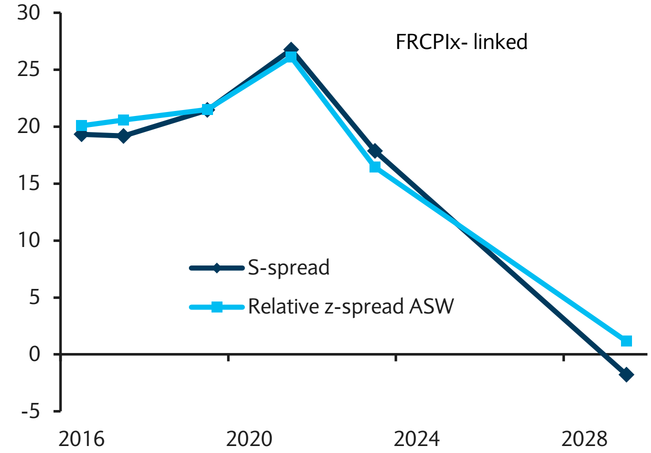
Source: Barclays Research (14 January 2014 market levels)

FIGURE 13
S-spread versus relative z-spreads for BTP€is



Source: Barclays Research (14 January 2014 market levels)

FIGURE 14
S-spread versus relative z-spreads for FRCPIx-linked OATs



Source: Barclays Research (14 January 2014 market levels)

A systematic approach to relative value

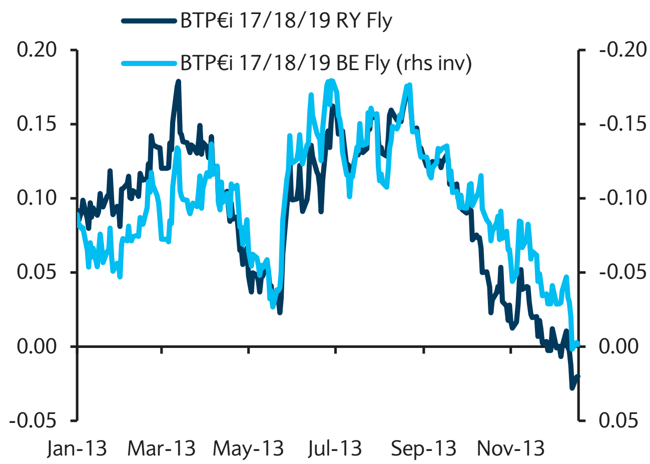
FIGURE 15
3m z-scores for relative value metrics, ranked cheap to rich (Dark blue implies rich, Grey cheap)

	Fwd RY 3m z-score	Fwd BE 3m z-score	Z-Spread 3m z-score	S-Spread 3m z-score	Weighted sum of z-scores
OAT€i18	-0.04	-0.23	0.54	-0.14	0.03
OAT€i22	-1.29	1.83	-0.43	-0.15	-0.01
OAT€i32	0.34	0.66	-0.86	-0.34	-0.05
OAT€i20	-0.11	-0.73	0.17	-0.64	-0.33
OAT€i24	-1.04	0.02	-0.61	-0.15	-0.44
OAT€i40	-0.12	0.01	-1.66	-0.40	-0.54
OAT€i15			-1.44	-0.82	-1.13
OAT€i27	-1.39	-2.28	-0.94	-0.95	-1.39
DBR€i20	-0.01	-0.11	0.52	-0.18	0.06
OBL€i18	0.05	-0.62	0.75	-0.12	0.01
DBR€i23	-0.45	0.40	-0.03	-0.66	-0.18
BTP€i19	0.51	1.24	-1.92	1.03	0.21
BTP€i26	-0.99	0.97	-1.54	-0.49	-0.51
BTP€i14			-1.08	-0.15	-0.61
BTP€i41	-1.62	1.30	-2.03	-0.11	-0.62
BTP€i16	-1.36	0.04	-1.44	-0.52	-0.82
BTP€i23	0.05	-1.56	-1.88	-0.44	-0.96
BTP€i17	-2.10	-0.65	-1.57	-0.63	-1.24
BTP€i21	-2.38	-1.01	-1.99	-1.25	-1.66
BTP€i35	-2.55	-1.22	-1.92	-1.07	-1.69
BTP€i18	-2.62	-2.03	-1.72	-1.01	-1.84
OATi23	0.43	2.73	-0.32	-0.05	0.70
OATi21	-0.15	-0.05	-0.04	-0.40	-0.16
OATi17	-0.03	-0.06	-0.39	-0.21	-0.17
OATi19	0.17	-0.21	0.00	-0.70	-0.18
OATi29	0.47	-0.29	-0.66	-0.53	-0.25
BTANi16			-0.71	0.04	-0.33

Source: Barclays Research (14 January 2014 market levels)

FIGURE 16

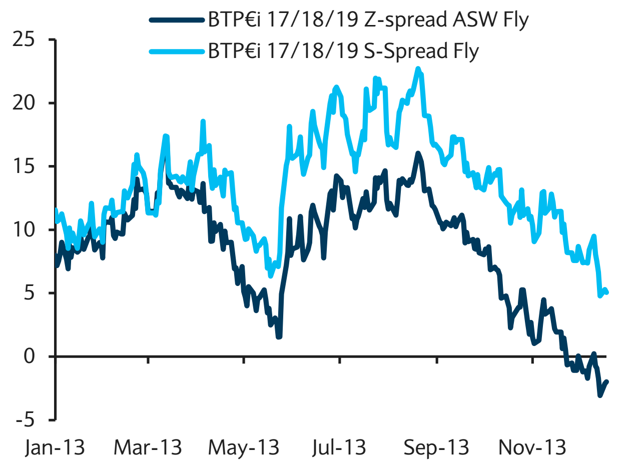
BTP€i18 richening on the curve in real yield, breakeven…



Source: Barclays Research (series up to14 January 2014)

FIGURE 17

… and absolute and relative asset swap



Source: Barclays Research (series up to14 January 2014)

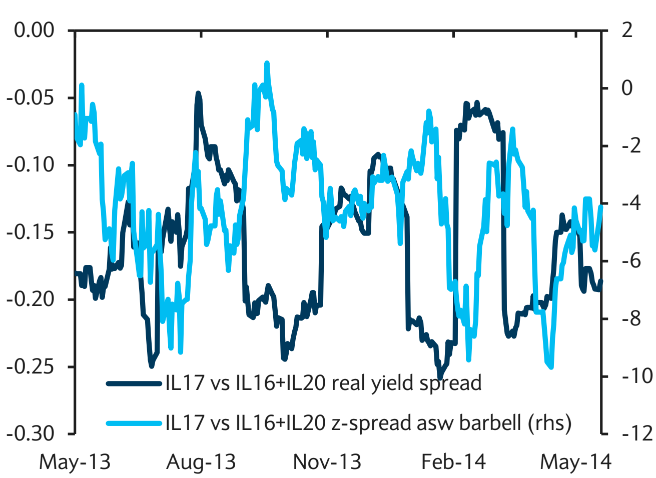
We can aggregate the metrics discussed above to have a systematic relative value framework, but we also move beyond a static approach by taking their 3m z-scores. We retain the incremental forward real yields and breakevens, the z-spread asset swap and the S-spread measures. For each bond, we sum up the z-scores and use the averages to rank the different issues. We can weight the relative importance of the different metrics differently, but we feel that each is relevant enough for equal weightings (however, for the shortest bonds, incremental forwards are not available, and the importance of the asset swap measures is therefore doubled).

Relative value in UK linkers

Assessing relative value in UK linkers is perhaps the least straightforward of the three major inflation markets. The different indexation models underpinning old-style 8m linkers and new-style 3m linkers mean that comparing the real yield spread of the various issues is a poor guide to relative value. Old-style linker real yields are adjusted at each RPI print to account for the difference between actual inflation accretion and the 3% linear assumption embedded in the pricing formula for the bonds. New-style linkers by contrast follow the internationally standard Canadian model for indexation. UK linkers do not have a deflation floor, so this

FIGURE 18

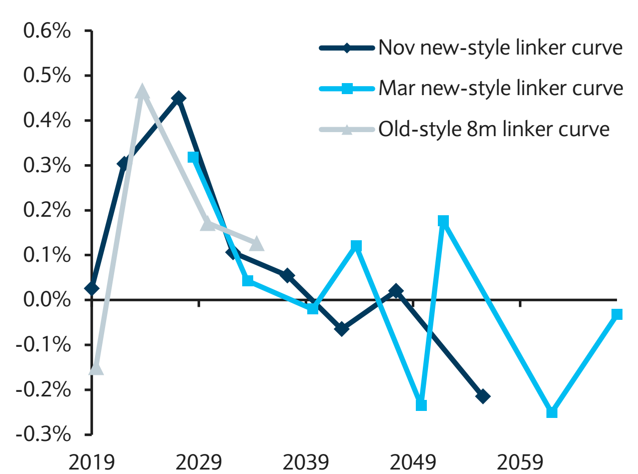
Old-style real yields distorted by adjustment



Source: Barclays Research

FIGURE 19

Forward UK real yield curves



Source: Barclays Research

complication is avoided when valuing linkers. New-style linkers are issued with both November and March maturities creating a seasonal differential between the two issues. This means that when constructing forward real yields, best practice is to compare old-style issues with old-style and for new-styles forwards between Nov/Nov and Mar/Mar issues to avoid distortions. Our preferred relative value metric for UK linkers is the z-spread asset swap, which is calculated via an iterative process. The measure is calculated by projecting the real bond flows into nominal space and then determining the parallel shift that needs to be applied to the nominal curve to equate the discounted value of the cash flows and the bond's dirty price (the full settlement price of the bond including accrued interest and inflation uplift).

Figure 18 shows a chart of the new-style IL17 plotted against a real yield barbell of the old-style IL16+20. As can be seen, the real yields significantly exaggerate the moves, whereas the z-spread measure is more stable and not subject to as many discrete jumps. When assessing micro relative value, we tend to always compare real yield, breakeven and z-spread flies to come to a clear conclusion. Forward real yields are an important element of assessing value in the UK linker market, given the prevalence of indexation among domestic investors. Long-dated linker supply results in benchmark indices extending, and as such active managers face being taken short duration versus their benchmarks. Unlike passive managers, actives have a choice as to which longer-dated bonds to buy and which shorter bonds to sell. Forward real yields offer a guide as to which bonds offer the best value for a cash-for-cash extension trade, generally is advantageous to sell and buy the two bonds between which the implied forward yield is cheapest (ie, highest).

Moving towards a relative value framework

Figure 20 shows a range of 3m z-scores ([Spot Level – 3m Avg]/3m STDEV) for various linker metrics. We then sum up these z-scores, and divide these by the number of available metrics and subsequently use this to rank the various linkers on the curve in order of cheapness. Cheap issues appear first in the table, and rich issues at the bottom. Where we use a z-spread butterfly as an indicator of relative value, links to a chart in Barclays Live appear in last right-hand column of the table. At present, Barclays Live does not provide the facility to chart bond/bond forward yields and so we are unable to offer this facility.

Z-spread asset swap is the cleanest measure of RV

We show the z-spread asset swap as a measure of outright richness/cheapness. This strips out distortions between old- and new-style linkers, and also seasonality. The z-spread asset swap is defined as the bp shift by which the nominal swap curve needs to be bumped in order to make the discounted value of the inflation-uplifted linker cash flows (determined by the current RPI swap curve) equal to the bond's dirty price. This provides a consistent measure for comparing different linkers. The z-score of the outright z-spread also provides an indication as to the relative performance of various parts of the curve. For analysing RV, the z-scores of the incremental forward real yields are useful for identifying which parts of the curve have underperformed. Given the issues we described earlier with using a fitted curve, we instead have constructed a series of butterfly structures. We aim to use relatively nearby bonds for each linker, but also minimise the residual duration of the butterfly structure to avoid directional bias. At the ultra-long end of the curve, this means that the flies we analyse use notably shorter bonds given the very high duration of the IL62 and IL68. We believe these combinations of bonds to be relatively frequently traded, potentially having the advantage of easily transforming relative value indicators into trade ideas. However, systematic relative value indicators should not be used blindly, and indeed just because a bond has cheapened over a 3m horizon does not make it structurally cheap. Instead, we think the advantage of our UK linker relative value framework is that it provides a quick screen of moves across UK linkers from a number of different standpoints but that it is merely a starting point for guiding analysis.

FIGURE 20

3m z-scores for various UK linker relative value metrics, ranked cheap to rich (Dark blue implies rich, Grey cheap)

		Z-spread 3m z-score	Fwd RY 3m z-score	Z-spd fly 3m z-score	Weighted sum of z-scores	Fly structure
IL47	3m lag Nov	-1.68	0.40	2.79	0.50	*IL42/IL47/IL55*
IL44	3m lag Mar	-1.78	1.08	1.18	0.16	*IL40/IL44/Il50*
IL27	3m lag Nov	-1.21	-0.95	1.78	-0.13	*IL22/IL27/IL32*
IL20	8m lag	-1.37	0.37	-0.01	-0.34	*IL17/IL20/IL22*
IL50	3m lag Mar	-1.65	-0.23	0.72	-0.39	*IL47/IL50/IL55*
IL17	3m lag Nov	-1.33		0.49	-0.42	*IL16/IL17/IL20*
IL40	3m lag Mar	-2.05	0.17	0.56	-0.44	*IL37/IL40/IL42*
IL24	8m lag	-1.32	-0.82	0.64	-0.50	*IL20/IL24/IL27*
new IL24	3m lag Mar	-1.30	-0.60	0.27	-0.54	*IL22/new IL24/IL27*
IL42	3m lag Nov	-1.95	0.40	-0.42	-0.66	*IL40/IL42/IL44*
IL22	3m lag Nov	-1.34	-0.54	-0.49	-0.79	*IL20/IL22/new IL24*
IL52	3m lag Mar	-1.72	-0.26	-0.61	-0.86	*IL44/IL52/IL62*
IL29	3m lag Mar	-1.85	-1.60	0.52	-0.98	*new IL24/IL29/IL34*
IL68	3m lag Mar	-1.64	-0.52		-1.08	
IL55	3m lag Nov	-1.88	-0.78	-0.83	-1.16	*IL40/IL55/IL62*
IL62	3m lag Mar	-1.96	-1.02	-0.82	-1.27	*IL55/IL62/IL68*
IL30	8m lag	-2.63	-1.59	0.02	-1.40	*IL24/IL30/IL35*
IL34	3m lag Mar	-2.56	-0.91	-0.75	-1.41	*IL29/IL34/IL40*
IL37	3m lag Nov	-2.62	-0.36	-1.62	-1.53	*IL32/IL37/IL42*
IL32	3m lag Nov	-2.42	-1.87	-1.33	-1.87	*IL27/IL32/IL37*
IL35	8m lag	-3.13	-1.66	-1.10	-1.96	*IL30/IL35/IL37*
IL16	8m lag	-2.13			-2.13	

Note: Fly structures link to dynamic data in Barclays Live Chart. Source: Barclays Research

INFLATION THEMES

Barclays Live: Inflation Market Analytics

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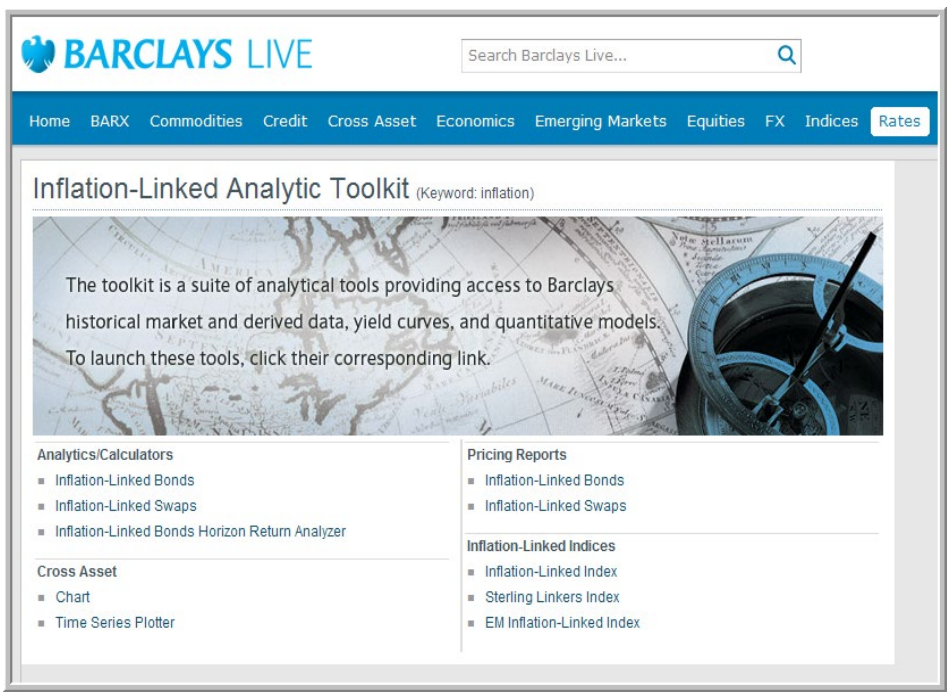
Barclays Live offers a proprietary suite of inflation-linked analytical tools, indices, and market data to identify relative value in the global inflation markets and against other asset classes. In addition, all Inflation-linked research is available on Barclays Live in real time and can be received automatically via email or read anywhere from the new Barclays Live iPad app.

Inflation-Linked Analytic Toolkit *(Keyword: Inflation)*

The Inflation-Linked Analytics Toolkit provides a suite of tools and quantitative models to analyse the global inflation linked markets. Features include:

- Calculators to estimate projected total returns, yields, carry and breakevens.
- Relative value tools to view historical data, regressions, correlations and curves.
- Daily pricing reports that display market data and highlight statistical value across issues and tenors.
- Global Inflation-Linked Indices with market metrics on each index and sub-index.



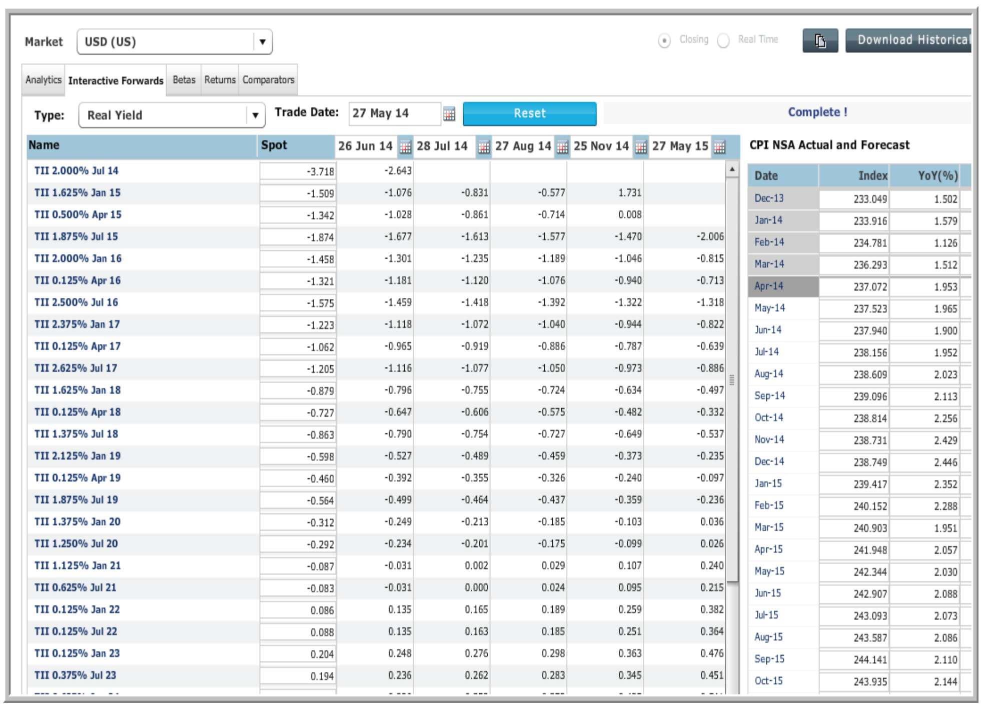
**The listed individual is a member of Barclays Live Sales and is not a research analyst.*

Calculators

Inflation-Linked Bonds *(*Keyword*: ILBond)*

Global inflation bond analysis including forward carry and breakeven calculations, as well as beta and returns data.

- Monitor inflation-linked market data by currency and view historical data for linkers or spreads.
- Input user-defined inflation and repo assumptions to calculate forward carry, real yields, breakeven inflation, and breakeven protection for inflation-linked bonds.
- Adjust spot rates to see the effect on forwards at multiple horizons.
- Customise CPI forecasts by index or percentage.
- View yield and returns beta calculations, as well as daily, monthly, and year-to-date total returns.



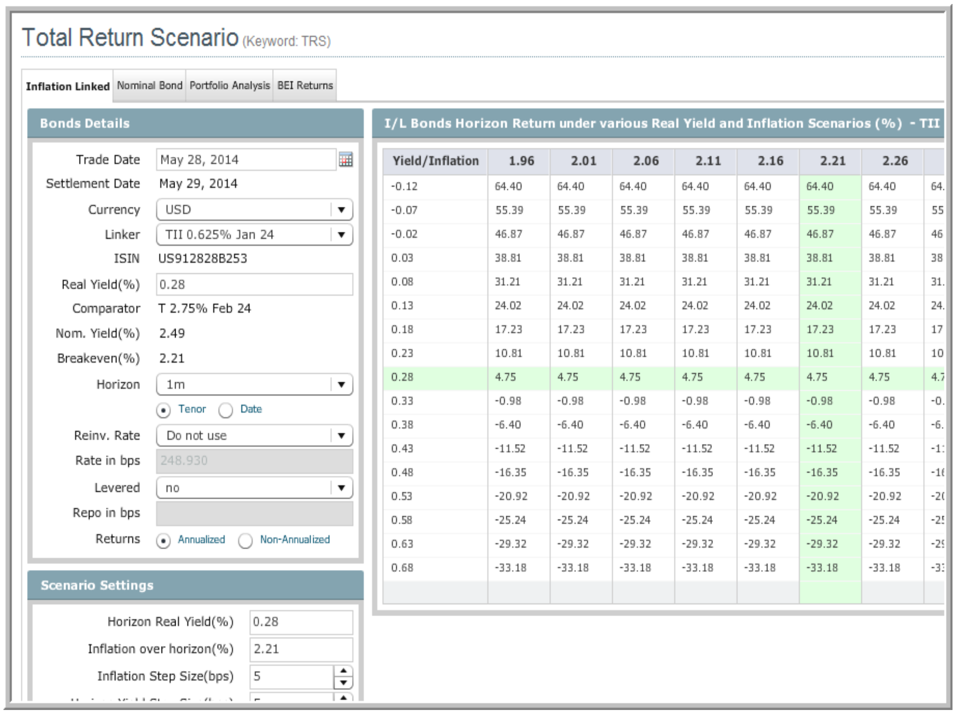
Name	Spot	26 Jun 14	28 Jul 14	27 Aug 14	25 Nov 14	27 May 15
TII 2.000% Jul 14	-3.718	-2.643				
TII 1.625% Jan 15	-1.509	-1.076	-0.831	-0.577	1.731	
TII 0.500% Apr 15	-1.342	-1.028	-0.861	-0.714	0.008	
TII 1.875% Jul 15	-1.874	-1.677	-1.613	-1.577	-1.470	-2.006
TII 2.000% Jan 16	-1.458	-1.301	-1.235	-1.189	-1.046	-0.815
TII 0.125% Apr 16	-1.321	-1.181	-1.120	-1.076	-0.940	-0.713
TII 2.500% Jul 16	-1.575	-1.459	-1.418	-1.392	-1.322	-1.318
TII 2.375% Jan 17	-1.223	-1.118	-1.072	-1.040	-0.944	-0.822
TII 0.125% Apr 17	-1.062	-0.965	-0.919	-0.886	-0.787	-0.639
TII 2.625% Jul 17	-1.205	-1.116	-1.077	-1.050	-0.973	-0.886
TII 1.625% Jan 18	-0.879	-0.796	-0.755	-0.724	-0.634	-0.497
TII 0.125% Apr 18	-0.727	-0.647	-0.606	-0.575	-0.482	-0.332
TII 1.375% Jul 18	-0.863	-0.790	-0.754	-0.727	-0.649	-0.537
TII 2.125% Jan 19	-0.598	-0.527	-0.489	-0.459	-0.373	-0.235
TII 0.125% Apr 19	-0.460	-0.392	-0.355	-0.326	-0.240	-0.097
TII 1.875% Jul 19	-0.564	-0.499	-0.464	-0.437	-0.359	-0.236
TII 1.375% Jan 20	-0.312	-0.249	-0.213	-0.185	-0.103	0.036
TII 1.250% Jul 20	-0.292	-0.234	-0.201	-0.175	-0.099	0.026
TII 1.125% Jan 21	-0.087	-0.031	0.002	0.029	0.107	0.240
TII 0.625% Jul 21	-0.083	-0.031	0.000	0.024	0.095	0.215
TII 0.125% Jan 22	0.086	0.135	0.165	0.189	0.259	0.382
TII 0.125% Jul 22	0.088	0.135	0.163	0.185	0.251	0.364
TII 0.125% Jan 23	0.204	0.248	0.276	0.298	0.363	0.476
TII 0.375% Jul 23	0.194	0.236	0.262	0.283	0.345	0.451

Date	Index	YoY(%)
Dec-13	233.049	1.502
Jan-14	233.916	1.579
Feb-14	234.781	1.126
Mar-14	236.293	1.512
Apr-14	237.072	1.953
May-14	237.523	1.965
Jun-14	237.940	1.900
Jul-14	238.156	1.952
Aug-14	238.609	2.023
Sep-14	239.096	2.113
Oct-14	238.814	2.256
Nov-14	238.731	2.429
Dec-14	238.749	2.446
Jan-15	239.417	2.352
Feb-15	240.152	2.288
Mar-15	240.903	1.951
Apr-15	241.948	2.057
May-15	242.344	2.030
Jun-15	242.907	2.088
Jul-15	243.093	2.073
Aug-15	243.587	2.086
Sep-15	244.141	2.110
Oct-15	243.935	2.144

Inflation-Linked Horizon Analyzer (Keyword*: ILHRA*)

Scenario analysis with total return calculations for inflation-linked bonds under various inflation realisations and real yield shifts through horizon.

- Calculate nominal total returns under various nominal yield shifts through horizon.
- View aggregate scenario returns for an inflation-linked bond portfolio in the Inflation-linked bonds portfolio analysis tab.
- Analyse in multiple currencies, horizons and linker markets.

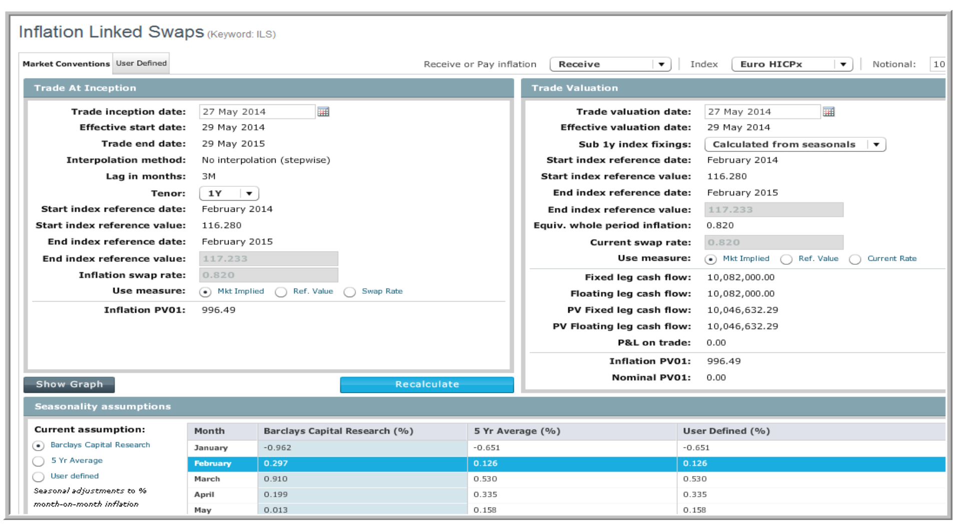


Yield/Inflation	1.96	2.01	2.06	2.11	2.16	2.21	2.26
-0.12	64.40	64.40	64.40	64.40	64.40	64.40	64.40
-0.07	55.39	55.39	55.39	55.39	55.39	55.39	55.39
-0.02	46.87	46.87	46.87	46.87	46.87	46.87	46.87
0.03	38.81	38.81	38.81	38.81	38.81	38.81	38.81
0.08	31.21	31.21	31.21	31.21	31.21	31.21	31.21
0.13	24.02	24.02	24.02	24.02	24.02	24.02	24.02
0.18	17.23	17.23	17.23	17.23	17.23	17.23	17.23
0.23	10.81	10.81	10.81	10.81	10.81	10.81	10.81
0.28	4.75	4.75	4.75	4.75	4.75	4.75	4.75
0.33	-0.98	-0.98	-0.98	-0.98	-0.98	-0.98	-0.98
0.38	-6.40	-6.40	-6.40	-6.40	-6.40	-6.40	-6.40
0.43	-11.52	-11.52	-11.52	-11.52	-11.52	-11.52	-11.52
0.48	-16.35	-16.35	-16.35	-16.35	-16.35	-16.35	-16.35
0.53	-20.92	-20.92	-20.92	-20.92	-20.92	-20.92	-20.92
0.58	-25.24	-25.24	-25.24	-25.24	-25.24	-25.24	-25.24
0.63	-29.32	-29.32	-29.32	-29.32	-29.32	-29.32	-29.32
0.68	-33.18	-33.18	-33.18	-33.18	-33.18	-33.18	-33.18

Inflation-Linked Swaps Calculator (*Keyword*: ILSwaps)

Inflation-Linked swap anlaysis with user defined inputs that affect cashflows and P&L calculations.

- View month-on-month inflation rates that can be based on Barclays research, a five-year average, or user-defined.
- Define the inflation-linked index in multiple currencies.
- View outputs for inflation and nominal PV01 and cash flows on fixed and floating legs.



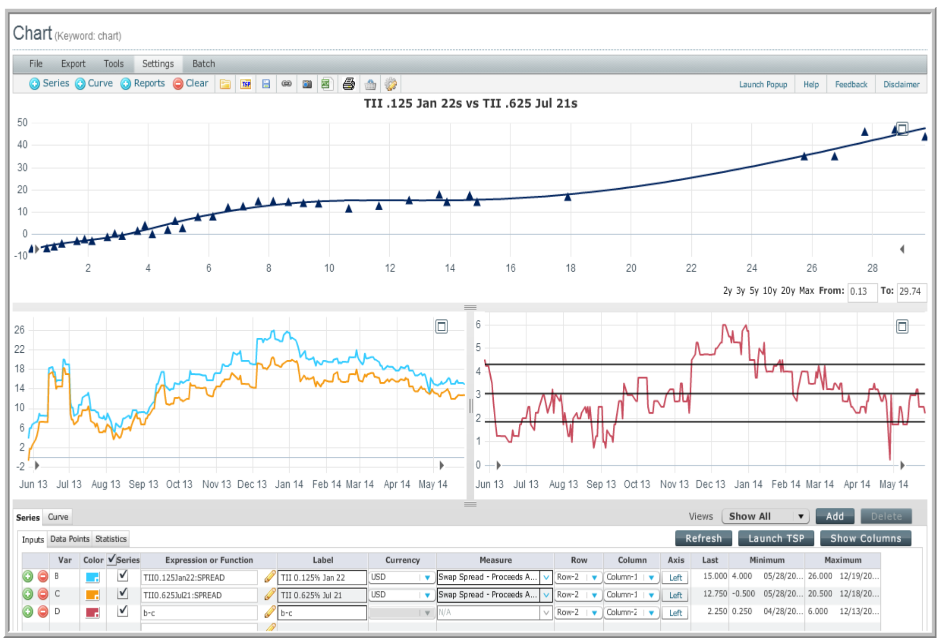
Month	Barclays Capital Research (%)	5 Yr Average (%)	User Defined (%)
January	-0.962	-0.651	-0.651
February	0.297	0.126	0.126
March	0.910	0.530	0.530
April	0.199	0.335	0.335
May	0.013	0.158	0.158

Relative Value Analytics and Market data

Chart (Keyword: Chart)

Perform time series and curve analysis for global inflation-linked markets or against other asset classes.

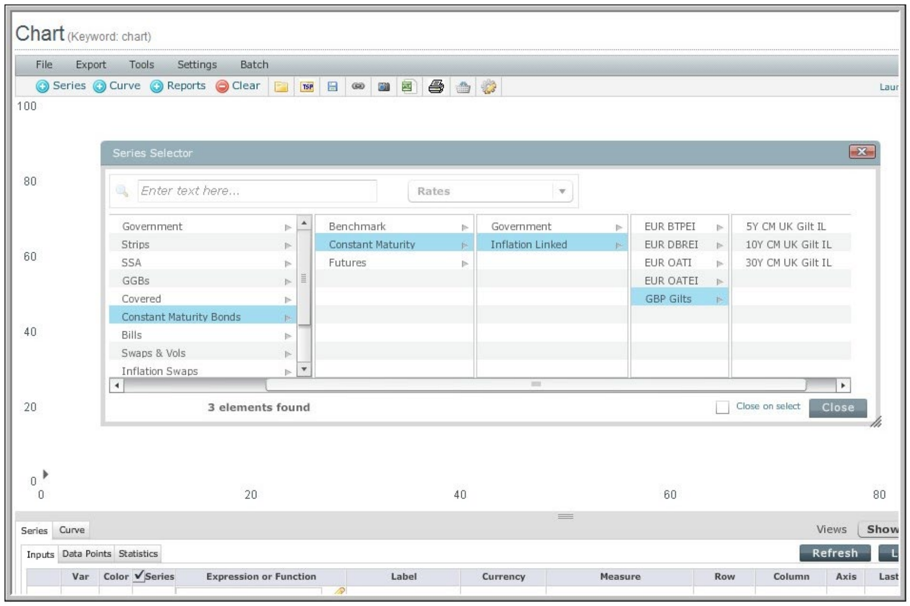
- Graph and download historical data for inflation-linked bond metrics.
- Compare linker spreads and yields by maturity or duration.
- View the change in a curve over specified periods to show the curve shape change and which linkers have out- or underperformed the most.
- Calculate statistics on the fly and view correlation, regression, or residual charts.
- Schedule batch email reports to receive charts and data automatically via email.
- Upload custom portfolios of bonds to track investments quickly and easily.



Constant Maturity Analysis in Chart

TIPS benchmark data have been available on Barclays Live for a number of years and are based on the current on-the-run bond. In Europe and the UK, the spacings between maturities can be significant; thus, we use an interpolation as opposed to a benchmark approach. We linearly interpolate between two liquid issues with maturities on either side of the tenor selected for the constant maturity series. For example, the 10y OAT€i constant maturity is a linear interpolation between the real yields and breakevens of the OAT€i22 and OAT€i24. The weighting is calculated as: w1=(Target Maturity – Short Bond life)/(Long Bond life – Short Bond life), so weightings may differ for the bonds on either side of the tenor. As such, the methodology is an approximation but is the best option, in our view, for the euro and UK inflation markets.

- Graph and download historical data for TIPS benchmarks and EU and UK linker constant maturities in the Chart + **Series** menu under Rates > Constant Maturities.



Pricing reports

Customisable reports that display market data and relative value metrics for individual issues in either single or multiple currencies.

- Access the reports directly from Chart to view historical graphs for any data points displayed or pull from the pricing reports page within the Inflation-linked analytic toolkit.

Inflation-Linked Bond reports (Keyword: RVINBond)

- Customise the columns displayed and sort or filter by the catergories. For instance, click on one of the z-spread columns to view rich/cheap bonds in order relative to the swap or cash curve.

BARCLAYS

Export Tools

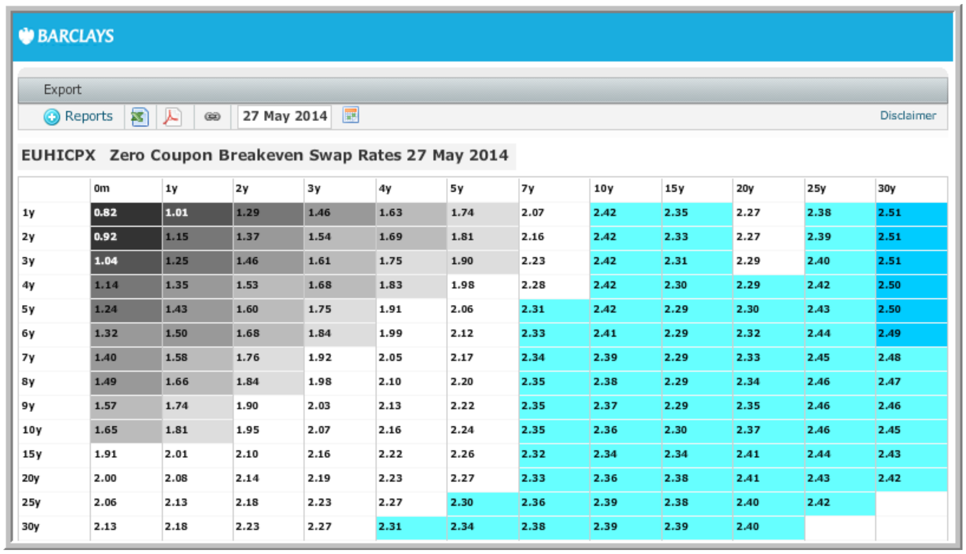
Reports Curve LIVE

USD Inflation Linked Bond Report

Issue	ISIN	Coupon	Maturity	Issue Size	DV01	Price	Real Yield	Breakeven Spread Current	Breakeven to Swaps 3M Z Score	Spread to Fitted Curve 3M Z Score	Breakeven Protections 3M	Spread to Fitted Curve Current	Swap Spread Proceeds ASW	Swap Spread Calculated proceeds ASW	Swap Spread Z Spread ASW	Current
TII 2.000% Jul 14	US912828CP39	2.000	15-Jul-14	19.0	0.13	100.71	-3.563	3.604	-1.04	0.72		-198....	-6.2	-5.88	-6.3	3.
TII 1.625% Jan 15	US912828DH04	1.625	15-Jan-15	19.0	0.65	101.95	-1.462	1.525	-2.13	2.62	0.93	18.23	-6.0	-6.43	-6.0	1.
TII 0.500% Apr 15	US912828MY36	0.500	15-Apr-15	21.2	0.90	101.61	-1.318	1.398	-1.53	1.99	0.61	30.50	-5.2	-5.50	-5.3	1.
TII 1.875% Jul 15	US912828EA42	1.875	15-Jul-15	17.0	1.18	104.26	-1.845	1.974	-1.13	0.77	0.27	-24.76	-4.0	-3.89	-4.0	2.
TII 2.000% Jan 16	US912828ET33	2.000	15-Jan-16	17.0	1.72	105.72	-1.458	1.698	-0.92	1.03	0.23	6.77	-2.7	-2.52	-2.8	1.
TII 0.125% Apr 16	US912828QD52	0.125	15-Apr-16	38.4	1.94	102.75	-1.318	1.637	-0.77	0.94	0.20	14.83	-2.0	-2.26	-2.0	1.
TII 2.500% Jul 16	US912828FL97	2.500	15-Jul-16	20.0	2.29	108.87	-1.584	2.009	-0.45	0.42	0.13	-18.09	-2.7	-2.87	-2.8	2.
TII 2.375% Jan 17	US912828GD62	2.375	15-Jan-17	17.2	2.84	109.70	-1.245	1.871	0.10	-2.73	0.12	0.51	-1.0	-1.21	-1.0	1.
TII 0.125% Apr 17	US912828SQ48	0.125	15-Apr-17	44.4	2.99	103.55	-1.087	1.795	0.35	-2.66	0.11	7.57	0.5	-1.29	0.5	1.
TII 2.625% Jul 17	US912828GX27	2.625	15-Jul-17	14.0	3.43	112.36	-1.239	2.080	-0.02	-1.44	0.08	-14.66	-0.5	-0.83	-0.5	2.
TII 1.625% Jan 18	US912828HN36	1.625	15-Jan-18	16.4	3.90	109.41	-0.920	1.968	0.29	-1.38	0.07	0.98	1.8	0.49	1.8	2.
TII 0.125% Apr 18	US912828UX60	0.125	15-Apr-18	50.0	4.02	103.55	-0.774	1.912	0.46	-1.04	0.07	7.12	4.3	1.25	4.3	1.
TII 1.375% Jul 18	US912828JE19	1.375	15-Jul-18	15.0	4.44	109.63	-0.910	2.124	0.22	-0.51	0.05	-12.98	0.3	-0.90	0.2	2.
TII 2.125% Jan 19	US912828JX99	2.125	15-Jan-19	14.7	5.05	113.07	-0.653	2.053	0.43	-0.92	0.05	-0.22	2.3	1.60	2.4	2.
TII 0.125% Apr 19	US912828C996	0.125	15-Apr-19	18.0	5.03	103.12	-0.507	1.980			0.05	5.70	6.3	2.38	6.2	2.
TII 1.875% Jul 19	US912828LA68	1.875	15-Jul-19	15.2	5.59	113.03	-0.622	2.185	0.47	-0.83	0.04	-9.45	3.0	2.10	3.1	2.
TII 1.375% Jan 20	US912828MF47	1.375	15-Jan-20	19.0	6.00	109.97	-0.377	2.077	0.13	0.76	0.04	3.63	8.0	6.14	8.1	2.
TII 1.250% Jul 20	US912828NM88	1.250	15-Jul-20	32.4	6.54	109.99	-0.362	2.166	0.20	0.41	0.03	-4.70	8.3	6.50	8.3	2.
TII 1.125% Jan 21	US912828PP91	1.125	15-Jan-21	36.7	6.97	108.58	-0.162	2.060	0.17	0.83	0.03	6.21	12.3	9.79	12.2	2.
TII 0.625% Jul 21	US912828QV50	0.625	15-Jul-21	35.8	7.39	105.62	-0.159	2.201	0.35	0.61	0.02	-2.58	12.8	9.57	12.4	2.

Inflation-Linked Swap reports (Keyword: RVINSwap)

- View inflation-linked zero coupon breakeven and real swap rates for spot and forwards with rich/cheap heat maps based on the 1 year z-score.
- When accessed via the + Reports menu in chart, you can pull up reports for previous days and view the difference in the spot and forward rates between two dates.

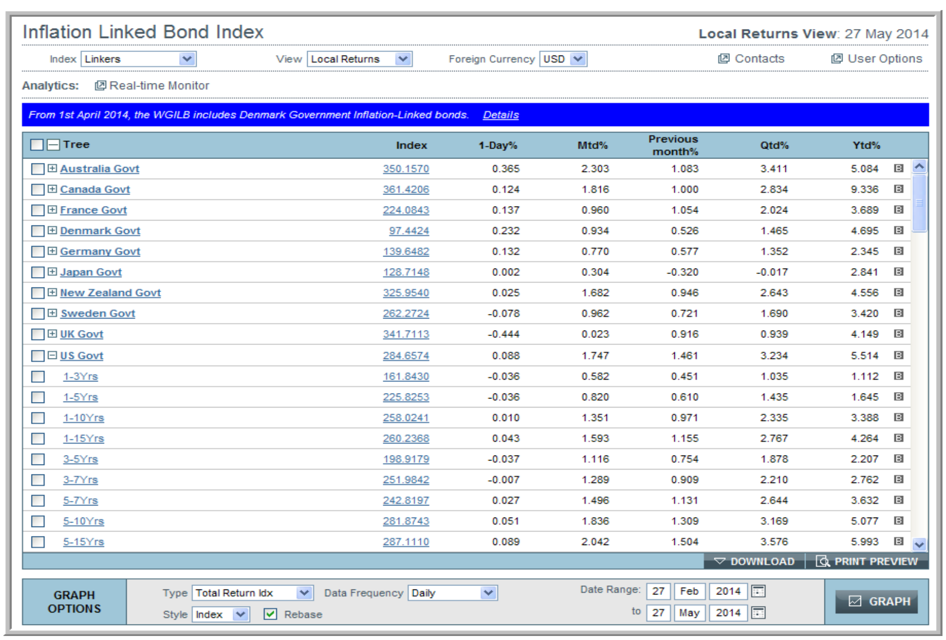


	0m	1y	2y	3y	4y	5y	7y	10y	15y	20y	25y	30y
1y	0.82	1.01	1.29	1.46	1.63	1.74	2.07	2.42	2.35	2.27	2.38	2.51
2y	0.92	1.15	1.37	1.54	1.69	1.81	2.16	2.42	2.33	2.27	2.39	2.51
3y	1.04	1.25	1.46	1.61	1.75	1.90	2.23	2.42	2.31	2.29	2.40	2.51
4y	1.14	1.35	1.53	1.68	1.83	1.98	2.28	2.42	2.30	2.29	2.42	2.50
5y	1.24	1.43	1.60	1.75	1.91	2.06	2.31	2.42	2.29	2.30	2.43	2.50
6y	1.32	1.50	1.68	1.84	1.99	2.12	2.33	2.41	2.29	2.32	2.44	2.49
7y	1.40	1.58	1.76	1.92	2.05	2.17	2.34	2.39	2.29	2.33	2.45	2.48
8y	1.49	1.66	1.84	1.98	2.10	2.20	2.35	2.38	2.29	2.34	2.46	2.47
9y	1.57	1.74	1.90	2.03	2.13	2.22	2.35	2.37	2.29	2.35	2.46	2.46
10y	1.65	1.81	1.95	2.07	2.16	2.24	2.35	2.36	2.30	2.37	2.46	2.45
15y	1.91	2.01	2.10	2.16	2.22	2.26	2.32	2.34	2.34	2.41	2.44	2.43
20y	2.00	2.08	2.14	2.19	2.23	2.27	2.33	2.36	2.38	2.41	2.43	2.42
25y	2.06	2.13	2.18	2.23	2.27	2.30	2.36	2.39	2.38	2.40	2.42	
30y	2.13	2.18	2.23	2.27	2.31	2.34	2.38	2.39	2.39	2.40		

Global Inflation-Linked Indices (Keyword: Inflation-Linked Index)

Access index values and returns for dollar, sterling, and emerging markets indices and their sub-indices.

- Choose the index region from the top and view returns in any currency.
- Click on the index or sub-index to view values for that index and more index buckets and to download the constituents of the index.



Tree	Index	1-Day%	Mtd%	Previous month%	Qtd%	Ytd%
Australia Govt	350.1570	0.365	2.303	1.083	3.411	5.084
Canada Govt	361.4206	0.124	1.816	1.000	2.834	9.336
France Govt	224.0843	0.137	0.960	1.054	2.024	3.689
Denmark Govt	97.4424	0.232	0.934	0.526	1.465	4.695
Germany Govt	139.6482	0.132	0.770	0.577	1.352	2.345
Japan Govt	128.7148	0.002	0.304	-0.320	-0.017	2.841
New Zealand Govt	325.9540	0.025	1.682	0.946	2.643	4.556
Sweden Govt	262.2724	-0.078	0.962	0.721	1.690	3.420
UK Govt	341.7113	-0.444	0.023	0.916	0.939	4.149
US Govt	284.6574	0.088	1.747	1.461	3.234	5.514
1-3Yrs	161.8430	-0.036	0.582	0.451	1.035	1.112
1-5Yrs	225.8253	-0.036	0.820	0.610	1.435	1.645
1-10Yrs	258.0241	0.010	1.351	0.971	2.335	3.388
1-15Yrs	260.2368	0.043	1.593	1.155	2.767	4.264
3-5Yrs	198.9179	-0.037	1.116	0.754	1.878	2.207
3-7Yrs	251.9842	-0.007	1.289	0.909	2.210	2.762
5-7Yrs	242.8197	0.027	1.496	1.131	2.644	3.632
5-10Yrs	281.8743	0.051	1.836	1.309	3.169	5.077
5-15Yrs	287.1110	0.089	2.042	1.504	3.576	5.993

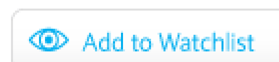
Research (Keyword: InfPubs)

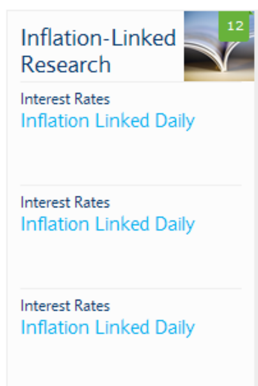
The following Inflation-linked reports are available on Barclays Live and can be subscribed to from the Subscriptions page of Barclays Live (*keyword:Subscriptions*) or set up in Tiles to be viewed in your *Watchlist* on the desktop or on the Barclays Live iPad app.

- Inflation-Linked Monthly
- Inflation-Linked Daily
- Daily US Inflation Forwards Packet (Rich/Cheap securities table)
- Weekly Commentary
- Inflation-Linked Special Reports
- Inflation Volatility Market Report
- US TIPS Relative Value Report
- Periodic Inflation-Derivatives Digest
- Monthly US CPI Monitor from the US Economics Team

You can view forecasts by region for consumer prices, real GDP, central bank rates, global bond yields, commodities and FX from the Global forecasts page (Keyword: Forecasts)

Read research on the go with the new Barclays Live iPad app. Tiles in your Watchlist can be customised to include various research feeds and saved for off-line reading or viewed directly from your desktop.

To add a custom Inflation-Linked Research tile click here: 



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INFLATION THEMES

Economic implications of demographic change

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- **According to United Nations projections, a demographic revolution has been under way for more than half a century and will likely take several more generations to complete. Yet China and the more advanced economies, which account for the vast majority of the world's economic and financial activity, face an important inflection point, similar to the ones that confronted Japan and Germany in the mid-1990s: population growth is decelerating sharply and, in China and much of the economically advanced world, is turning negative. Moreover, dependency ratios are rising, after a long period of stability or decline.**

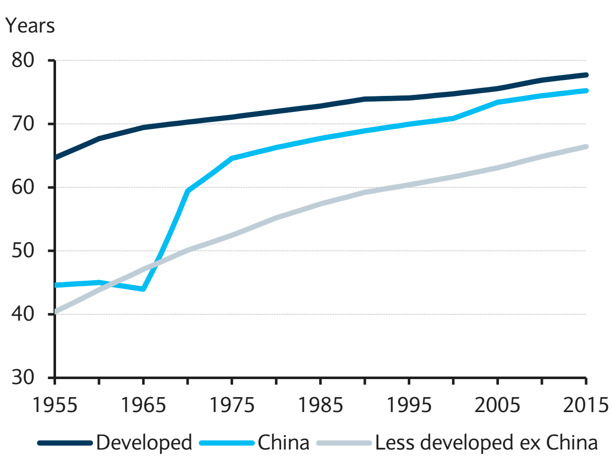
- **We highlight four ways in which this inflection point, as well as disparities within the multi-generational trend, could affect the next decade: 1) complicate the task of fiscal consolidation, mainly through a rise in age-related public spending. The good news here is that the most heavily affected economies are not the fiscally stressed economies of the eurozone; 2) support the process of economic rebalancing in China while magnifying the challenge of shifting the economy away from its investment-led development pattern; 3) complicate the debt dynamics of southern Europe, where population growth is poised to turn negative; and 4) potentially tilt the terms of trade in favour of labor in the US, after two decades in which labor income lagged returns to capital.**

- **However, contrary to what Japan's experience might seem to suggest, we do not think demographics will be the decisive influence on the balance between inflationary and deflationary forces in the decade to come.**

What's happening to populations?

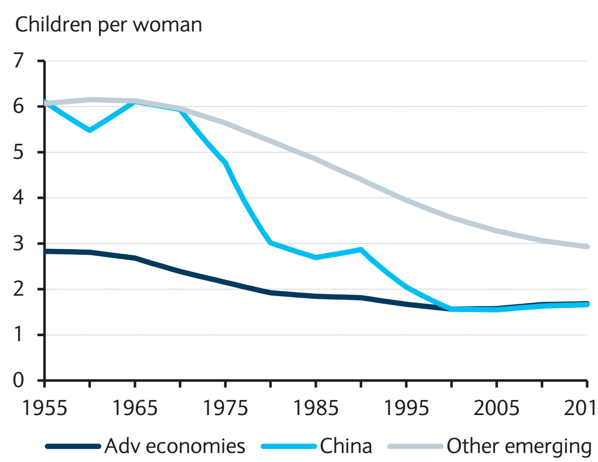
Humankind is living through its most momentous demographic transformation in recorded history, though it will likely take several more generations before a new steady state emerges. In the meantime, the investment landscape will continue to be conditioned by the gradual and uneven transition to a new equilibrium.

FIGURE 1
Life expectancy has been rising in emerging and advanced economies



Source: UN, Haver Analytics, Barclays Research

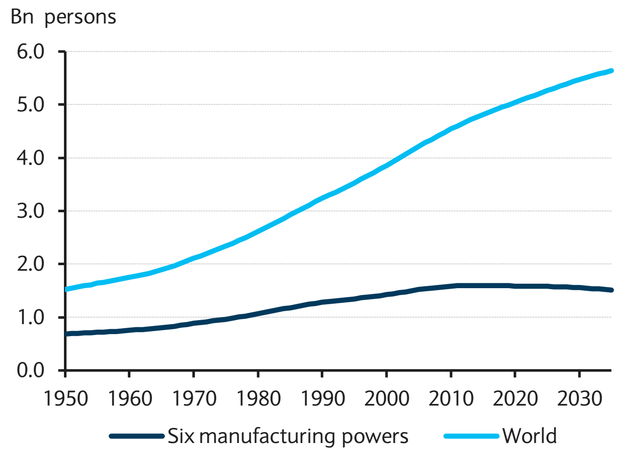
FIGURE 2
Fertility rates have declined



Source: UN, Haver Analytics, Barclays Research

FIGURE 3

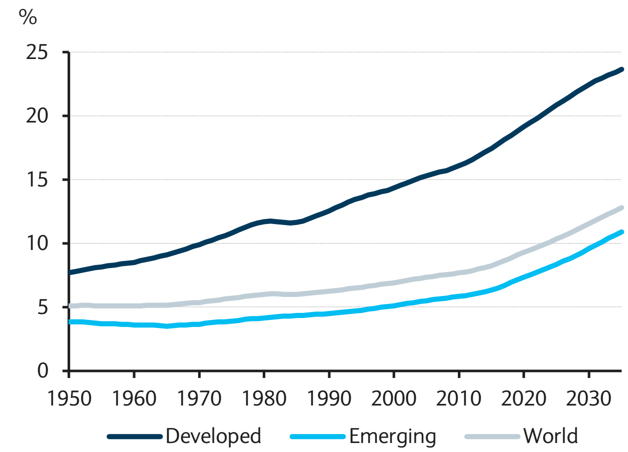
The world's working age population will rise more slowly, but fall in the existing centers of world economic activity



Note: The six manufacturing powers are the US, China, Japan, the euro area, the UK, and Korea Source: UN, Haver Analytics, Barclays Research

FIGURE 4

The world is getting older but emerging economies will remain relatively young (% of population older than 65)



Source: UN, Haver Analytics, Barclays Research

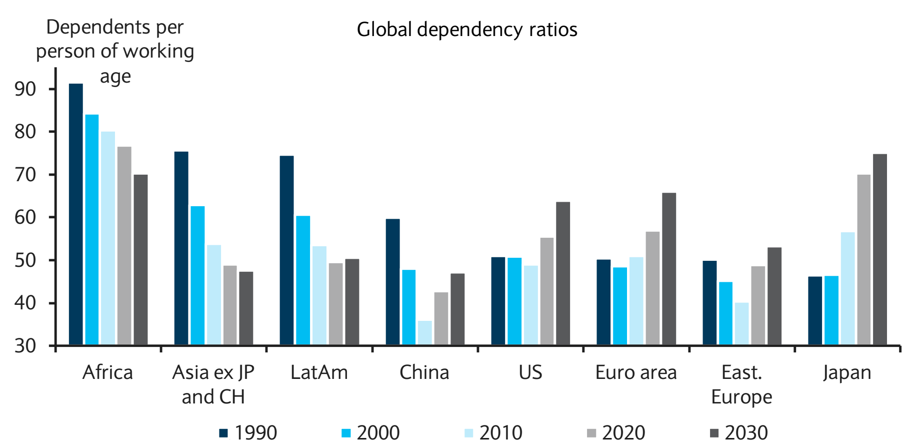
There are many elements of continuity in the dynamics set to form the backdrop for economic developments in the decade ahead. Populations will continue to age, as they have mostly been doing for half a century, and population growth will continue to slow. In some ways, the next 10 years should look a lot like the past 10. But in other respects, populations are facing an inflection point that could shift the economic and financial context significantly.

The population revolution in a nutshell

Population change is fundamentally about birth and death, and in the past half-century both have been transformed in most of the world. Improvements in health care, reflecting rising living standards and improved technology, have led to large rises in life expectancy in most advanced and emerging economies. At the same time, prosperity, technology and, in some cases, policy, have led to a large fall in birth rates.

FIGURE 5

Dependency ratios will rise significantly in advanced economies but continue to fall in much of the emerging world



Source: UN, Haver Analytics, Barclays Research

These fundamental drivers have created a population dynamic that is being felt globally (although with important differences that we discuss below): after rising rapidly in response to falling mortality rates, the decline in the birth rate eventually leads to a population that grows more slowly as it steadily ages.

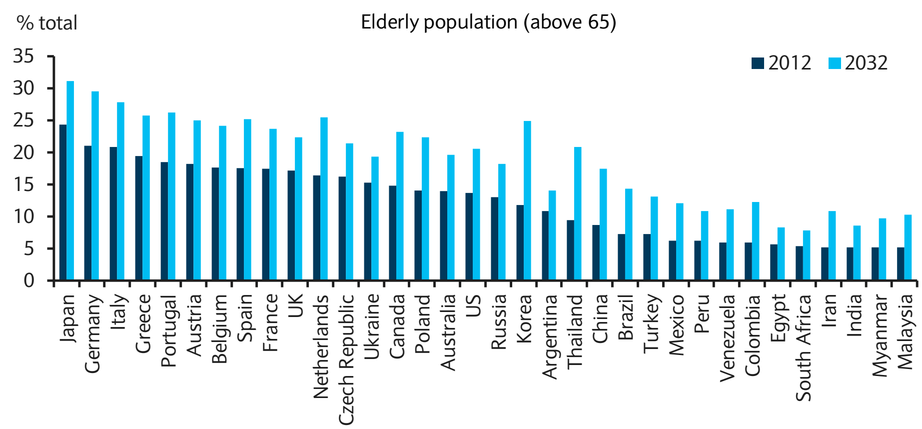
The dependency ratio – conventionally defined as the ratio of the number of young (below 15 years of age) and elderly (65 and older) persons to those of working age (15-64) – tends to follow a 'U' shaped path, declining in the early stage of the demographic transition as the lower birth rate reduces the number of children needing support. Later in the transition, the rising share of the elderly leads to a rise in the dependency ratio.

In the past two decades, the dependency ratio has been either stable (US, euro area) or declining (emerging markets, including China) in most of the world, with the major exception of Japan, where the dependency ratio has risen significantly in the past decade.

This interplay between falling birth rates and rising life expectancy is about as universal an influence over world development as exists, and on a long enough time horizon, population dynamics are likely to be marked by a strong common thread. But on a more immediately relevant (although still extended) time horizon of 10-15 years, the landscape is far more variegated, and the influence of population dynamics on the world economy and financial markets is likely to reside less in broad global tendencies than in the specific developments and circumstances in the more economically influential regions.

FIGURE 6

Japan and Germany are the oldest societies; Africa and EM Asia are much younger



Source: UN, Haver Analytics, Barclays Research

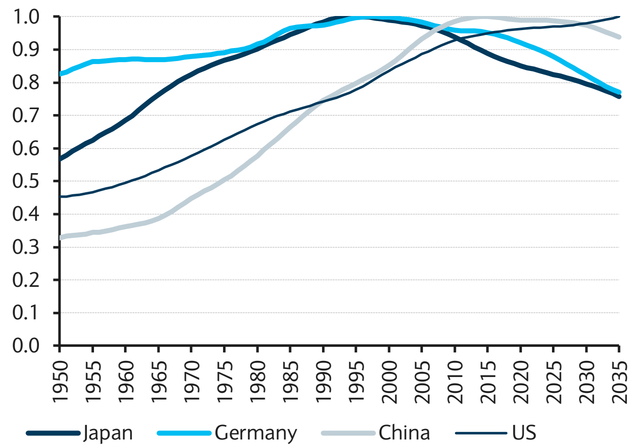
Advanced economies are in the demographic vanguard

Largely reflecting their more advanced stage of development, with timing also influenced to some extent by the 'baby boom' that followed the economic and social disruption of the Second World War, the advanced economies of Japan, continental Europe, and, less markedly, the US and UK, are at the forefront of the global demographic transition. Japan and Germany are the oldest societies in the world, with much of continental Europe not far behind (Figure 6).

Japan and Germany have been the forerunners of lower population growth; in both countries, the working age population has been falling for roughly 20 years (Figure 7). This gives them considerable interest as precedents for other countries facing the same prospect. And such precedents are becoming increasingly relevant. In the past decade, Germany and Japan were nearly alone in population decline, joined by only a few countries,

FIGURE 7

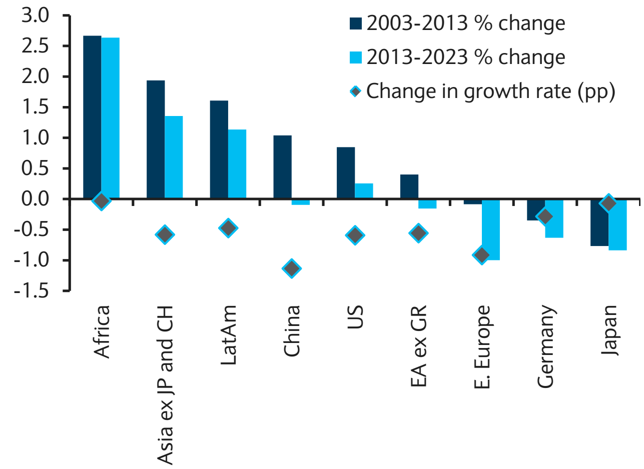
Working age population falling in Japan, Germany and China



Note: normalized to equal 1.0 in the year of peak population. Source: UN, Haver Analytics, Barclays Research

FIGURE 8

Working age population to keep rising in much of Asia, Africa, and Latin America



Source: UN, Haver Analytics, Barclays Research

including Greece, and a few members of the former Soviet bloc, where population growth has been undercut not only by a fall in birth rates, but by a period of stagnation, and even decline, in life expectancy dating back to the mid-1970s. In the coming decade, however, falling populations are set to become much more common. Eastern Europe looks likely to overtake Germany and Japan as the region with the fastest-shrinking working age population (Figure 8).

The shrinkage of the working-age population is set to be less rapid in Western Europe, though it will be quite generalized, with France and the UK alone among the major European economies not expected to post a decline in the coming decade (the forecast decline for Spain is quite modest).

The decline in China's workforce has begun, and although it is expected to be considerably more gradual than it was in Germany and Japan, it will likely have a greater impact given China's key role in the global economic and financial system. Korea is also facing a very abrupt transition. Its working age population is expected to peak within the next 2-3 years, then decline on a trajectory not dissimilar to Germany's. Korea and Thailand also stand out for the speed at which their populations are aging (Figure 6).

China

China merits special attention in this area because of its systemic importance and the special character of its demographic development. Because of the one-child policy, China's birth rate fell far in advance of its development trajectory (Figure 1). Thus, its population is aging more rapidly and shrinking at a far earlier stage of economic development than elsewhere. Below, we highlight the characteristics of the Chinese demographic transition stemming from this atypical history.

First, although the working age population is falling at a much earlier point in China's economic development than occurred in Germany or Japan, the rate of shrinkage is set to be much smaller than it has been in those countries (Figure 7). That said, the deceleration of population growth from a rather rapid rate in the past 10 years to a modest rate of decline in the coming decade looks quite abrupt (Figure 8) and comparable to the deceleration in Japan in the early 1990s. To the extent that economic consequences result from the deceleration of population growth, as we shall suggest that they do, China faces a substantial demographic shock, despite the modest rate of decline in the population.

Second, although China is aging rapidly, it started out with a relatively young population. So even after 20 years of this atypically rapid rate of aging, the Chinese population will not stand out as abnormally aged by global standards (Figure 6). In fact, although the Chinese dependency ratio is forecast to rise substantially in the decades to come, it is expected to remain quite low by international standards (Figure 5).

Finally, it should be noted the difference between the Chinese experience and that of Germany and Japan lies not only in the level of development at which their populations began to decline, but also in the fact that China's development has followed a qualitatively different path. These differences are likely to affect the manner in which the demographic transition influences the Chinese economy. For example, the conventional model of retirement presumes that the generation leaving the workforce has saved for retirement during the working years, owns much of the national wealth, and spends it over the course of the retirement years. But given the speed of the (largely state-directed) development during the past two decades, this model may not fit present Chinese realities as well as it might an economy with a more extended period of less frenetic development (eg, the benefits of the rapid Chinese modernization may be accruing to younger workers who may not retire for many years).

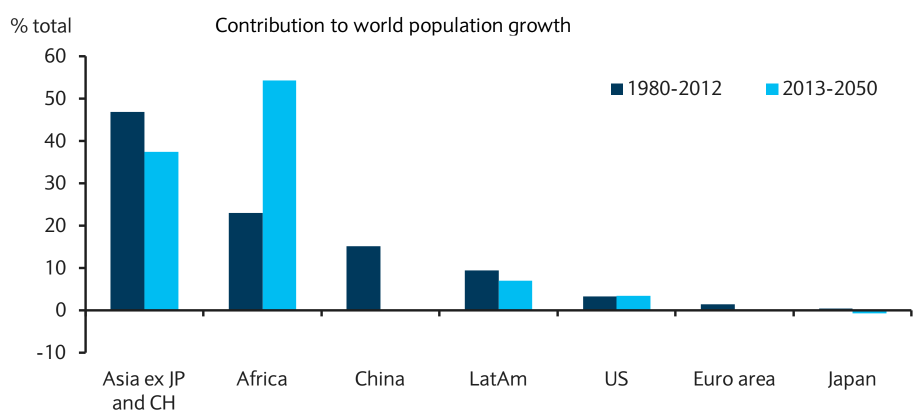
How flat is the earth?

There is a common demographic dynamic that seems to be playing out on a multi-generational time scale globally. But on a timeframe more relevant to market participants, the diversity is as important as the common trend. The most important divergence is between lower-income emerging market economies that comprise most of the world's population and the economically more advanced economies, including China, where a disproportionate share of the world's economic activity is located.

In most of the economically less-advanced regions of the world, the drivers of the demographic transition are playing out according to the script; life expectancy is increasing and birth rates are falling. But in Africa, Latin America, India and much of the rest of Asia, the transition is in an early stage. Populations are getting older and the elderly more numerous, as they have been doing for decades, but dependency ratios should continue to fall for at least a decade (Figure 5). And although population growth is slowing, both total and working-age population will continue to rise for decades to come (Figure 3). There is no sense in which these societies have reached a demographic inflection point. And because they have such large populations, they are likely to keep the world population rising in the coming decades (Figure 3).

FIGURE 9

Population growth will be even more concentrated away from existing economic powers



Source: UN, Haver Analytics, Barclays Research

The outlook for the economically (and demographically) more advanced regions of the world is quite different, and there are at least two important ways in which this part of the world faces a demographic inflection point akin to the one that Japan and Germany reached in the 1990s. First, growth of the total and working-age populations is projected to decelerate sharply (US, France, UK) or turn negative (China, Japan, Korea, and much of continental Europe). For this group of economies as a whole, population growth has turned negative (Figure 3). Second, dependency ratios are now rising, after decades of stability (US, euro area) or declines (China, Eastern Europe) in the ratio (Figure 5).

The vast majority of the world's economic and financial activity takes place in the advanced economies, where demographic challenges loom fairly large. This is likely to remain the case for the next decade. The question arises whether the more favourable demographic context in less advanced economies can provide a meaningful offset to, in particular, the shrinkage of the labor force that is in store for the more advanced economies. It is not a far-fetched scenario; below, we suggest that the emergence of China as a global manufacturing powerhouse created just such a shock for the global labor force in the past two decades. At present, though, an event comparable to the Chinese development surge of the past 20 years seems unlikely. And to the extent that demographic influences are global rather than national, we think the relevant context is the more constrained demographic outlook facing the economically more advanced parts of the world. That said, we think investors should be alive to the opportunities that global population dynamics present for younger and more rapidly growing populations, and the associated possibility that a more rapid than expected integration of labor forces in India, Africa, or elsewhere into the global workforce could temper some of the challenges posed by demographic transitions in the more advanced economies.

It's complicated

Demographic change is multi-dimensional, encompassing the size as well as the age distribution of the population. Different elements of the demographic transformation are likely to interact differently with economies and financial markets. The age structure will affect savings behaviour, but it will also affect investment demand, and it may do so not only by changing the age distribution but also the rate of growth of the population. Population trends affect not only aggregate demand, but also supply, when there is a substantial impact on the potential labor force. Asset allocation may also be affected by demographic developments. International spillovers are likely to be significant when the affected economy is systemically important.

These complexities make us reluctant to summarize the demographic state of the world into a number or two, or to extrapolate from previous correlations the future impact on economies and financial markets. Instead, we highlight ways in which key demographic developments are likely to drive important economic and financial outlook in the decade (or so) to come. In some cases, population trends take center stage, and in others they play a supporting role. But in each of the cases that we consider, bar one, population trends will be a key driver of the outcome.

Population change will stress fiscal structures

Population aging constitutes a source of vulnerability for fiscal sustainability in many advanced economies, but also in emerging markets, in the longer run. On top of the expected decline in tax revenues, as result of a shrinkage in the working age populations, growth rates are expected to decline, driving down the interest rate- growth rate differential, which is an important indicator of a country's ability to keep its debt levels sustainable (particularly in EM, according to the IMF [13]), over the next two decades. But

[13] *IMF Fiscal Monitor, October 2013*

perhaps a less-discussed effect of older populations, which is far from negligible, is the rise in public spending on healthcare and pensions, in addition to other possible age-related spending (such as residential care in some countries) and the direct impact of these on government balances. In the advanced economies, public health spending has risen by about 4pp of GDP since 1970, about half the overall increase in non-interest public spending. According to IMF projections, total age-related spending is expected to grow by more than 4% of GDP in advanced economies and 3.2% of GDP in emerging markets by 2030, after accounting for the large fiscal consolidations already at work and those in the pipeline. For advanced economies, this number is almost equal the required fiscal adjustment that countries will have to undertake by 2030 to stabilize their debts. For emerging markets, it is three times the adjustment they would have to make without the aging factor.

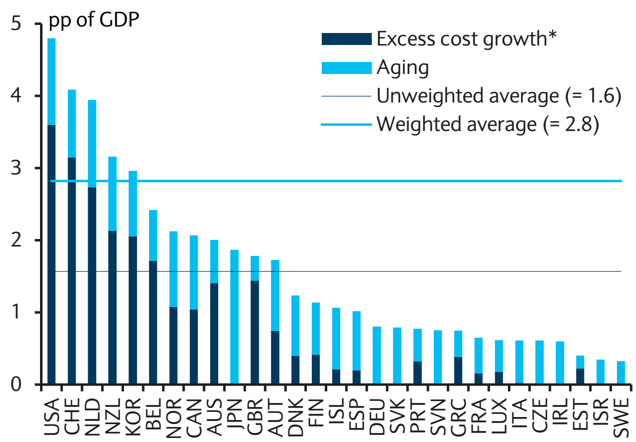
In the past 3-5 years, public expenditure on health, which is the largest portion of age-related spending in advanced economies, actually slowed significantly (in all advanced economies except Japan and Israel). This is not surprising; advanced economies experienced a sharp deterioration in macroeconomic conditions after 2008/9, which can explain a lot of this slowdown, in addition to large fiscal consolidations that naturally included cutting public health expenses. Indeed, according to the IMF analysis, those countries that suffered the largest drop in output and undertaken large fiscal consolidation, namely the euro periphery countries, have also experienced the largest declines in health spending. Another interesting turning point of the past couple of years consisted of large-scale reforms aimed at cutting spending. Yet these spending- reduction reforms will most likely have no impact on long-term spending growth.

The recent years' slowdown may still have a persistent effect, as continued fiscal pressure and still-weak macroeconomic conditions will leave their mark. As Figure 10 shows, by 2030, the euro area countries are expected to show the lowest increase in public spending on health. However, as is evident in the chart, when stripping out the overall projected increase in health spending from the portion unaffected by aging (ie, the growth in public health spending in excess of GDP growth, after controlling for aging), the expected increase in spending in these countries is much more similar to other advanced economies. In other words, the impact of demographics is hardly mitigated by cyclical factors such as temporary slowdown in macroeconomic conditions, fiscal consolidations and so on.

The differences among countries in the size and type of the expected increase in age-related spending are large (Figure 11). The US, where the demographic prospects are considerably less pressing than those in, for example, Japan and the euro area, is nevertheless expected to face a huge increase in age-related costs by 2030, mostly because of a large projected increase in healthcare spending (accelerated by the national healthcare reforms). The increase of 4.8% of GDP in age-related spending, which is in line with the most recent (2013) projections of the US congressional budget office (under the assumption that subnational spending grows at a similar rate as federal health spending), will more than double the overall adjustment the US needs to undertake by 2030. China is another example of a country where, despite less imminent demographic problems, the age-related spending increase is expected to far exceed those countries with much older populations, like Japan and Germany. This is mainly because of the large costs of transitioning its pension system from focusing on formal-sector workers to a more universal coverage. The dramatic reform that was introduced in 2009 brought millions of additional people under the public system coverage, and that number will continue to increase, alongside the increase in the ratio of pension-aged people to the total population.

FIGURE 10

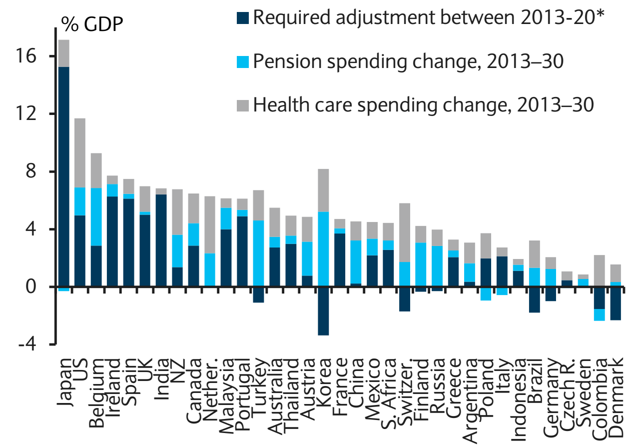
Projected increase in public health spending in advanced economies, 2013-30



* Excess cost growth is the growth of public health spending in excess of GDP growth, after aging is controlled for. Source: IMF Fiscal Monitor, October 2013

FIGURE 11

Total required fiscal adjustment and age-related spending, 2013-30



* The cyclically adjusted primary balance needed to bring down the debt ratio to 60% GDP (in AE) and 40% GDP (in EM) in 2030, or stabilize the debt at end-2013 if it is less than 60%/40%, less the CAPB in end-2013. Source: IMF Fiscal Monitor, October 2013, Barclays Research

The two most striking cases of expected increase in age-related spending are Korea and Turkey. Were it not for the large adverse effect of aging, both would have had enough fiscal space to expand their budgets over the next two decades. Turkey is surprising: with a still-young population (median age is 29, the second youngest in the OECD), the government is already spending on public pensions the same proportion of GDP as the US, and more than the UK, Denmark and Netherlands, despite all these countries having 2-3 times as many people over 65 relative to their populations as Turkey does[14]. In Korea, this is mostly driven by an expected surge in public expenditure on pensions, the result of a rapidly developing country where a public pension system was introduced only in 1988, and the ratio of pension-aged population (65+) is expected to rise faster than in any other country (an increase of 11.2pp in 2013-30, compared with 6.2 in the US, 5.6 in Japan, 7.3 in China, 7.6 in the Netherlands, 7.1 in Germany and lower levels in the rest of the eurozone). In 2009, the expenditure of the Korean government on pensions was the lowest in the OECD (after Iceland) and it is projected to catch up fast. In France and Italy, where the rise in the ratio of elderly to total population is expected to be fairly moderate (5.4 and 5.6pp), should face very muted rises in age-related spending in the same period.

Demographics and rebalancing in China

The rebalancing imperative for China is in the most important respects unrelated to its population dynamics. China's development trajectory would be "unsteady, unbalanced, and unsustainable" even if it were not facing a demographic inflection point. But demographic pressures will play a significant role in the rebalancing process. In key respects, the demographic transition supports the rebalancing strategy. But in other ways, demographic developments in the pipeline increase risks around the rebalancing agenda.

Population dynamics are a key part of China's much-discussed 'Lewis moment'[15]. The sharp slowdown in growth of the working-age population has interacted with 20 years of rapid

[14] *OECD "Pensions At A Glance"*, 2013.

[15] A 'Lewis moment,' named after Nobel Prize-winning economist Arthur Lewis, refers to the period in a country's development when labor demand associated with industrialization has absorbed all the surplus labor previously engaged in lower-productivity occupations in the countryside. Before the Lewis moment, industrial firms can hire workers at a wage determined by the low-productivity occupations in rural areas. After the Lewis moment, wages tend to rise with productivity in the modern sector.

growth in labor demand to exhaust much of the surplus labor available to be shifted from low-productivity rural employment to higher productivity, mainly urban occupations. The continuing decline in the working age population should help maintain tight labor markets and keep upward pressure on real wages. To the extent that the rebalancing agenda requires an increase in household income to support the consumption spending that is needed to replace investment as a driver of domestic demand, this aspect of the demographic transition provides a strong economic tailwind.

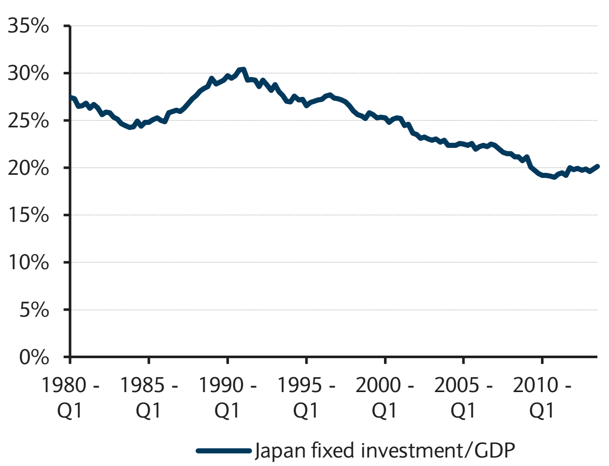
The aging of the population should also support the rebalancing from investment to consumption. Cross-country evidence (see, for example, IMF *World Economic Outlook*, September 2004) suggests that countries with higher proportions of elderly tend to have lower savings rates. (They also tend to have lower investment rates, but the impact on saving was found to be larger.) We are not sure that the cross-country evidence adequately captures the special characteristics of the Chinese case, but the idea that aging of the population supports a lower saving rate is at least qualitatively plausible.

But China's population dynamics also pose a risk to the rebalancing agenda. It stands to reason that demography affects investment demand not only through its impact on the age distribution, but also via the rate of increase of the population. One source of demand for investment is to maintain the per-worker capital stock, and to accommodate trend growth in demand for output. If population growth slows, this source of demand for investment declines as well. To see how big this could be, note that along a steady-state growth trajectory, net investment has to be sufficient to maintain a steady ratio of capital to labor. The investment rate required to achieve this is equal to the rate of population growth times the capital-output ratio. In the US and Japan, the replacement cost of the capital stock is roughly 2 times GDP. So a 1% deceleration in the rate of growth of the population implies a (permanent) decline in required investment of about 2pp of GDP. (We are unaware of any estimates of the Chinese capital stock, but in light of the investment-intensity of Chinese growth the capital-GDP ratio is likely higher, and the demographic multiplier at least as high, as in Japan.)

While Japan and China are very different in many ways, the parallel with the initial stage of the Japanese 'lost decade' seems apposite to us. The bubble economy of the 1980s promoted an investment boom of 3-5% of GDP that needed to be 'worked off' in the post-bubble era (Figure 12). Finding substitutes for the lost demand was the Japanese 'rebalancing' challenge, and it proved difficult to accomplish (not least because the adverse shocks kept coming).

FIGURE 12

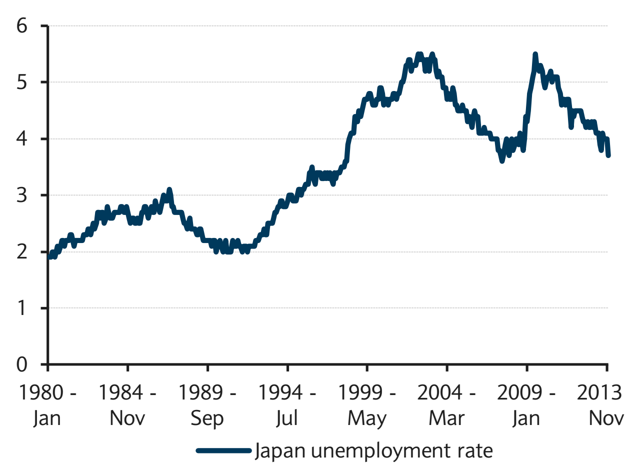
Japanese investment stabilized below pre-boom level…



Source: Haver Analytics, Barclays Research

FIGURE 13

…despite recovery of the economy



Source: Haver Analytics, Barclays Research

In our view, the Japanese 'rebalancing' problem of the 1990s was compounded by a steady decline in underlying investment demand that resulted from the increasingly rapid rate of shrinkage of the working age population. How big might this have been? The working age population is now shrinking at the rate of about 0.9% per year, compared with growth of about 0.5% of GDP before the mid-1990s. The 1.5pp swing in population growth could therefore (in line with the arithmetic described above) generate a 3pp decline in the 'equilibrium' Japanese investment ratio. This is not small by comparison with the magnitude of the cyclical over-investment that needed to be accommodated in the early 1990s, and it helps explain why Japanese investment has stabilized well below its pre-boom level, even as the economy has regained its cyclical poise.

The downside risk for the Chinese rebalancing seems clear. The slowdown in population growth is less intense than it was in Japan, and the Chinese authorities have policy levers that Japanese authorities did not have. But the investment boom that needs to be 'worked off' is probably substantially larger than the one that confronted Japan in the early 1990s. The demographic risk to investment is not the main policy problem facing Chinese authorities, and it certainly does not put a reasonably smooth transition out of the country's reach. But it raises the stakes in achievement of the structural transformations required to secure a more balanced growth trajectory.

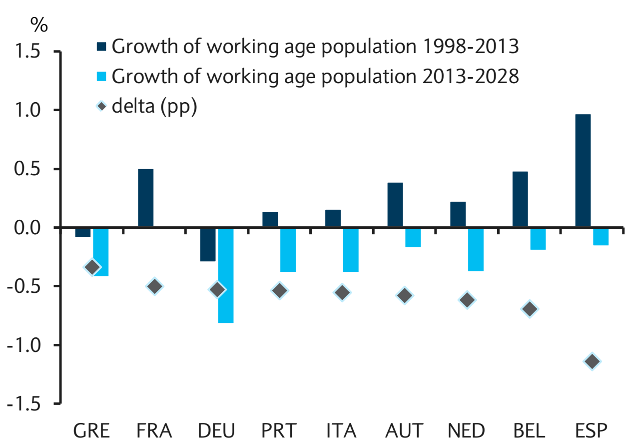
Demographics compound euro area fiscal stress

Demographic trends will affect national budgets in several ways. One of the most important of these is the anticipated rise in age-related spending, discussed above. A reassuring finding of that discussion is that the fiscally stressed economies of the eurozone are not the most heavily affected. In general, the economies at most risk happen to be those where, rightly or wrongly, market participants view fiscal challenges as manageable, such as the US, New Zealand, and Korea.

But population dynamics may also affect the sustainability of public debt if the anticipated deceleration in the potential labor force results in slower growth of national income and, by extension, the tax base. All else equal, including the interest rate at which the debt is serviced, a slowdown in trend growth requires an increase in the primary fiscal surplus equal to the change in the rate of growth multiplied by the magnitude of the public debt.

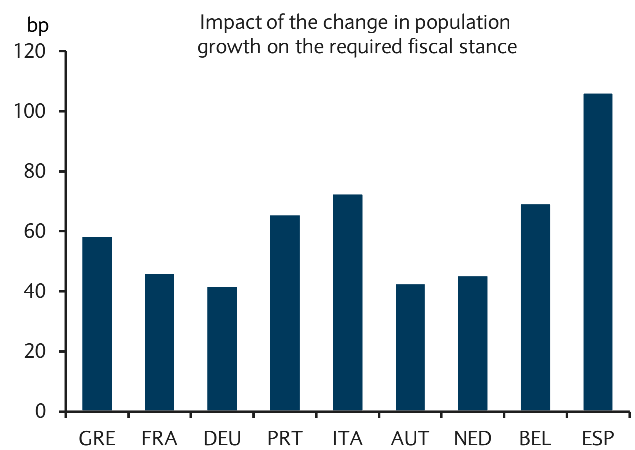
Figure 14 highlights the deceleration of growth in the working age population forecast for a number of eurozone economies. As we highlighted above, most euro area economies are

FIGURE 14
A sharp deceleration in euro area population growth…



Source: UN, Haver Analytics, Barclays Research

FIGURE 15
… adds to the required fiscal adjustment



Source: Haver Analytics, Barclays Research

expected to experience declines in the working age population. The rate of decline will be comparable to the one that Germany has experienced in the past 15 years, but the German population will continue to decline most rapidly.

In Figure 15 we illustrate the impact on the required fiscal effort, on the implied assumptions that the interest rate and productivity growth are unaffected by the deceleration of growth in the potential workforce. We compute the effect using the recent historical ratio of debt to GDP; in those countries, like Spain, where debt is expected to continue rising for the next few years, these estimates are conservative.

The impact is largest in Spain, because it suffers the largest deceleration in the rate of population growth. The impact amounts to about 1pp of GDP; modest by comparison with the very large fiscal consolidation that has been required of Spain, but far from trivial. The demographic transition in Portugal, Italy and Belgium also require a meaningful fiscal effort, in excess of 0.6% of GDP.

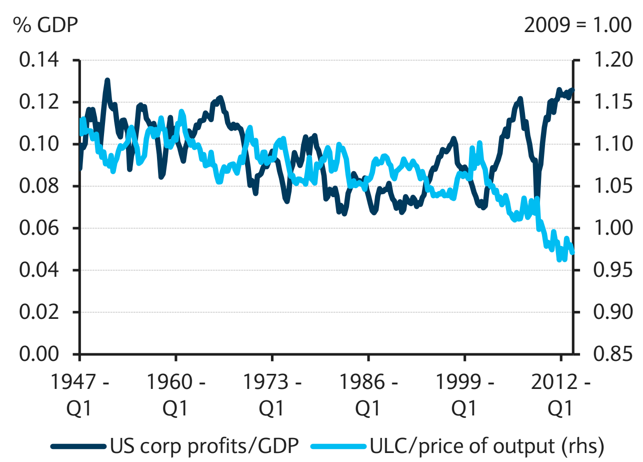
Each of these countries faces other challenges and opportunities to maintain or restore fiscal sustainability, which will also be influenced by a restoration of full employment, an improvement in trend productivity growth, and by institutional adaptations that improve confidence and lower interest rates. Demographic factors may be secondary compared with the fiscal imbalances that accumulated during the credit boom of the early 2000s, and the stresses that have been generated by the ensuing economic downdraft. But they are large enough to deserve careful consideration by investors in the affected economies.

The end of the global labor glut and the return to capital

Few events have been as consequential for world financial markets as the two-decade boom in US corporate earnings that began in the early 1990s. This was largely unexpected in the early 1990s, when the profitability tide turned, and it has been the object of surprisingly little economic investigation. The rise in corporate profits as a share of GDP (Figure 16) has quite likely been aided by the participation of US businesses in faster-growing economies outside the US. But this did not make the past 20 years one of ‘win-win’ for capital and labor. The rise in corporate profitability is clearly associated with an unprecedented degree of pressure on the return to labor (which we measure in Figure 16 with the ratio of unit labor costs divided by the price of output in the non-farm business sector).

FIGURE 16

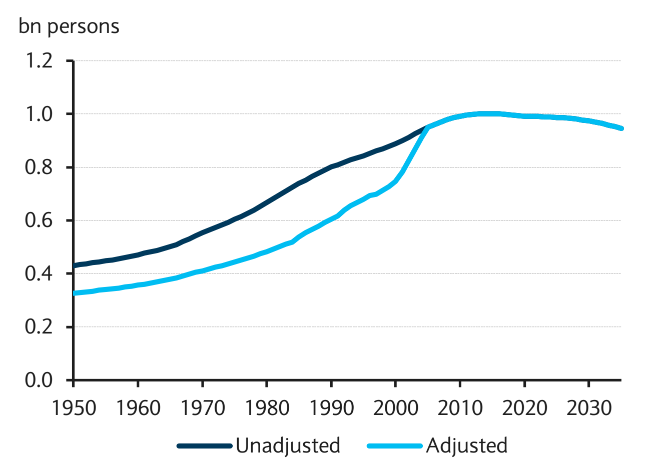
A 20-year boom is US corporate profits coincided with downward pressure on labor compensation



Source: Haver Analytics, Barclays Research

FIGURE 17

Strong growth in the labor supply of major manufacturing economies is now going into reverse



Note: We include the US, Japan, euro area, UK, China and Korea in the data. The unadjusted data is the sum of the working-age population in these economies. The adjustment is described in the text. Source: UN, Haver Analytics, Barclays Research.

There are a number of explanations for the pressure on US labor markets that has been so closely associated with the strong performance of capital income. Here, we focus on developments in the world labor market.

Labor markets are largely regional, but in a world knitted together by international trade, regional or national labor markets are also indirectly but strongly linked, and labor market conditions depend not only on local but also on global developments. Figure 17 illustrates developments of the past decade and the outlook for the global labor supply (more specifically, the working-age population in the six largest manufacturing powers, the US, China, Japan, the eurozone, the UK and Korea). The chart highlights the abrupt deceleration and imminent decline in the working age population that we have already discussed.

In our view, this chart underestimates the magnitude of the labor market shock during 1990-2010 because that was when the Chinese labor force transitioned from almost complete isolation from the world economy to become an integral part of the global manufacturing workforce. To illustrate what this meant for the global labor force, we made an adjustment to the Chinese data, multiplying it by 0.5 in the years before 1985 (to reflect China's weak integration in the world economy), and by 1.0 in 2005 and after (reflecting China's full integration by then), with the interim weight rising along with the exposure of the Chinese economy to international trade.

The coming decades could be much friendlier for labor, and hostile for returns to capital

This is an *ad hoc* and purely illustrative approach, but we think it captures an important element of the Chinese development 'miracle' of the past two decades. It suggests that the pressure on labor markets in advanced economies was due, at least in part, to rapid growth in the effective supply of labor in key manufacturing regions. More to the point, it highlights that this influence is now reversing course, as the labor force shrinks in China and many advanced economies. The coming decades could as a result be much friendlier for labor, and hostile for returns to capital, than the past two have been. The adverse cyclical overhang from the 2008 financial collapse, the 2010 eurozone confidence crisis, and the ongoing rebalancing of the Chinese economy continue to keep labor markets weak. But as these influences fade, we think investors should look to the secular trend in returns to capital with some caution.

Demographics and deflation – or not?

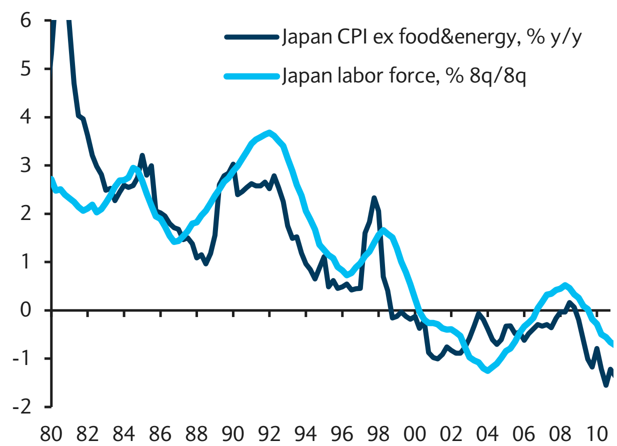
A lesson that many market participants seem to have learned from the Japanese experience is that an abrupt demographic transition is bad for the economy, creating strong deflationary tendencies. We do believe that the sharp transition in population dynamics in Japan, and in particular the shrinkage of its working age population since 1995, was one of the 'shocks' that undermined economic performance in the 1990s, and helped set the stage for the decade and a half of deflation from which Japan seems only now to be emerging.

In this context, the question arises whether the coming demographic inflection point that now faces most of the advanced economies will be similarly deflationary. We are sceptical, and think that demographics will be only one of several drivers of the inflationary (or deflationary, as the case may be) context in advanced economies, and likely not the decisive one.

Circumstantial evidence of a link between deflation and demographics is not hard to find. In Japan, the evolution of deflation is strikingly correlated with demographic trends (Figure 18). In a 2012 speech, BOJ governor Shirakawa suggested that there seems to be positive correlation between population growth and inflation in advanced economies. (We reproduce these findings in Figure 19.)

FIGURE 18

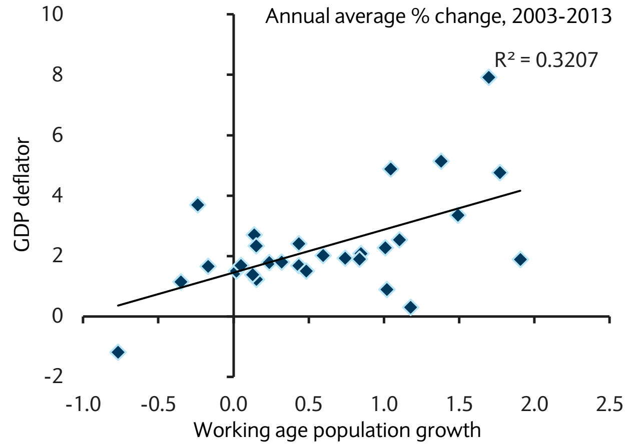
Japan's deflation was likely associated with negative demographics, among other factors



Source: Haver Analytics, Barclays Research

FIGURE 19

… and cross-country comparison points to an apparent correlation between population growth and inflation



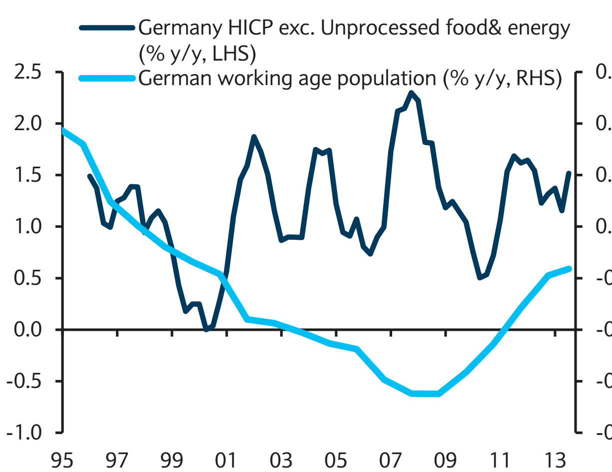
* Sample includes 29 OECD countries. Source: OECD, UN Population Statistics, Barclays Research

We think there is less to this evidence than meets the eye. A close examination of the Japanese experience suggests that the demographic shock was only one of a series of shocks and policy choices leading to deflation. The cross-country correlation between population growth and inflation in the OECD is largely driven by two outliers, Japan (the country with negative inflation in Figure 19) and Turkey (the country with 8% inflation in Figure 19), and does not survive the incorporation of non-OECD countries, such as Russia, where demographics have been weak and inflation high by international standards. The association between demographics and deflation is also quite weak in the other demographic trailblazer, Germany (Figure 20). Like Germany and Japan, Ukraine experienced persistent declines in population during the past decade, and this has been combined with both very high and (more recently) low inflation (Figure 21).

At a theoretical level it is possible to identify deflationary consequences of demographic advance. As discussed in the context of China, slower growth in the potential workforce may lead to a reduction in investment demand. Politics may also play a role, eg, if older

FIGURE 20

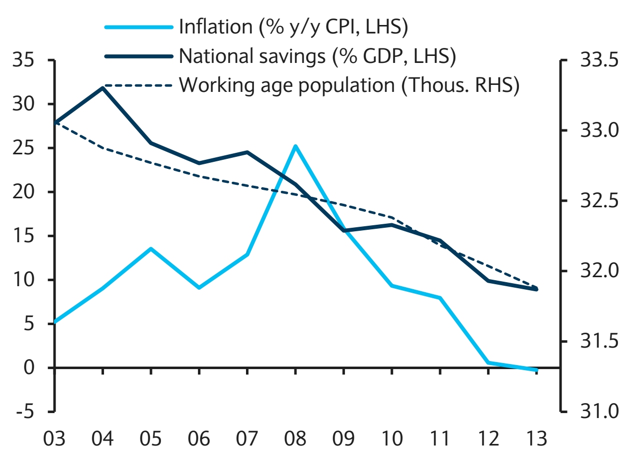
Germany experienced no deflation, despite weak demographics



Source: Haver Analytics, UN Population Statistics, Barclays Research

FIGURE 21

In Ukraine, persistently weak demographics have been combined with both high and low inflation



Source: Haver Analytics, UN Population Statistics, Barclays Research societies become more inflation-averse because the median voter is more reliant on fixed income. We suspect that this was an important, though not the only, driver of weak economic performance and therefore deflation in Japan during the 1990s.

But contradictory influences are equally easy to find. Aging (or, more generally, a rise in the dependency ratio) may be associated with lower investment, but it is also associated with lower savings. The net effect of the shift in savings and investment on domestic demand is uncertain, in principle, and on some estimates, the saving effect is larger (see IMF *World Economic Outlook,* September 2004). Inflation depends on supply as well as demand, and a sharp reduction in the labor force comprises an adverse supply shock that may put upward pressure on labor costs and price inflation. This is likely to remain an important factor in the development of the Chinese economy, as we have argued. In addition, the rise in the ratio of dependent population to the working population may create fiscal stress; to the extent that fiscal theories of price level apply, this fiscal stress could be associated with an eventual intensification of inflationary tendencies.

Above all, demographic factors generally play out over a timeframe over which monetary policy – even with its 'long and variable lags' – can make its influence felt. These shifts in population are only one of the disturbances that monetary authorities are forced to confront, and their effect on the inflationary context is uncertain and quite likely conditional on economic structure and specifics of the demographic transition. The Japanese experience offers an interesting precedent, but it seems to us that the association between demographic advance and deflation is a lesson that some observers may have learned too well. We would look elsewhere for dominant drivers of the inflationary context in the decade to come.

Appendices

APPENDIX

Key information sources

FIGURE 1
Barclays links

www.barclays.com	Barclays
live.barclays.com	Barclays Live (Publications & Analytics)

FIGURE 2
Barclays Live keywords (type into search box)

inflation	Inflation Portal
infpubs	Inflation-linked Research
ilbond	Inflation-linked Bond analytics tool
ilswaps	Inflation-linked Swaps analytics tool
ilhra	Inflation-linked Bonds Horizon Returns Analysis
chart	Chart: Time Series and Curve plotting
indices	Index Portal
gilb	Developed Market Inflation-linked Bond Indices
emgilb	EM Inflation-linked Bond Indices

FIGURE 3
Issuer links

www.aofm.gov.au	Australian Office of Financial Management
www.bankofcanada.ca	Bank of Canada
www.aft.gouv.fr	Agence France Tresor (AFT)
www.bundesbank.de	German Bundesbank
www.dt.tesoro.it/en	Public Debt Division, Italian Treasury
www.mof.go.jp/english	Japanese Ministry of Finance
www.treasury.gov.za	South African National Treasury
www.riksgalden.se	The Swedish National Debt Office
www.dmo.gov.uk	UK Debt Management Office
www.treas.gov	US Treasury
www.treasurydirect.gov	US Treasury Direct
noticias.mecon.gov.ar	Argentinian Finance Ministry
www.tesouro.fazenda.gov.br	Brazilian National Treasury
www.shcp.gob.mx	Mexican Ministry of Finance and Public Credit
www.hacienda.cl	Chilean Ministry of Finance
www.mf.gov.pl	Polish Ministry of Finance
www.minhacienda.gov.co	Colombian Ministry of Finance
www.maliye.gov.tr	Turkish Finance Ministry
english.mosf.go.kr	South Korean Ministry of Finance

FIGURE 4
Useful links

www.federalreserve.gov	US Federal Reserve
www.boj.or.jp	Bank of Japan
www. ecb.int	European Central Bank
www.bls.gov	US Bureau of Labor Statistics
www.bankofengland.co.uk	The Bank of England
www.statistics.gov.uk	UK National Statistics Office
www.riksbank.com	Riksbank
www.rba.gov.au	Reserve Bank of Australia
www.bcb.gov.br	Brazilian Ministry of Finance
www.banxico.org.mx	Banco de Mexico
www.bcentral.cl	Chilean Central Bank
www.nbp.pl	National Bank of Poland

FIGURE 5
Bloomberg pages

BINF	Barclays Inflation-Linked Menu
BILR	Barclays Inflation-Linked Research
BCIN	Barclays Inflation-Linked Indices
BBEM	Barclays Inflation-Linked EM Indices
BCAP1	Barclays TIPS Prices
BCAP2	Barclays US Actives and Forwards
BCAP3	Barclays US Zero Coupon CPI Swaps
BCEQ9	Barclays Structured Inflation Notes
BCAP7	Barclays Inflation Forecasts
BXEI	Barclays Euro Inflation-Linked Prices
BXGL	Barclays UK Index Linked Prices
BISW	Barclays Inflation Derivatives
ILB	Global Inflation-Linked Bonds
ILBE	Bloomberg World Inflation Breakeven Rates
ILBI	Inflation-Linked CPI Indices
SWIL	Bloomberg default inflation settings
SWPM	Bloomberg swap pricing
DMO1	UK DMO screen announcements
TREX	Agence France Trésor
BKIT	Banca D'Italia

Summary sovereign table

FIGURE 1

Developed markets overview

	US	UK	France	Germany	Italy	Spain	Sweden	Denmark	Canada	Australia	New Zealand	Japan
Generic name	Treasury Inflation Indexed Securities, TIIS, TIPS	United Kingdom Index-Linked Gilts	OATi, OAT€i, BTAN€i	OBL€i DBR€i	BTP€i	SPGB€i	Swedish Govt Index-Linked	DGBi	Canadian Real Return Bonds	Australian Capital Indexed Bonds	New Zealand Inflation-indexed Bonds	JGBi
No bonds Outstanding*	35	23	14	5	10	1	6	1	7	7	3	15
Market value outstanding bn*	$1,035bn	£407bn	€210bn	€69bn	€133bn	€5bn	SEK232bn	DKK32bn	CAD65bn	AUD32bn	NZD10bn	¥4.2tn
Market value outstanding $bn*	$1,035bn	$683bn	$287bn	$95bn	$182bn	$7bn	$35bn	$5.8bn	$60bn	$30bn	$9bn	$42bn
First issue date	Jan 97	Mar 81	Sep 98	Mar 06	Sep 03	May 14	Apr 94	May 12	Dec 91	Jul 85	Nov 95	March 04
Linking Index	CPI All urban consumers NSA	RPI	French CPI ex-tobacco Euro HICP ex-tobacco	Euro HICP ex-tobacco	Euro HICP ex-tobacco	Euro HICP ex-tobacco	CPI NSA	Denmark CPI NSA	CPI All Items NSA	All groups CPI	All groups CPI	Nationwide CPI General ex-Fresh Food
Linking Index Bloomberg ticker	CPURNSA Index	UKRPI Index	FRCPXTOB Index, CPTFEMU Index	CPTFEMU Index	CPTFEMU Index	CPTFEMU Index	SWCPI Index	DNCPINEW Index	CACPI Index	AUCPI Index	NZCPCCPI Index	JCPNGENF Index
Indexation lag	2-3 months	8 months or 2-3months	2-3 months	2-3 months	2-3 months	2-3 months	2-3 months	2-3 months	2-3 months	6 months	6 months	2-3 months to 10th of month
Floor?	Par floor	No floor	Par floor	Par Floor	Par floor	Par floor	Par floor for new issues since 1999	Par floor	No floor	Coupon and principal par floor	Coupon and principal par floor	2 with par floor, 13 without
Coupon frequency	Semi-annual	Semi-annual	Annual	Annual	Semi-annual	Annual	Annual	Annual	Semi-annual	Quarterly	Quarterly	Semi-annual

Note: * At end May 2014, excludes bonds sub-1y maturity

Source: Barclays Research

FIGURE 2

Emerging markets overview

	Brazil	Mexico	Argentina	Chile	Colombia	Israel	South Africa	Turkey	Poland	South Korea	Thailand
Generic name	NTN-Bs, NTN-Cs	Udibonos	Argentinean Government Inflation-Linked	BCU	TES	Galil, ILCPI	South Africa Index-Linked	TURKGB	POLGB	KTBi	THAIGB
No. bonds outstanding*	13	8	4	19	2	10	9	11	2	4	2
Market value outstanding bn*	BRL582bn	MXN950bn	ARS65bn	CLP8.5tn	COP1.9tn	ILS185bn	ZAR373bn	TRY92bn	PLN8bn	KRW9.0tn	THB167bn
Market value outstanding bn*	$259bn	$74bn	$8bn	$15bn	$1.0bn	$53bn	$35bn	$44bn	$3bn	$9bn	$5bn
First issue date in current format	May 00	May 96	December 03	September 02	October 02	June 06	March 00	February 07	September 03	February 07	July 11
Linking Index	IPCA, IGPM	Unidas de Inversion (UDI)	CER Consumer Price Index	UF Consumer Price Index	UVR Consumer Price Index	Israel CPI	South Africa CPI NSA	Turkish CPI	Polish CPI	Korean CPI	Thailand CPI
Linking index Bloomberg ticker	BZPIIPCA Index	MXUDI Index	ARCPI Index	CLUFUF Index	COCPI Index	ISCPINM Index	SACPI Index	TUCPI Index	POCPIYOY Index	KOCPI Index	THCPI Index
Indexation lag	Up to 4 weeks, includes forecast	Up to 2 weeks	T-5, T-10 to ACERCER Index	1 month to 9th of month	1 month to 15th of month	Up to 1.5 months, adjusted on inflation release	3-4 months	2-3 months	2-3 months	2-3 months	2-3 months
Floor?	No floor	No floor	No floor	No floor	No floor	Coupon and principal par floor (Galils), No floor (ILCPI)	Par floor	Par floor	Par floor	No floor	Par floor
Coupon frequency	Semi-annual	Semi-annual	Monthly or semi-annual	Semi-annual	Monthly	Annual	Semi-annual	Semi-annual	Annual	Semi-annual	Semi-annual

Note: * At end of May 2014, excludes bonds sub-1y maturity

Source: Barclays Research

Real yield histories

FIGURE 1
US 10y TIPS real yield

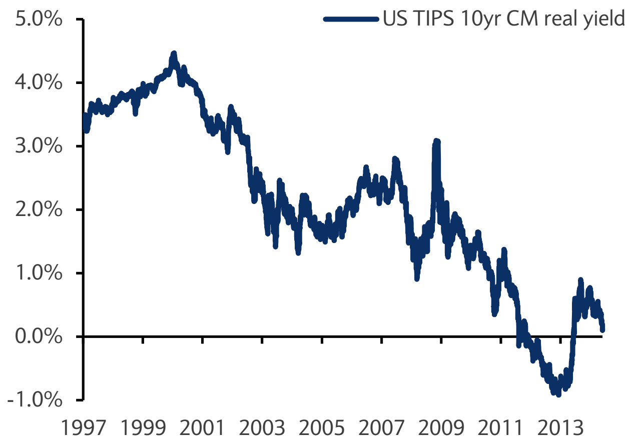


FIGURE 2
UK 10y real yield

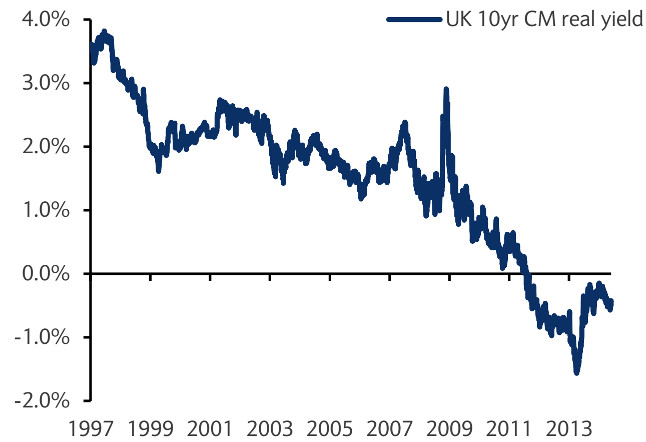


FIGURE 3
France OAT€i and OATi 10y real yields

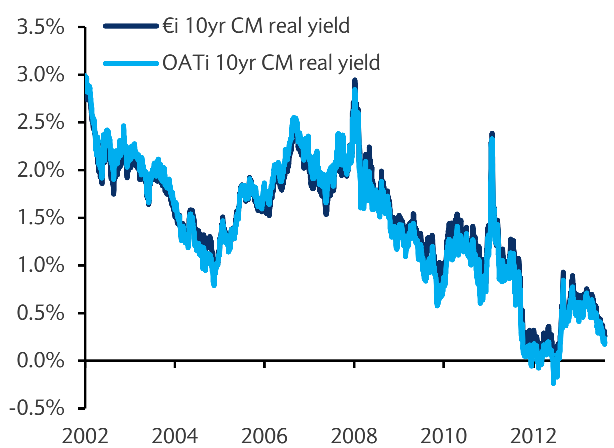


FIGURE 4
Germany DBR€i 10y real yield

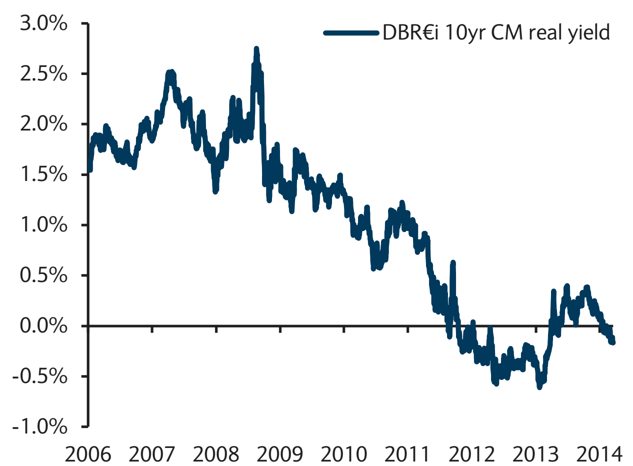


FIGURE 5
Italy 10y BTP€i real yield

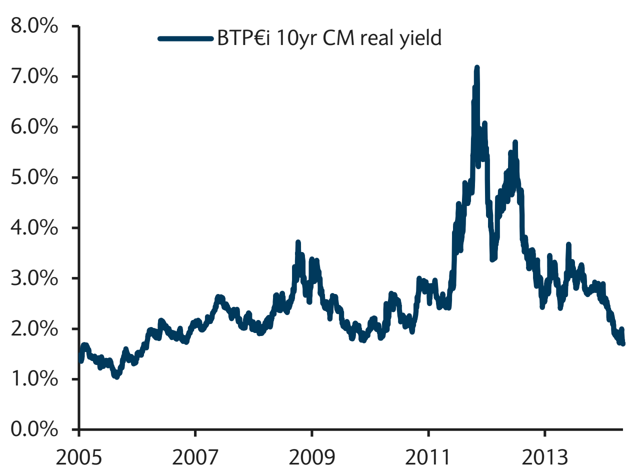
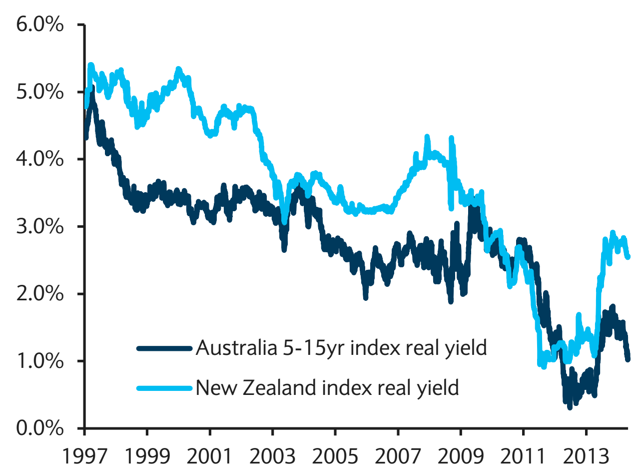


FIGURE 6
Australia and New Zealand 5-15y index real yield



Source: Barclays Research

FIGURE 7

Canada CANi 2021 real yield

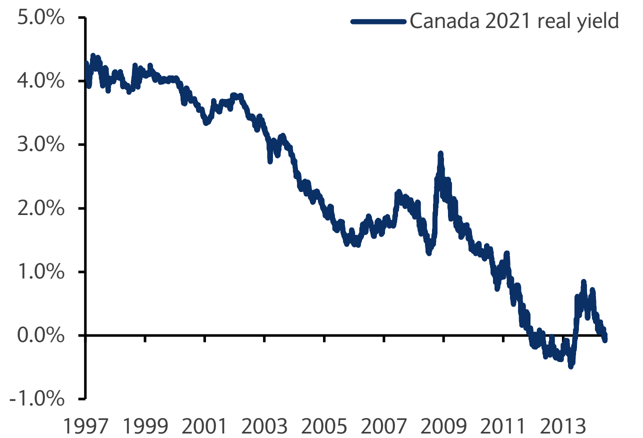


FIGURE 8

Japan OTR real yield

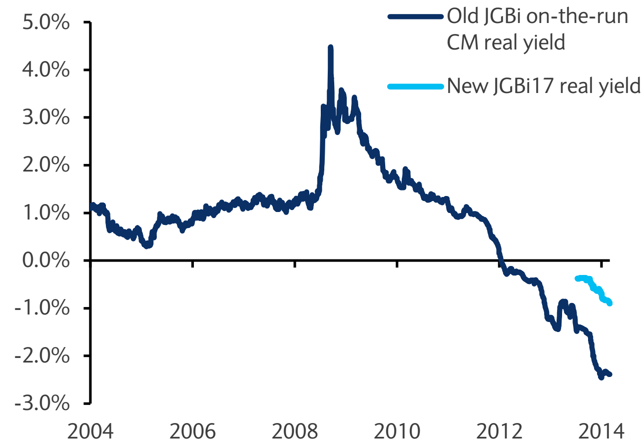


FIGURE 9

Sweden 10y real yield

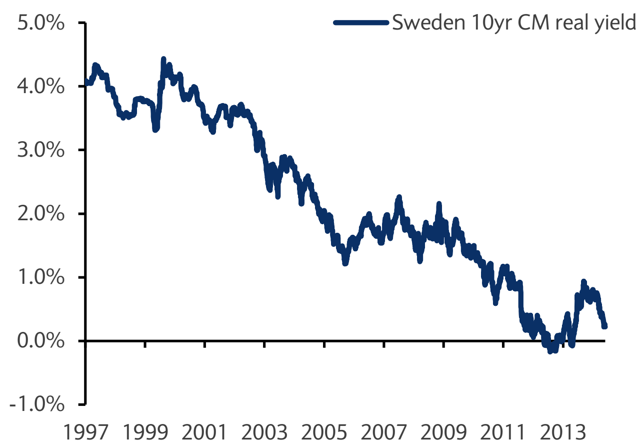


FIGURE 10

Israel 1-10y index real yield

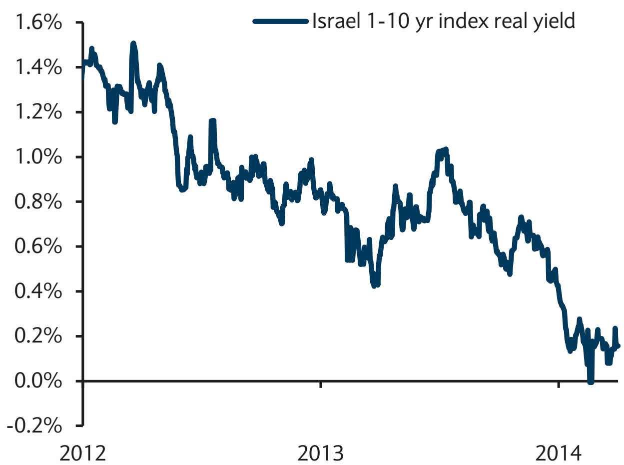


FIGURE 11

South Africa 1-10y index real yield

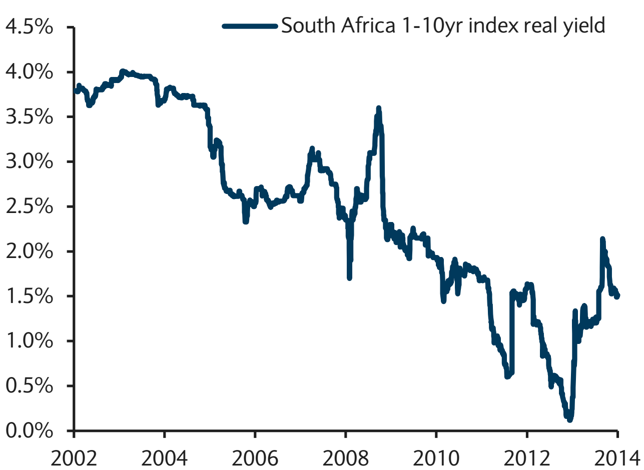
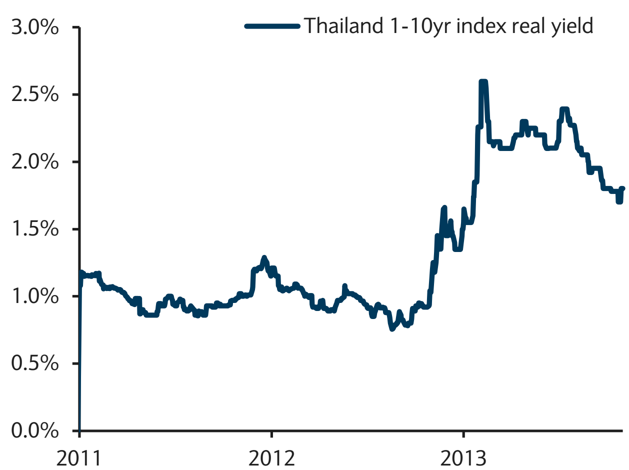


FIGURE 12

Thailand 1-10y index real yield



Source: Barclays Research

FIGURE 13
South Korea 5-15y index real yield

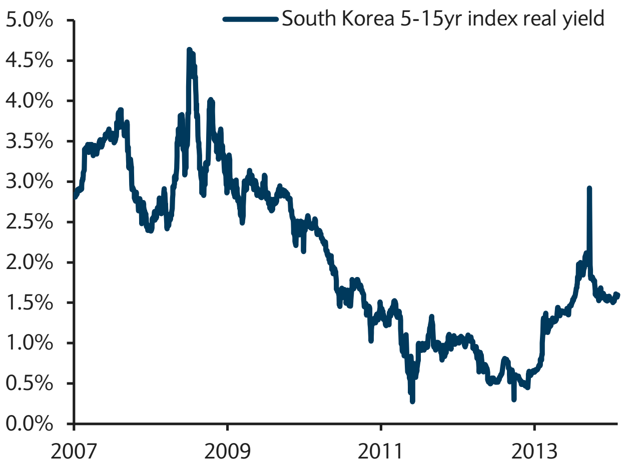


FIGURE 14
Brazil 5-15y index real yield

FIGURE 15
Chile 5-15y index real yield

FIGURE 16
Colombia 5-15y index real yield

FIGURE 17
Mexico 5-15y index real yield

FIGURE 18
Turkey 7-10y index real yield

Source: Barclays Research

Breakeven inflation histories

FIGURE 1

US 10y TIPS breakeven vs realised inflation

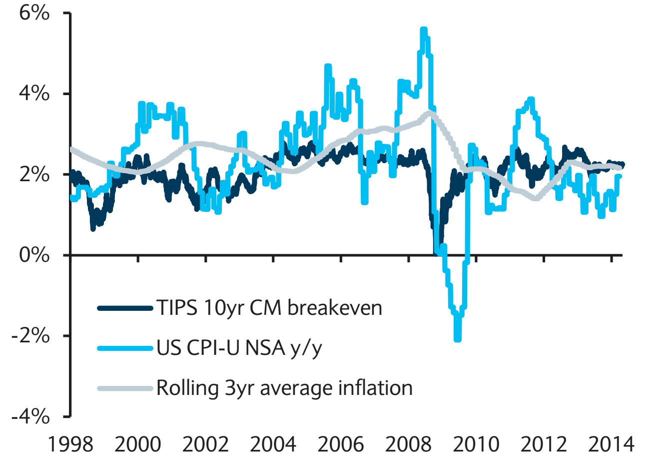


FIGURE 2

UK 10y breakeven vs realised inflation

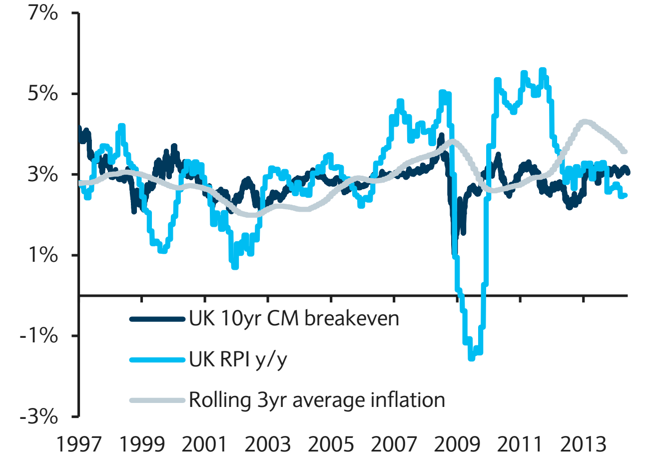


FIGURE 3

France 10y OATi breakeven vs realised inflation

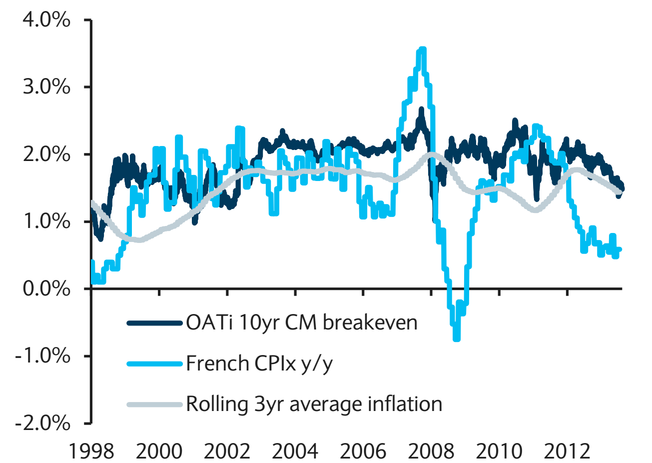


FIGURE 4

Euro €i 10y breakeven vs realised inflation

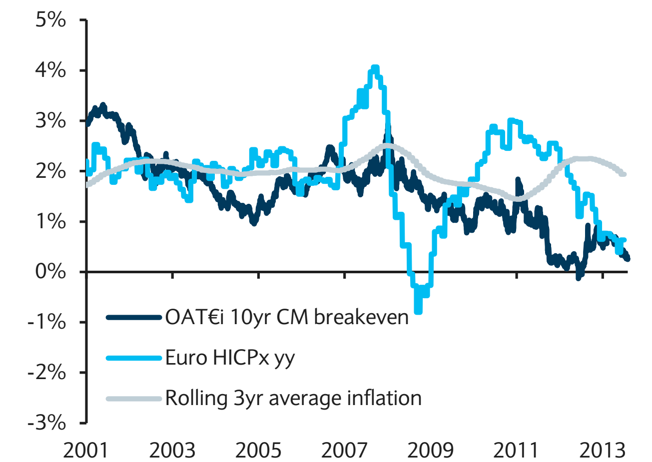


FIGURE 5

Canada 10y breakeven vs realised inflation

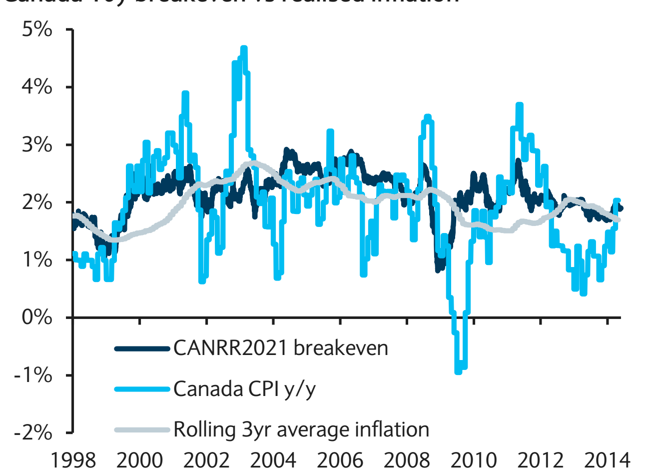
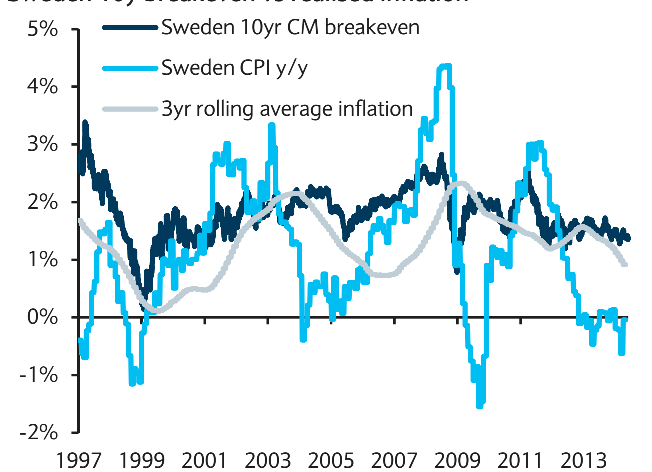


FIGURE 6

Sweden 10y breakeven vs realised inflation



Source: National Statistics Agencies, Barclays Research

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