

Inflation-linked Bonds Explained

Mastering Market & Mechanics

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Overview of inflation-linked market

Summary

In this section we want to give a basic understanding of the inflation-linked market

- ◆ **What are inflation-linked bonds?** Inflation-linked bonds are the flip side of nominal bonds. Nominal bonds are securities that have pre-determined nominal cash flows (*ergo* “fixed income”). Inflation-linked bonds instead aim to give real value certainty
- ◆ **Why inflation-linked bonds?** Historic motives for issuing IL debt are more closely related to confidence and policy. More recently, diversification and hedging have become more important drivers for issuance. Hedging and alpha generation instead drive investments
- ◆ **Who buys and sells?** The participants of the inflation market have been quite one-sided. But increasingly, there are institutions which are willing to be on either side of the market, depending on opportunities. Typically:
 - Payers: sovereigns, corporates, real estate companies
 - Receivers: banks, insurance companies, asset managers, structured products
- ◆ **Market structure:** of the big three, the sterling is the oldest market. However, both the dollar and euro markets are growing rapidly. In these two markets the Canadian Model was adopted, and is now widely accepted as the market standard. The DMO announced its intention to start issuing using this same structure

A Historical Perspective

First experiences with inflation-linked bonds

- ◆ Index-linked securities are bonds whose cash flows are linked to some kind of index. In general, a security can be indexed to any index (currencies, GDP, inflation, etc.)
- ◆ In the case of inflation-indexed bonds, these securities provide some degree of purchasing power certainty for the bondholder, and a real cost of finance for the issuer
- ◆ The first index-linked security dates back to 1742 when the State of Massachusetts first issued bills of public credit linked to the cost of silver on the London Exchange. This proved to be a costly exercise for the issuer, as the price of silver appreciated more rapidly than the general price level during the 1740s
- ◆ Parliament passed a law in 1747 that decreed that a broader group of commodities be used should any future debt be indexed. The next attempt was the issuance of *Depreciation Notes* in 1780



A Historical Perspective

First experiences with inflation-linked bonds

- ◆ There has been strong academic support in favour of indexed debt. Irving Fisher argued that it would protect both debtors and creditors from adverse effects on inflation. John Maynard Keynes in 1924 proposed to the Royal Commission on National Debt and Taxation that the British Government issue index-linked debt. Besides offering investors the opportunity to protect their purchasing power, he argued the government might save on interest costs since risk-averse investors might be prepared to pay a premium for protection. More recent support has come from Richard Musgrave, Milton Friedman and Robert Barro
- ◆ In 1950s countries like France and Finland issued indexed bonds in an effort to stabilize prices after the Second World War. These programs were dropped after devaluation of their currencies and fear that the debt would create further inflationary pressure
- ◆ In the 1950s and 1960s countries suffering hyperinflation - like Argentina, Brazil and Mexico - issued indexed debt in order to make their debt palatable
- ◆ Most recently, and since the 1980s, countries have issued inflation-linked debt as a commitment to already established low inflation, for cost saving purposes and to enhance the credibility of their monetary policies



How Indexed Bonds Work

The intuitive idea behind inflation-linked debt

- ◆ Inflation-linked bonds are bonds whose price is in some way linked to movements in a specific price index
- ◆ The aim is to provide investors with a means to protect the real value of their savings. Typically these bonds are linked to the domestic Consumer Price Index (CPI), but other indices can be used (wholesale prices, average earnings, GDP deflator, etc.)
- ◆ Different structures exist. The market standard is becoming the Capital Indexed Bond. This is also known as the Canadian model as the Canadian Treasury was an innovator, in 1991 creating a simplified approach to the indexation of inflation for real return bonds. US (TIPS), French (OATEi/i), Italian (BTPEi) and Greek (GGBei) bonds all use this structure. The UK DMO in 2005 announced its intention to also issue gilts using the Canadian model
- ◆ The value inherent in an IL bond can be decomposed into i) a real rate of return and ii) compensation for the erosion of purchasing power. At the time of purchase, the real return of the bond is known, while its nominal return is uncertain. In contrast, in a conventional (normal) bond, the nominal return is known at purchase, but the real return will depend on how realized inflation erodes the real value of the fixed nominal cash flows

How Indexed Bonds Work

The intuitive idea behind inflation-linked debt

Inflation Expected at 2%	Actual Inflation is 3%
Conventional bond: nominal return 5% E(real return 3%)	Conventional bond: nominal return 5%; A(real return 2%)
Index-linked bond: real return 3% E(nominal return 5%)	 Index-linked bond: real return 3% A(nominal return 6%)
Inflation Expected at 2%	Actual Inflation is 1%
Conventional bond: nominal return 5% E(real return 3%)	 Conventional bond: nominal return 5%; A(real return 4%)
Index-linked bond: real return 3% E(nominal return 5%)	Index-linked bond: real return 3% A(nominal return 4%)

Limits of Inflation-linked Bonds

IL bonds only provide partial real value certainty

- ◆ Complete real value certainty can never be achieved:
 - The inflation index to which pay outs are linked will only be an approximation to the particular consumption basket of the bondholder
 - Price indices, for practical purposes, cannot be published instantaneously. There will always be a lag between the relevant time period for which an index value is computed and the date on which the number is published
 - Taxes. Even if it were possible to overcome the first two issues, the various tax regimes in existence tend to cause post-tax real return to remain uncertain, even if pre-tax real yields are known

Choice of Index

Issuers and borrowers may have different preferences in indices

◆ Issuers:

- The preferred index for sovereigns is likely to be a broad-based index, such as the GDP deflator, as this is likely to provide the best correlation with its revenues and expenses
- Corporates are likely to want to issue bonds indexed to indices that are closely related to their line of business. In the 1950s, Austrian and French electricity companies issued bonds tied to the price of electricity. But this limits their appeal

◆ Investors:

- Pension funds are likely to want to buy bonds linked to earnings indices, to offset liabilities that are often linked to wage inflation

◆ The US experience:

- In its 1996 consultation, the US Treasury suggested indexation to the non-seasonally adjusted CPI for All Urban Consumers (CPI-U), the Core CPI (CPI-U, excluding food and energy), the Employment Cost Index (ECI) and the GDP deflator
 - CPI-U was chosen because it was felt this was the most widely understood index
 - The non-seasonally adjusted index was chosen to avoid problems with period revisions that may occur with the seasonally adjusted series

Choice of Index

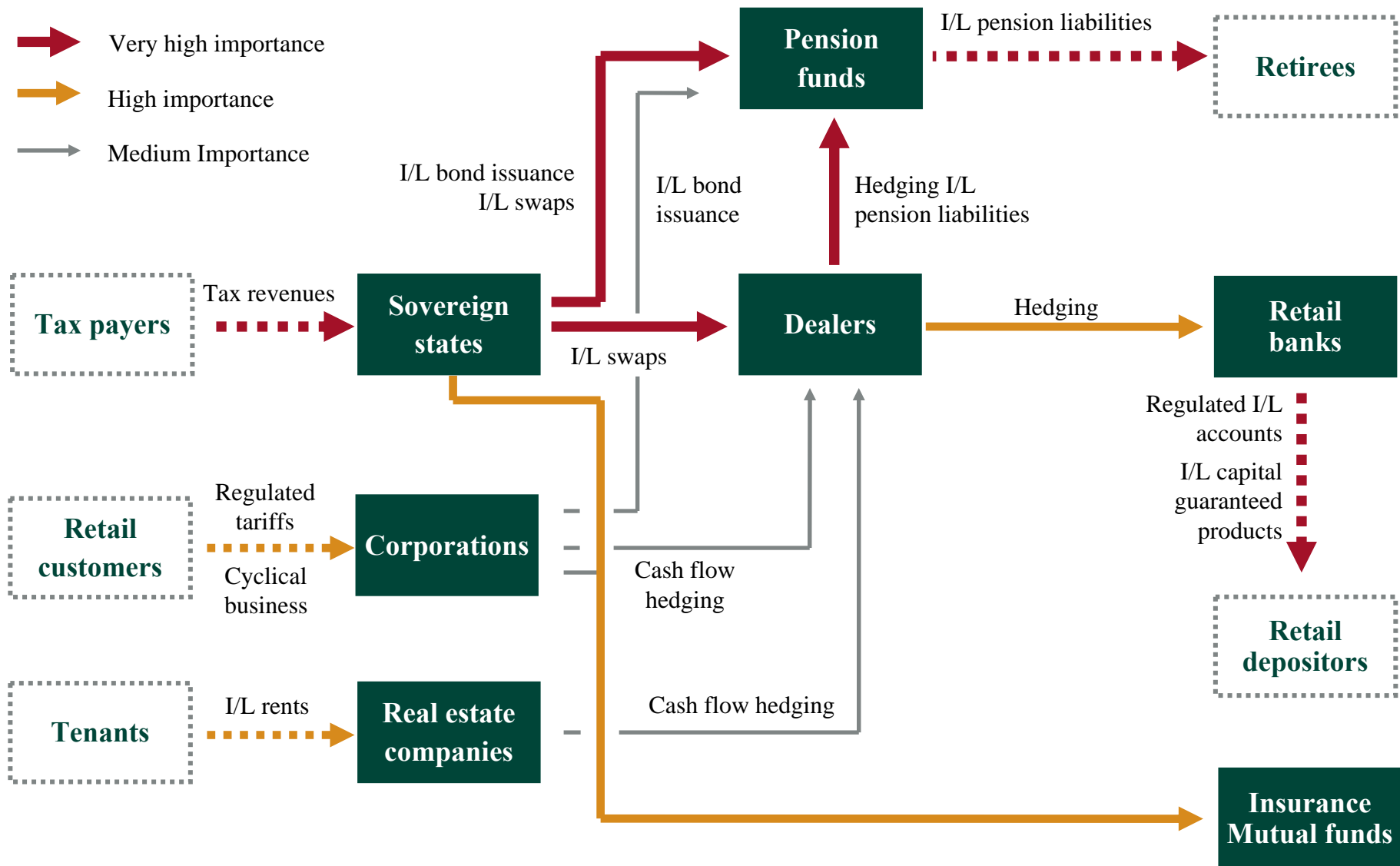
Properties an index must have

- ◆ Definition and data revisions: an index should be chosen that is not subject to regular revisions and that clear rules exist to describe the impact on bondholders should a revision occur. The prospectus should provide details as to contingencies in the event that publication of any given index value is delayed
- ◆ Integrity: it is important that the index is published by a body known to be independent of the issuer. This is easy for corporates, but this is one reason which led to the independence of the Bank of England, given the RPI includes the cost of mortgage interest payments (the Chancellor of the Exchequer could otherwise be tempted to hold interest rates low ahead of large redemptions). The index must also be disseminated widely and quickly
- ◆ Seasonality: seasonality per se is not a flaw. However, its existence does complicate analysis of IL debt (as we will see later). A solution is to use seasonally adjusted indices, but these have the drawback of being less well understood and subject to revision
- ◆ Lessons from the past:
 - In 1983 the Italian Treasury issued a CTR (Certificato del Tesoro Reali). The lack of interest in this bond is widely put down to the choice of index, the deflator of GDP at cost factor whose i) properties were not well understood, ii) was published only annually, iii) had a one year lag

Key Players in the Inflation-Linked Market

Overview of inflation-linked market

The demand for inflation-linked assets is structurally very high in Europe



Key Players in the Inflation-linked Market

Overview of inflation-linked market

Issuers with most significant long exposure to inflation

Infrastructure Companies

- ◆ **Power and gas transmission:** National Grid / Transco, Snam Rete Gas, Inexus, Gasunie, Italgas
- ◆ **Water:** Severn Trent, DWR Cymru, Thames Water
- ◆ **Highways, roads rail:** Cofiroute, SAPPR, Autostrade, National Express, RFF, Eurotunnel
- ◆ **Toll bridges:** Great Belt
- ◆ **Airport authorities:** BAA, ADP
- ◆ **Broadcasting:** BBC

Real Estate

- ◆ Colonial

Sovereigns and Agencies

- ◆ **Sovereigns:** European sovereigns
- ◆ **Agencies:** CADES

Cyclicals

- ◆ **Retailers:** Tesco, Carrefour, Casino

Key Players in the Inflation-linked Market

Overview of inflation-linked market

Companies with most significant short exposure to inflation

Pension Funds	Financial Institutions	Corporates and Sovereigns
<p>◆ UK</p> <ul style="list-style-type: none"> – £800bn of pension liabilities – Defined benefit pension plans often linked to inflation through the LPI formula (collared inflation) <p>◆ Holland</p> <ul style="list-style-type: none"> – €450bn of pension liabilities – Defined benefit pension plans, mostly indexed to final salary <p>◆ France</p> <ul style="list-style-type: none"> – Peugeot pension fund – International (e.g. UK) pension funds of French corporates (Thales, EADS, Alstom) 	<p>◆ France</p> <ul style="list-style-type: none"> – Regulated savings account (Livret A, CODEVI) – Amount outstanding: €110bn of Livret A; €46bn of CODEVI <p>◆ Rest of Europe</p> <ul style="list-style-type: none"> – Retail inflation-linked products (Italy, France) 	<p>◆ Utilities</p> <ul style="list-style-type: none"> – Nuclear producers of electricity with index-linked decommissioning costs: EDF (GDP link), British Energy (inflation) <p>◆ Others</p> <ul style="list-style-type: none"> – Labour intensive industries with salaries tracking inflation and inflation-insensitive output prices

Why Sell Inflation?

Surveys show an increase number of economists supporting the issuance of IL debt

Take advantage of asymmetric expectations

- ◆ Cost savings arise *ex post* if inflation turns out to be lower than the market had expected at the time of issuance. The perception that expectations were too high was one of the reasons Sweden and the UK began issuing indexed bonds. Studies from these agencies corroborate these expectations

Monetising the inflation-risk premium

- ◆ Governments can also make an *ex ante* saving on the inflation risk premium component of nominal bond yields - the premium in bond yields demanded by investors to reflect uncertainty about future inflation (which is different to the real term premium; both of these variables can change over time)
- ◆ Several academic studies support this idea as well. However one must be careful in interpreting the data as long histories for IL debt is often unavailable for many markets. Also the inflation risk premium is somewhat balanced by a liquidity premium. Other factors also give rise to differences in returns such as different tax treatments and the market's valuation of convexity

Why Sell Inflation?

Inflation-linked instruments are used to optimize the risk profile of the liability portfolio

Asset/liability management

- ◆ IL debt allows natural receivers of inflation such as governments (taxes are nominal) or utility companies (prices are linked to inflation) to reduce the variability of their cost of capital by linking the coupons of their debt to inflation. Since both assets (taxes, revenues) and liabilities (cost of debt) are linked to the same factor (inflation) the overall risk exposure is minimized

Business cycle hedge

- ◆ Since inflation tends to be positively correlated with the business cycle, linking the cost of capital to inflation minimizes financing cost as a risk factor at times of economic hardship

Liability portfolio diversification

- ◆ On the other hand, a considerable portion of inflation risk is uncorrelated to other financial risk factors. Hence, paying inflation-indexed coupons has appealing risk diversification properties. Optimal taxation theory suggests that it is desirable to minimise fluctuations in tax rates over time. To the extent that inflation is correlated to the economic cycle, IL debt can help achieve this goal

Cost reduction

- ◆ Variable rate debt is well-known to carry a compensation for risk to the issuer. By paying inflation-indexed coupons, issuers can therefore reduce their cost of capital

Why Sell Inflation?

IL debt can also be a policy tool, or to access the markets in difficult conditions

Transfer of wealth

- ◆ There is a school of thought which highlights the social responsibility of a government to transfer wealth in a socially responsible way. The argument states that a government should structure its debt to facilitate the provision of insurance between different groups in society, or between one generation and the next. IL debt allows the transfer of wealth and is both, credit risk free and protecting purchasing power

Promote low-inflation monetary policies

- ◆ The existence of IL debt removes one of the main incentives for a government to adopt inflationary policies (however, it does not itself provide any encouragement for a government to take active steps in reducing inflation). The decision to issue IL debt enhances policy credibility only if there is an established monetary policy framework and a long-term track record

Maintain access to capital markets

- ◆ In a situation of hyperinflation, governments may find difficulty in gaining access to the capital markets, as investors are aware that nominal securities will lose purchasing power. Linking debt to inflation removes this uncertainty. Argentina, Brazil and Mexico are some practical examples of this case

Why Sell Inflation?

Many issuers have inflation linked revenues and costs

		Description	Examples of Issuers Exposed
Indirect Exposure	Business Cycle Exposure	Inflation tends to increase when economic growth and corporate earnings are high. Cyclical businesses are particularly exposed	Retailers (Tesco, Metro, Carrefour)
	Fiscal Revenues	Tax income increases with consumption (VAT), earnings (corporate tax), and income which increase with inflation	Sovereigns Local authorities Agencies (CADES)
Strong Inflation Indexation	Real Estates Rental Income	Real estate prices rise with inflation Rents may be indexed to inflation	Real estate funds
	Regulated Tariffs	Infrastructure companies operating monopoly businesses typically charge inflation-linked tariffs	Utilities (Transco, Snam Rete Gas, Cofiroute)

Why Buy Inflation?

IL debt improves A/L matching, has diversification benefits and are a source of alpha

Defer consumption

- ◆ The purpose of saving (and investing) is to defer consumption of the saver and the saver's dependents. The only concern in the time transfer of this wealth is the future real purchasing power of savings. To focus on future nominal certainty is to suffer from money illusion. IL bonds, in this sense, are the lowest risk instrument to meet long-term savings needs

Diversification

- ◆ IL bonds have different behavioral characteristics to other asset classes. They form a distinct asset class offering portfolio diversification, and thus improving Markowitz's efficient frontier

New trading dimensions

- ◆ Inflation bonds add new trading dimensions. All trade types applicable to nominal bonds (directional, curve, relative value) apply equally to indexed debt. In addition, there is the dimension between IL debt and nominal securities (the breakeven), and the relative value between inflation bonds that are linked to different indices (e.g. HICPxT vs FR CPIxT)

Overview of the Inflation-linked Bond Market

Sovereigns are increasingly active in the inflation-linked market

- ◆ The AFT is now regularly issuing “at least” 10% of its gross annual issuance program in OATe/i format (14% in 2003A; 18% in 2004A; 18% in 2005E). The AFT has now moved to a regular auction calendar for OATe/i on the third Thursday of the month. The French Treasury announced a long-term target of indexing 15% of its total debt, which would make about €150bn, more than double today’s outstanding
- ◆ Italy started its program late, but has quickly picked up the pace of inflation-linked issuance. This is at the expense of its CCT and CTZ programs
- ◆ In the UK, inflation-linked bonds make up 27% of the overall gilt stock

Inflation-linked Bond Issuance Volumes & Forecasts (Nominal Amounts)

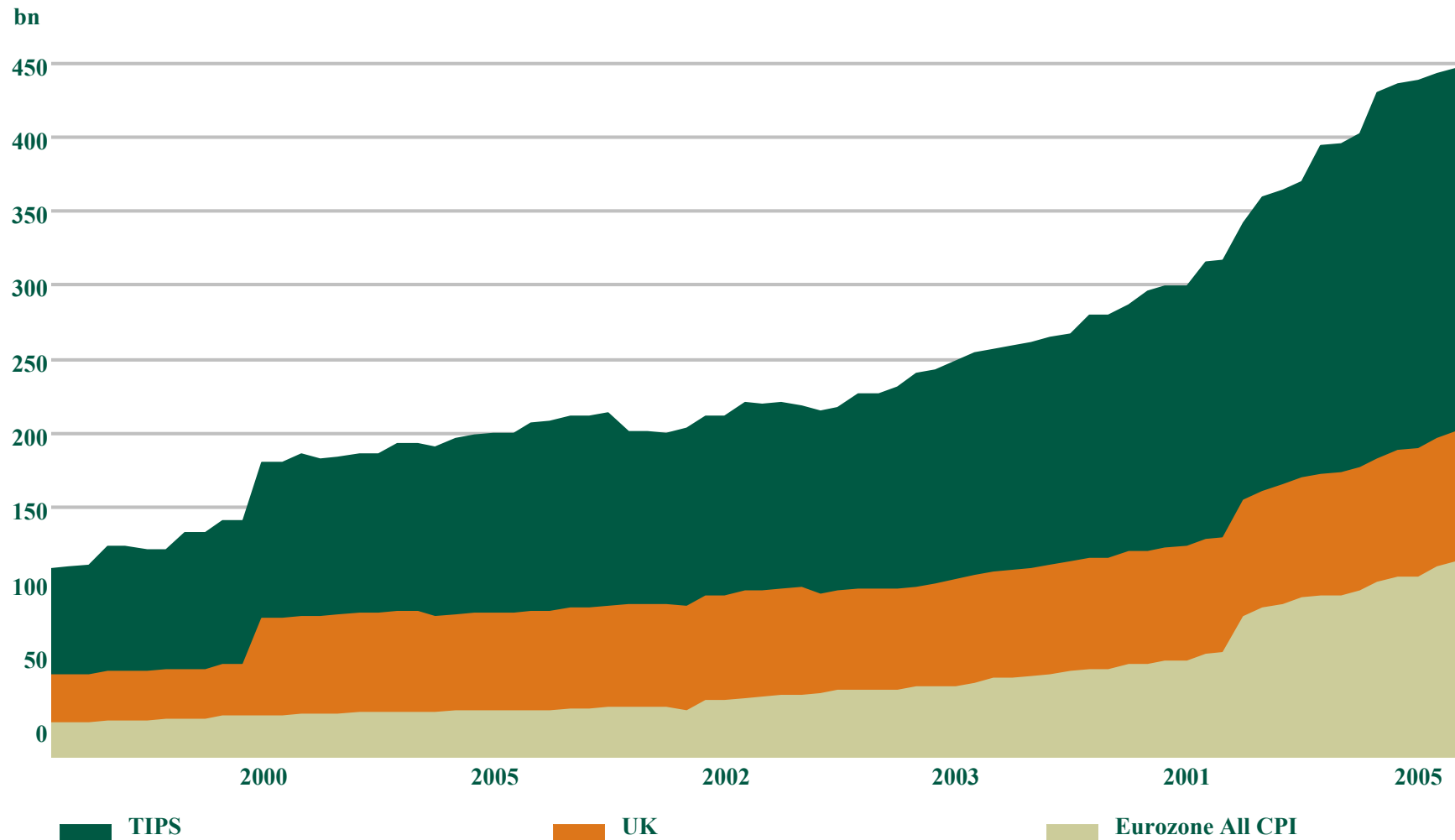
Local currency, bn	2002	2003	% Growth	2004	% Growth	2005
France	9.5	16	42	22.7	-3	22
Italy	0	10.2	75	17.8	29	23
Germany	0	0	<i>n.a.</i>	0	<i>n.a.</i>	10
Greece	0	1.3	69	2.2	-9	2
Total euro area	9.5	27.5	55	42.7	33	57
United Kingdom	3.7	3.4	29	4.4	14	5
United States	22	26	150	65	23	80
Japan	0	0	<i>n.a.</i>	800	150	2,000

Growth of the Inflation-linked Bond Market

Overview of inflation-linked market

Sovereigns are increasingly active in the inflation-linked market

Amount Outstanding in USD, GBP & EUR Inflation-linked Bonds

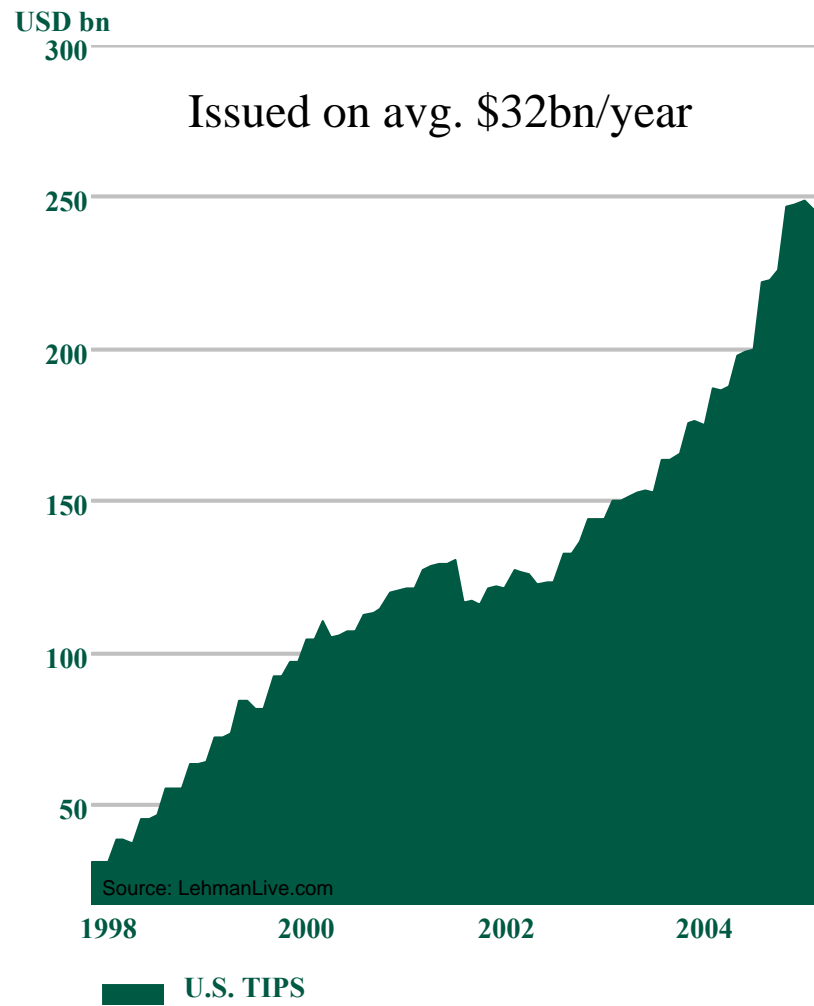


Amounts in local currency. Source: Lehman Brothers Inflation Indices

US: TIPS

Treasury Inflation Protected Securities

TIPS Outstanding



Summary Statistics

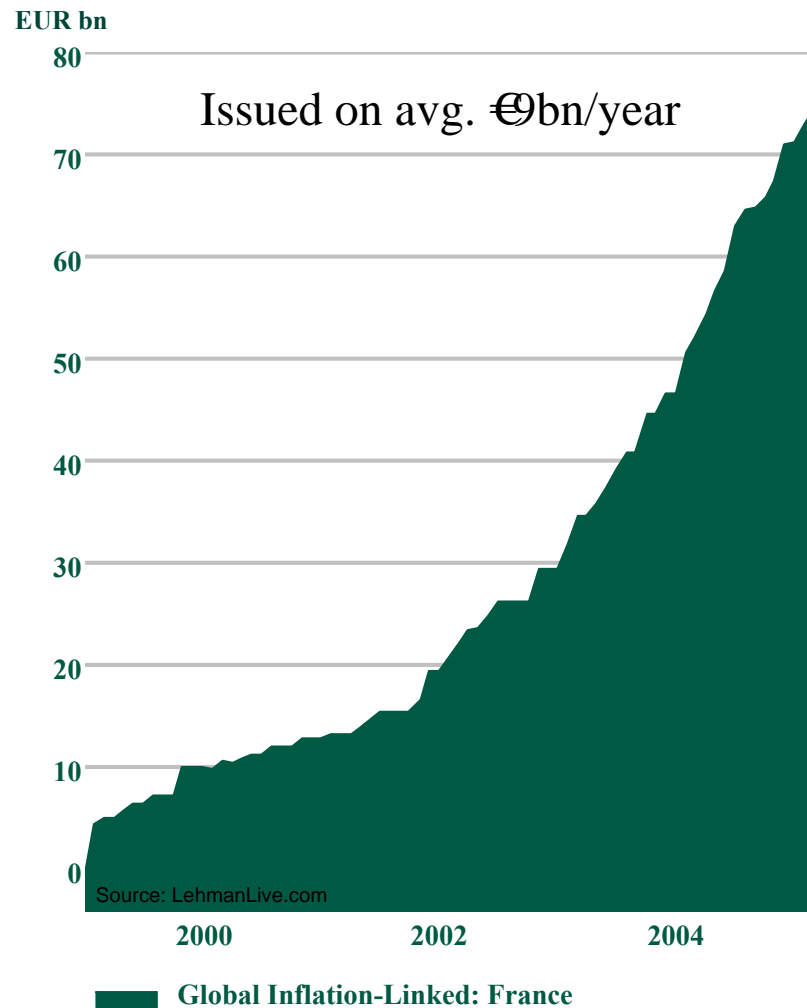
- ◆ First issue January 1997
- ◆ Inflation accretion is referenced to the CPI-U NSA, set with a 3-month lag
- ◆ Structure: Capital Indexed Bond
- ◆ Principal adjusted for inflation daily, but paid at maturity. Capital protected in case of deflation
- ◆ 16 outstanding bonds
- ◆ USD242bn outstanding
USD294bn market value
- ◆ Typical bid-offer:
 - 5y: 1.3bp / 6¢
 - 10y: 0.7bp / 6¢
 - 30y: 0.8bp / 19¢

France: OATei/i

Overview of inflation-linked market

Obligations Assimilables du Trésor Indexée sur L'Indice des Prix à la Consommation

OATei/i Outstanding



Summary Statistics

- ◆ First issue September 1998
- ◆ Inflation accretion is referenced to the national CPI excluding tobacco or HICPxT, set with a 3-month lag
- ◆ Structure: Capital Indexed Bond
- ◆ Principal adjusted for inflation daily, but paid at maturity. Capital protected in case of deflation
- ◆ 8 outstanding bonds
- ◆ EUR71bn outstanding
EUR84bn market value
- ◆ Typical bid-offer:

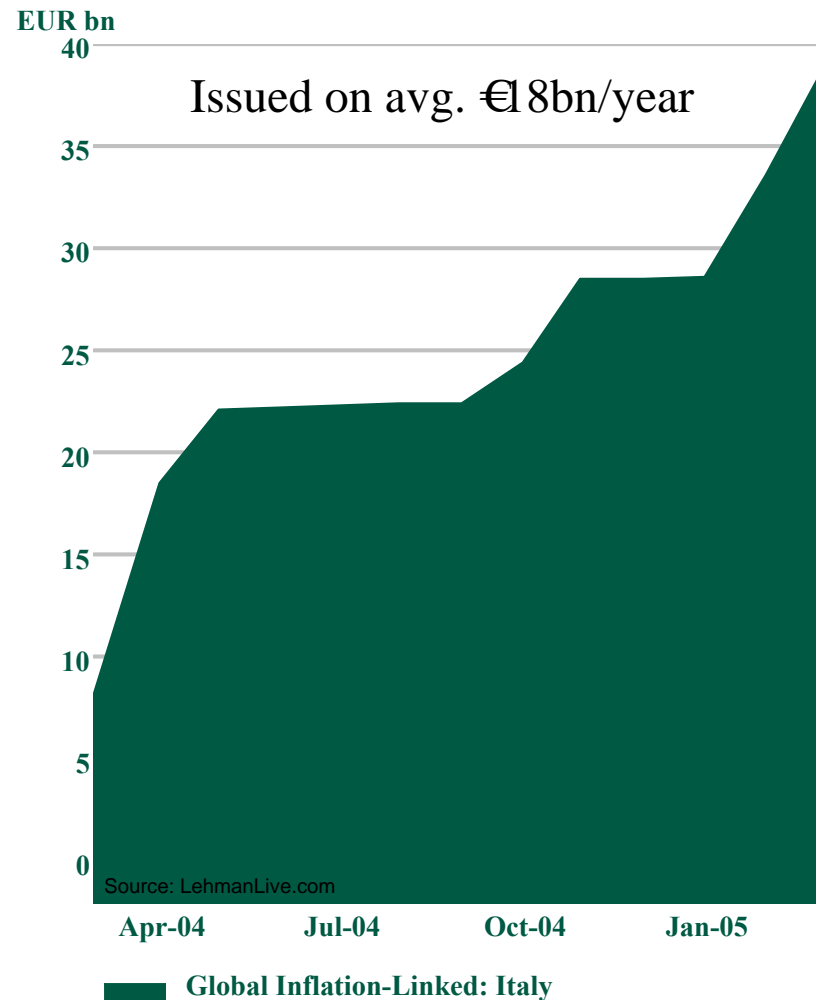
5y:	1bp /	4¢
10y:	1bp /	8¢
30y:	1bp /	20¢

Italy: BTPei

Overview of inflation-linked market

Buoni Poliennali del Tesoro Indicizzati all'Inflazione

BTPei Outstanding



Summary Statistics

- ◆ First issue September 2003
- ◆ Inflation accretion is referenced to HICPxT, set with a 3-month lag
- ◆ Structure: Capital Indexed Bond
- ◆ Principal adjusted for inflation daily, but paid at maturity. Capital protected in case of deflation
- ◆ 4 outstanding bonds
- ◆ EUR36bn outstanding
EUR38bn market value
- ◆ Typical bid-offer:

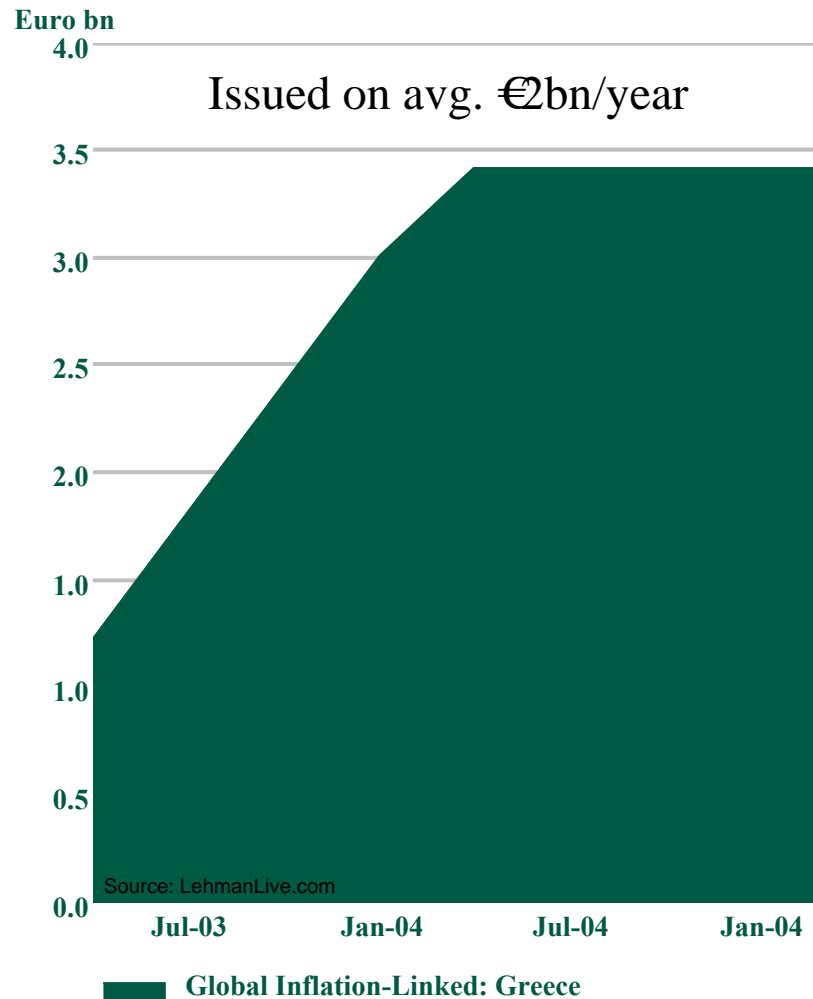
5y:	1bp /	4¢
10y:	1bp /	8¢
30y:	1bp /	20¢

Greece: GGBei

Overview of inflation-linked market

Inflation-linked Greek Government Bonds

GGBei Outstanding



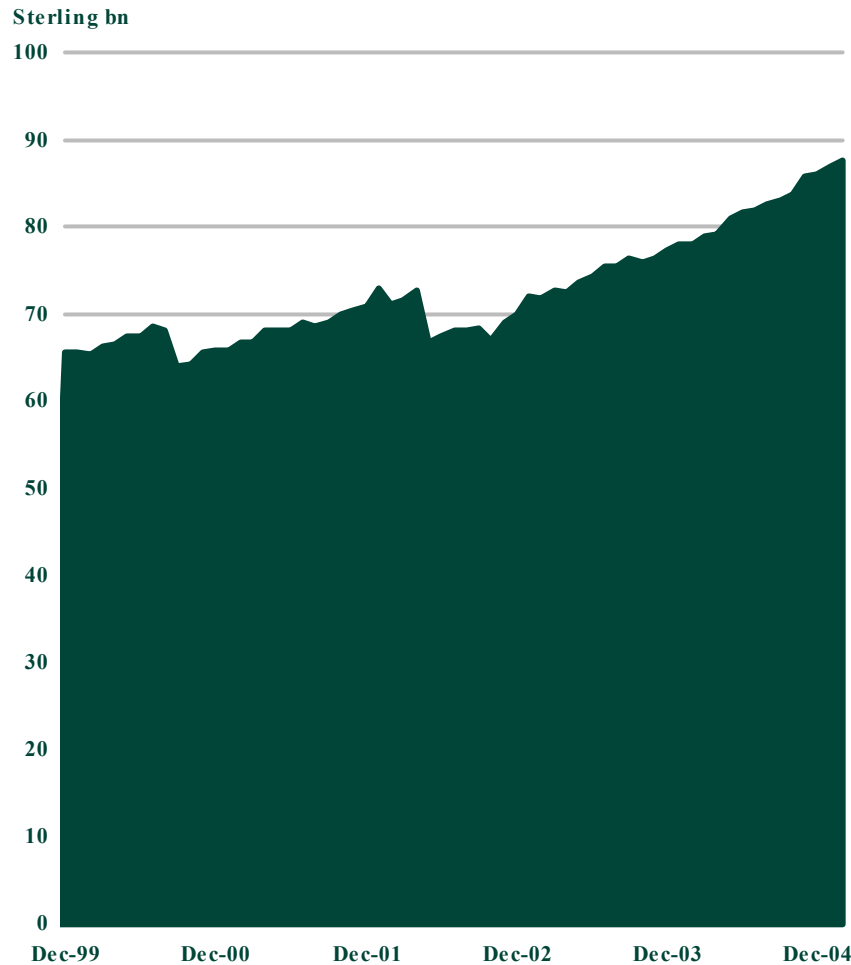
Summary Statistics

- ◆ First issue March 2003
- ◆ Inflation accretion is referenced to HICPxT, set with a 3-month lag
- ◆ Structure: Capital Indexed Bond
- ◆ Principal adjusted for inflation daily, but paid at maturity. Capital protected in case of deflation
- ◆ 1 outstanding bond
- ◆ EUR3.4bn outstanding
EUR4.1bn market value
- ◆ Typical bid-offer:
20y: 2bp / 40¢

UK: Linkers

Inflation-linked UK Government Linkers Bonds

Linkers Outstanding



Summary Statistics

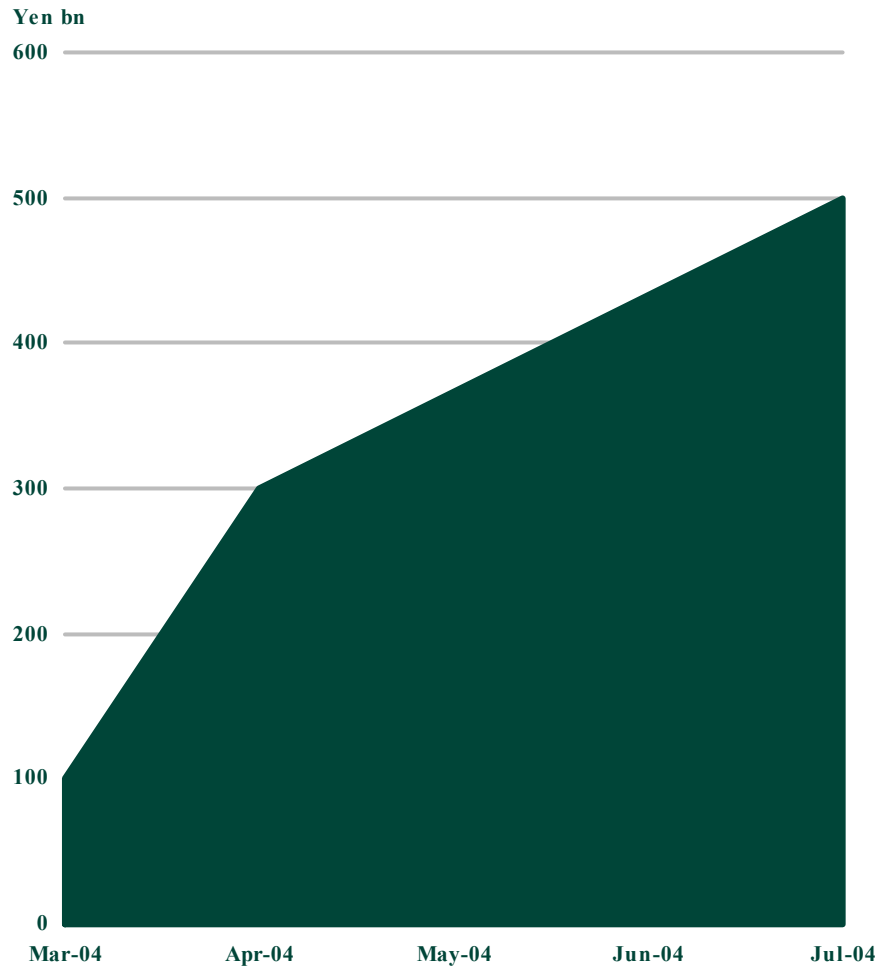
- ◆ First issue March 1981
- ◆ Inflation accretion is referenced to RPI, set with a 8-month lag
- ◆ Bonds are traded in nominal space. Typically a 3% inflation assumption is used to convert future cash flows into nominal
- ◆ 9 outstanding bonds
- ◆ GBP44.1bn outstanding
GBP96.5bn market value
- ◆ Typical bid-offer:
 - 5y: 2bp / 16¢
 - 10y: 2bp / 24¢
 - 30y: 1.5bp / 29¢

Japan: JGBi

Overview of inflation-linked market

Inflation-linked Japanese Government Bonds

JGBi Outstanding



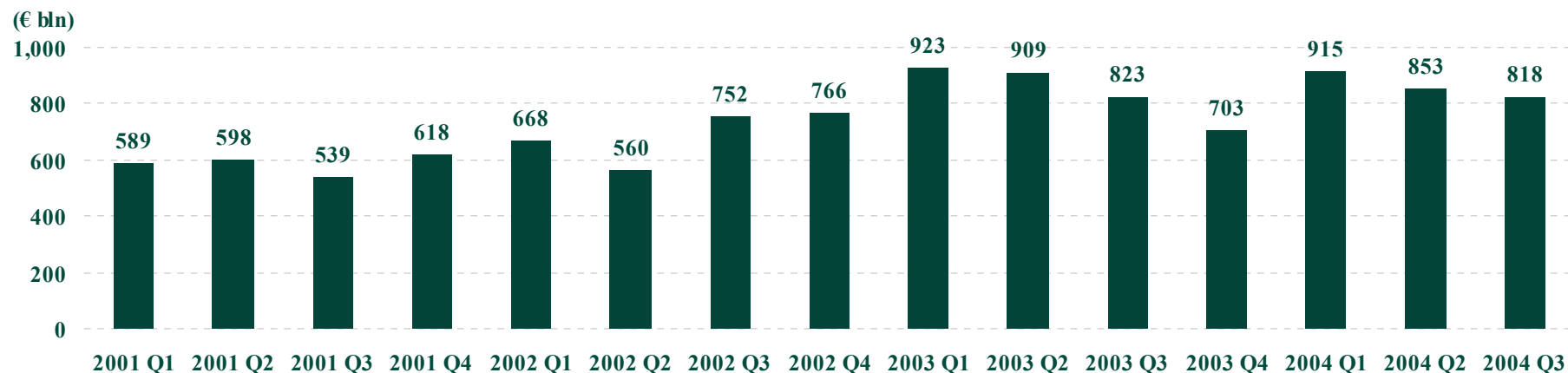
Summary Statistics

- ◆ First issue March 2004
- ◆ As of 1 April 2005 JGBi are be available to foreign investors
- ◆ Inflation accretion is referenced to core CPI (including energy), not seasonally adjusted
- ◆ Structure: Capital Indexed Bond
- ◆ Major difference with most other inflation-linked securities is the absence of a floor on the principal. If on redemption, the indexed CPI level were below the level at issue, investors would receive sub-par redemption
- ◆ 3 outstanding bonds
- ◆ JPY899bn outstanding
- ◆ Typical bid-offer:
10y: 3bp / 28¢

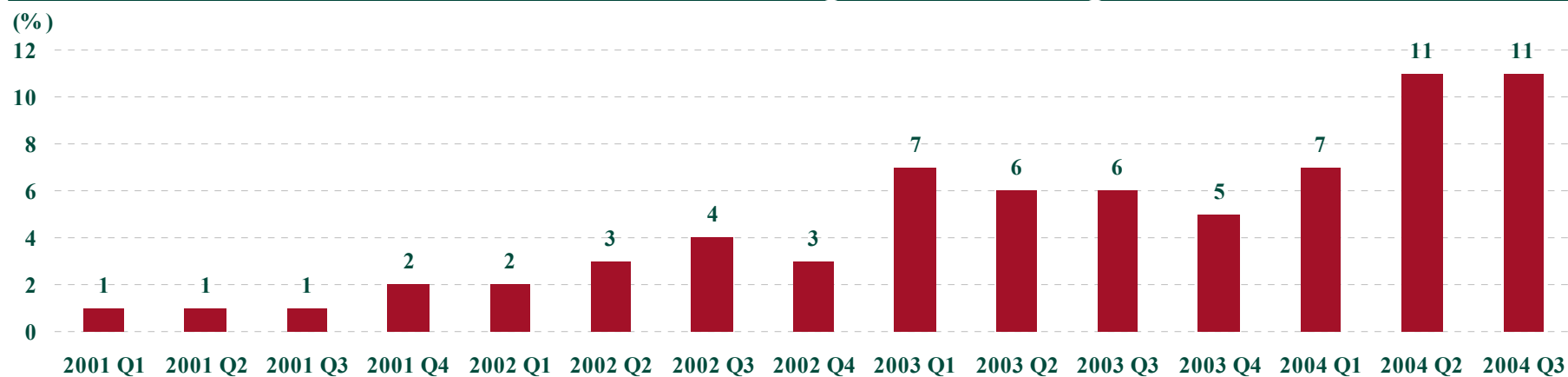
Traded Volumes in OATei/i Market

Overview of inflation-linked market

Total Outstanding Market



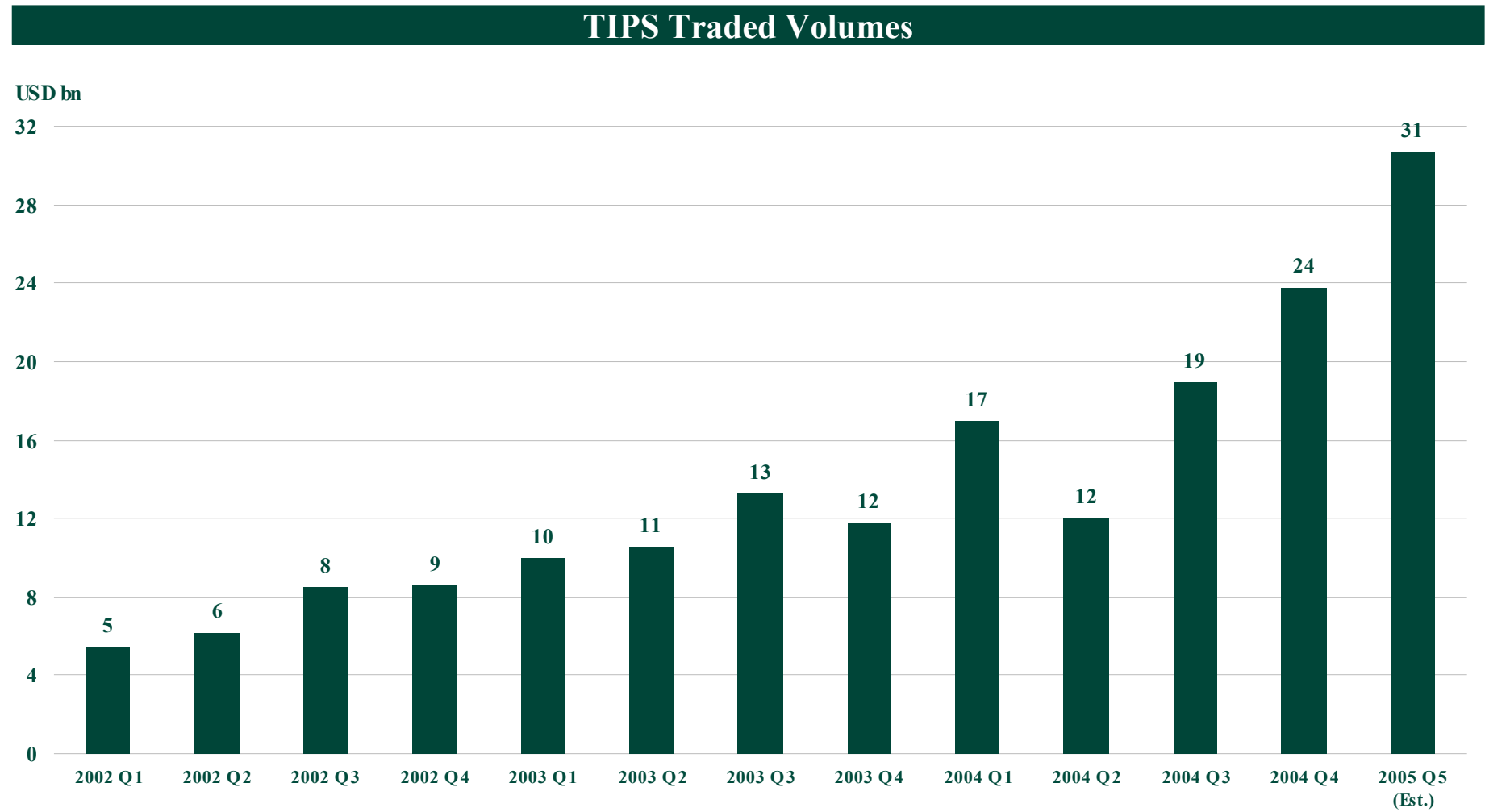
Traded Volumes as Percentage of Outstanding Market



Source: AFT

Traded Volumes in TIPS Market

Overview of inflation-linked market

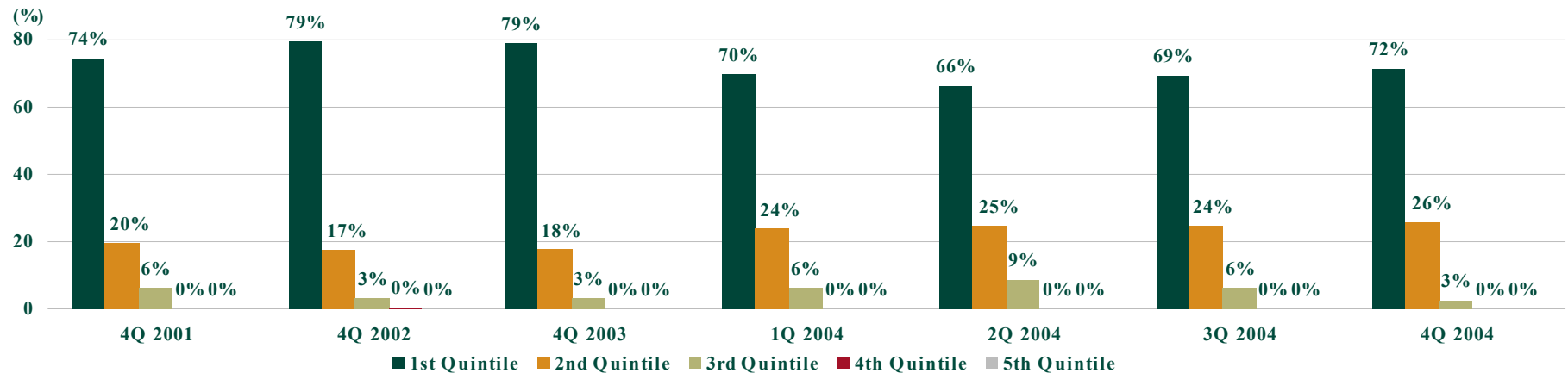


Source: US Federal Reserve Bank of New York

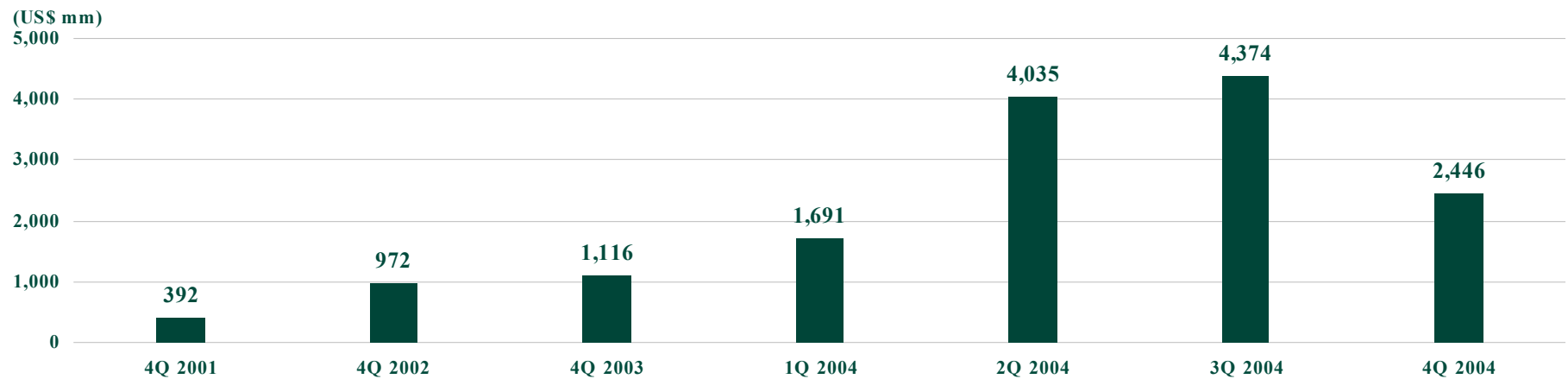
TIPS Market Concentration

Overview of inflation-linked market

Primary Dealers TIPS Market Share



Daily Average Transaction Volume



Source: US Federal Reserve Bank of New York

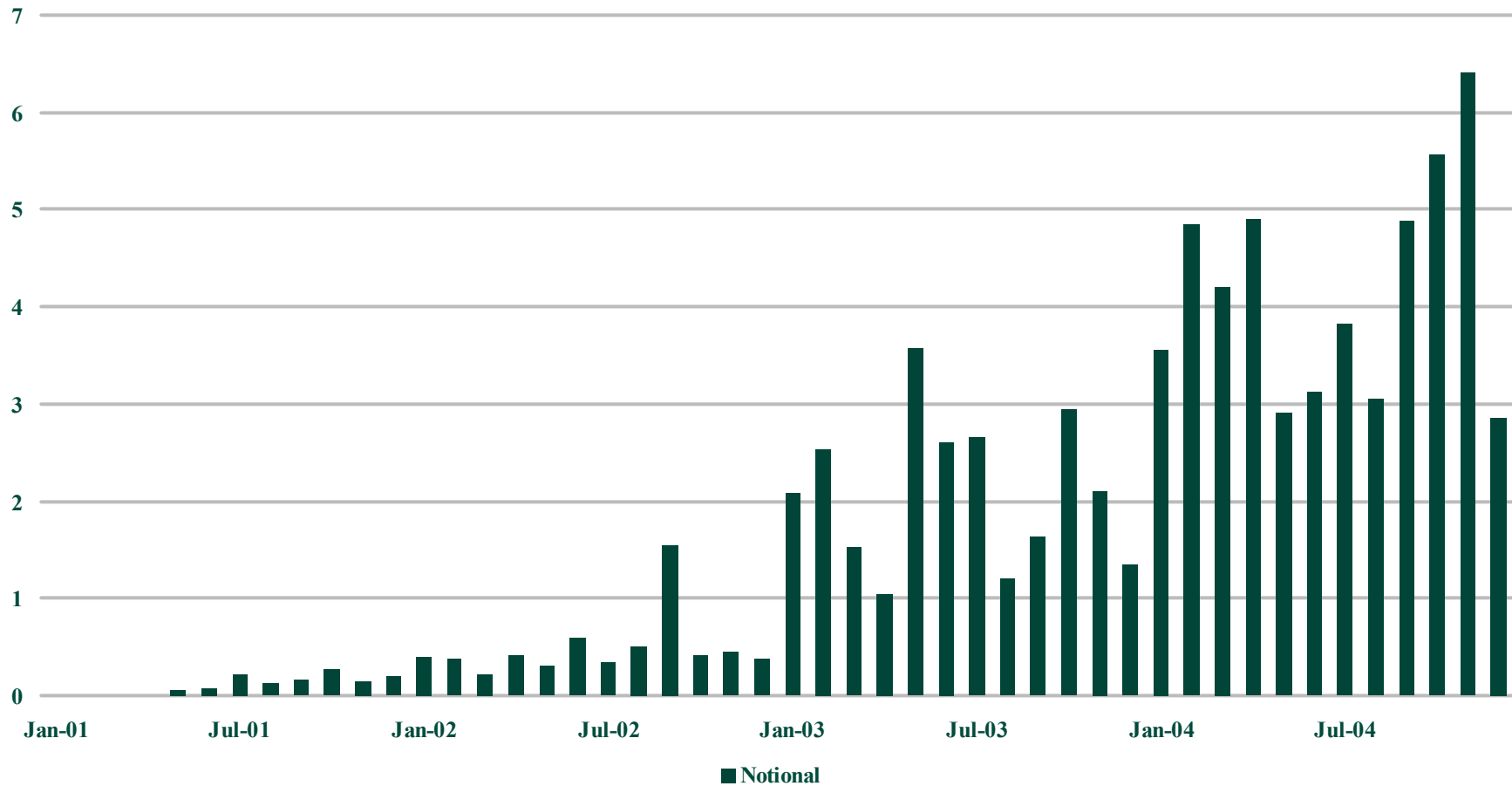
Volumes Are Also Picking Up in Inflation Swap Market

Overview of inflation-linked market

Swap volumes growing fast and surpassing bonds in certain segments of the curve

Volume of New Inflation Swaps by Month

EUR bn



Source: ICAP estimates

Mechanics of inflation-linked bonds

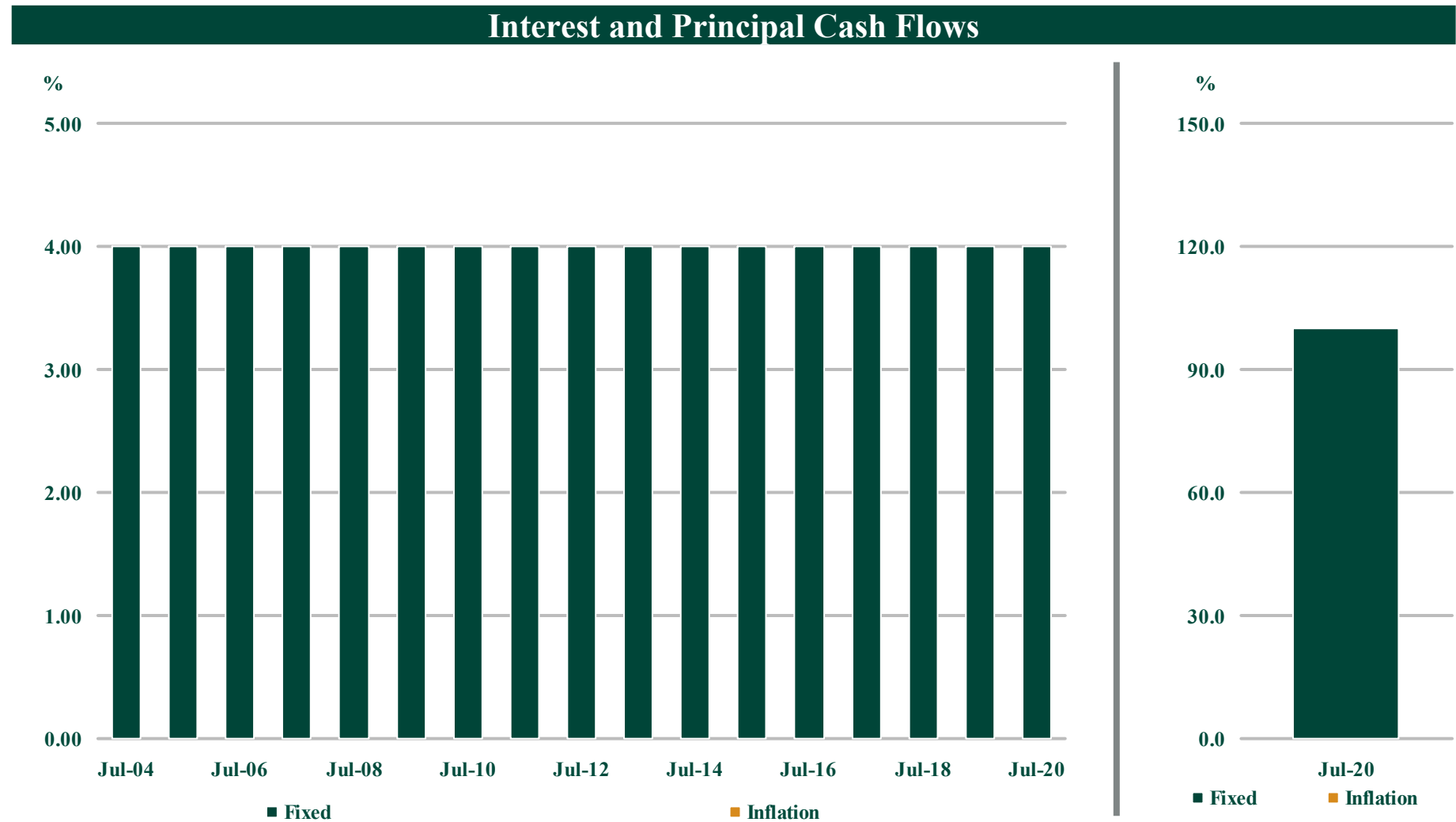
Summary

In this section we go over the mechanics of capital indexed bonds

- ◆ **Structure:** capital indexation (also known as the Canadian model) is the most common structure for inflation-linked bonds. In this structure, inflation is simply “added on.” The mechanical features in this bond are for the most part identical to nominal bonds, only the interpretation of the numbers changes
- ◆ **Bond comparisons:** inflation-linked bonds can be compared in three different ways:
 - **Breakeven inflation:** given the greater liquidity in the nominal market, and (originally) the scarcity of inflation bonds, typically IL bonds are valued on a breakeven inflation basis. Roughly speaking, this is the expected rate of inflation to maturity which makes one indifferent between the two asset classes
 - **Asset swap spreads:** like in nominal space, asset swap spreads are the purest way to compare bonds as they take into account all the cash flows of a security and compare them to a common base. The difficulty in creating a forward inflation curve makes this a parameter that is not often looked at
 - **Relative value:** IL bonds can be compared to one another for value, like we do in nominal space. But their relative scarcity make it difficult to find comparisons which are not influenced by other factors (curve, flows, etc.)

Nominal Bonds

Cash flow structure of “normal” bonds



Hypothetical July 2020 bond

Capital Indexed Bonds

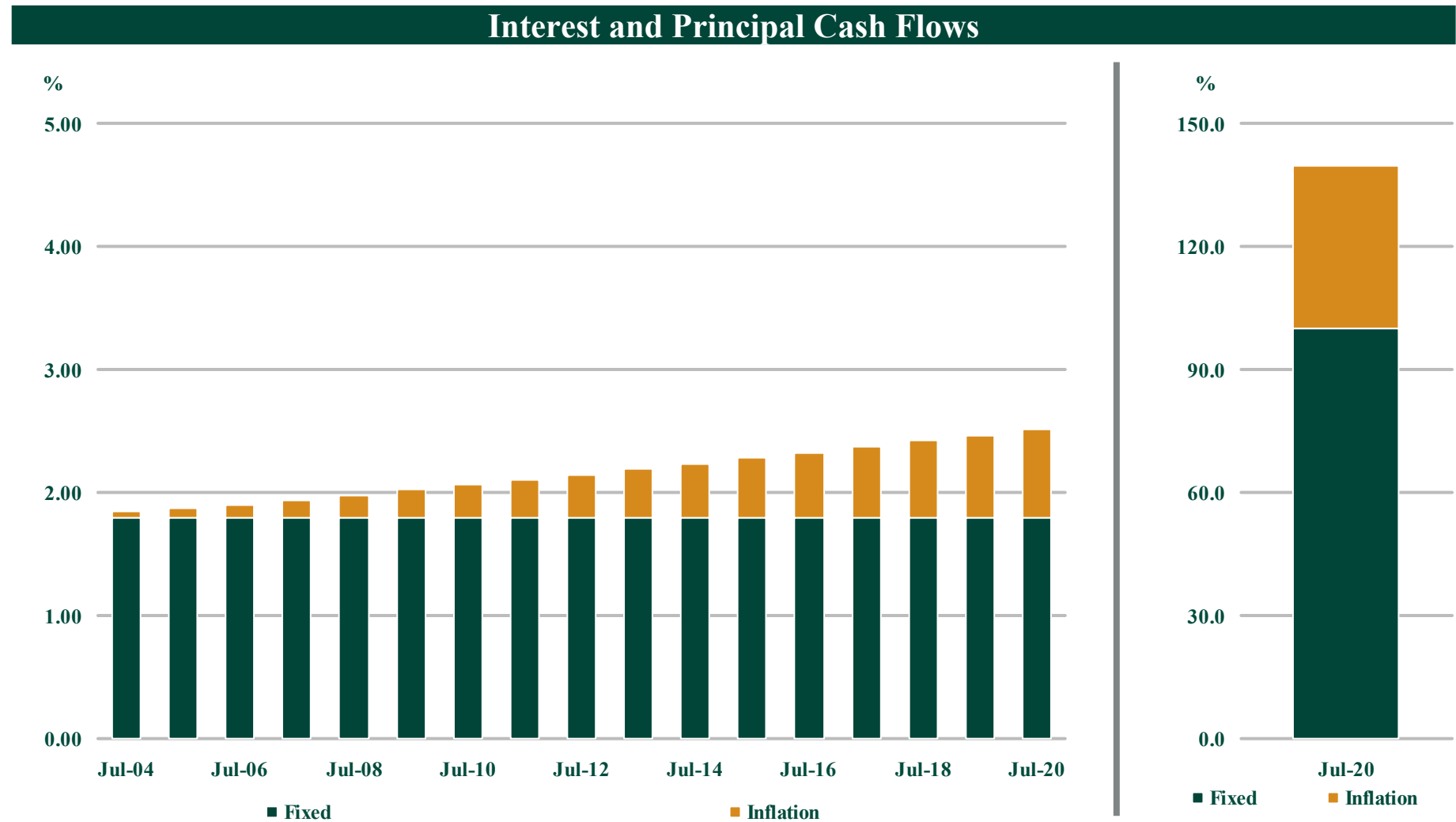
This is the most common type (also known as Canadian model)

- ◆ Coupon: fixed real coupon times compounded inflation since date of issue
- ◆ Principal: par times compounded inflation since date of issue
- ◆ This is the most common type of IL bond and is becoming the “market standard” (TIPS, OATei/i, BTPei, GGBei, JGBi)
 - Typically interest payments are not protected against the possibility of deflation. This means that coupon payments can fall below their stated real coupon rate
 - Typically the principal is protected against deflation, so cannot fall below par. However, there are examples where this is not the case. The Japanese MOF structured JGBis without a par floor, because they did not want breakevens to be distorted by the value of the floor

Capital Indexed Bonds

Mechanics of inflation-linked bonds

Cash flow structure



Hypothetical July 2020 bond, assuming constant 2.00% yoy inflation

Interest Indexed Bonds

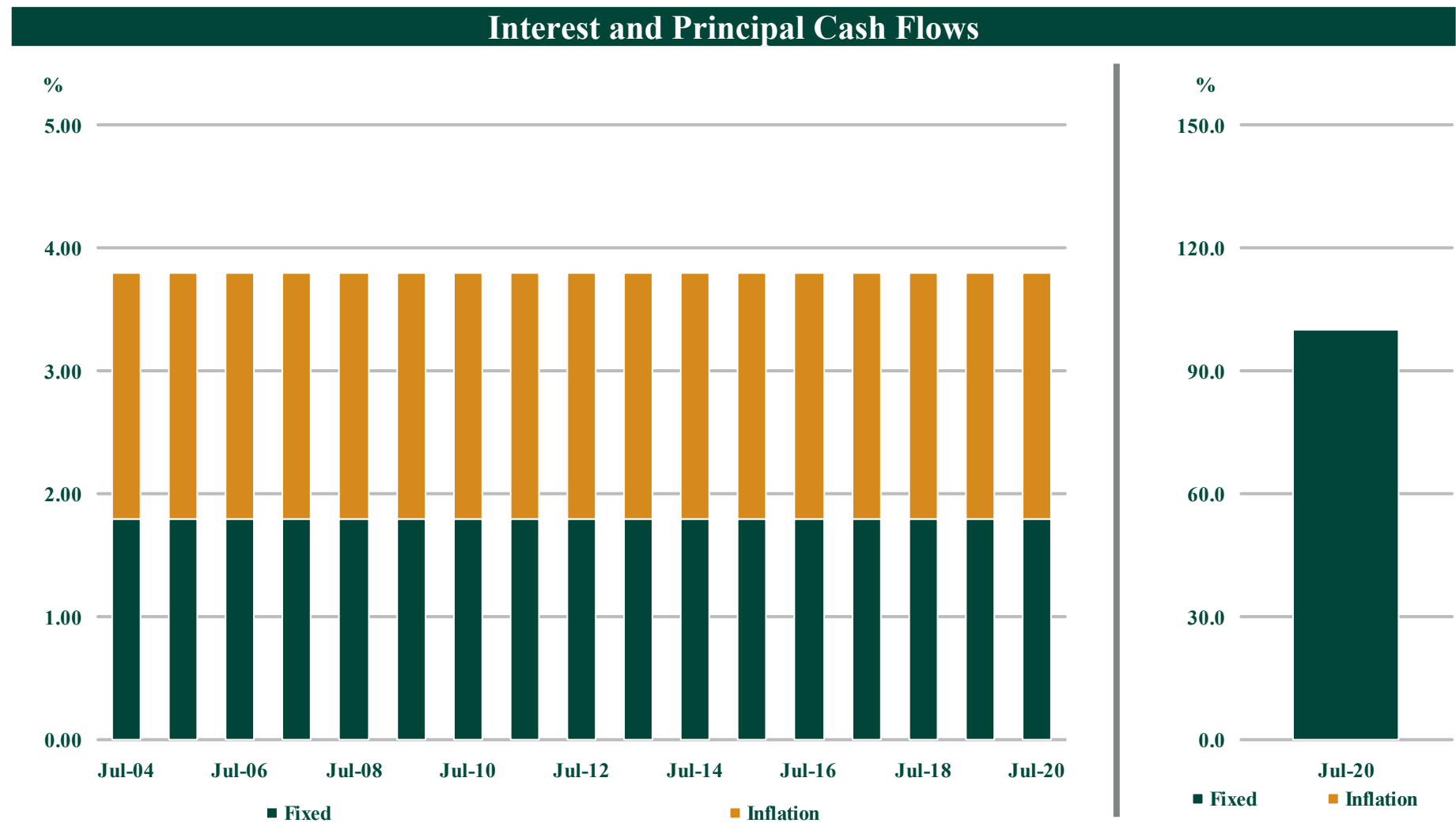
Real coupon plus yoy inflation rate. No inflation compensation in the principal

- ◆ Coupon: fixed real coupon plus periodic inflation rate (e.g. real coupon + yoy inflation)
- ◆ Principal: par
- ◆ The structure is equivalent to paying a fixed coupon (with no inflation adjustment) plus indexation of the principal, where the latter is paid out on a periodic basis (rather than at maturity). Note that in this way, inflation is not compounded
- ◆ The bond is easy to understand because the structure is intuitive. However, an important distinction between the CIB and the IIB is that only the former provides preservation of purchasing power over the life of the bond
- ◆ Australia issued IIBs in the 1980s, but dropped them in favour of CIBs (which were issued in parallel) because the latter proved more popular

Interest Indexed Bonds

Mechanics of inflation-linked bonds

Cash flow structure



Hypothetical July 2020 bond, assuming constant 2.00% yoy inflation

Current Pay Bond

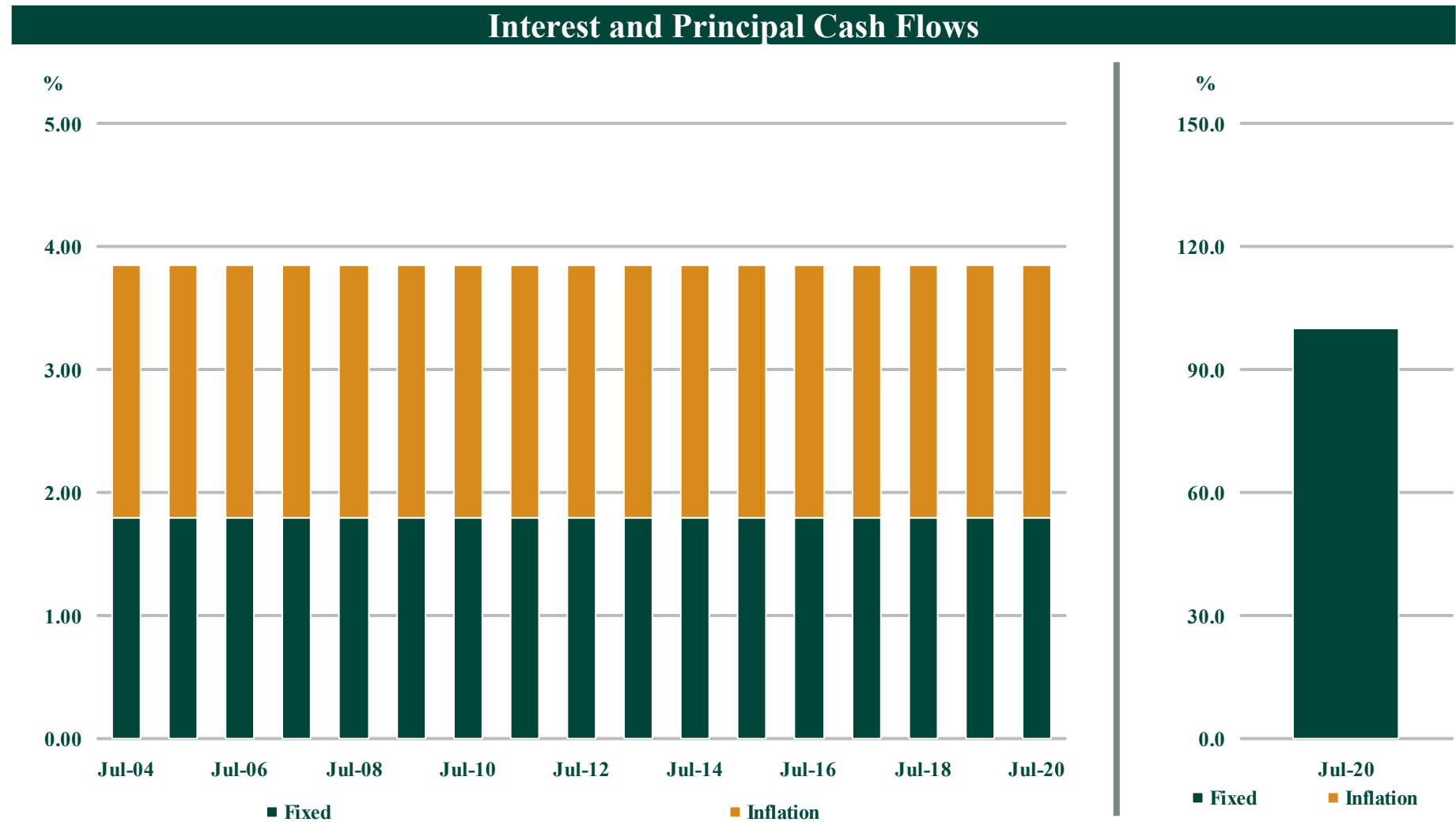
Like IIBs, but with inflation compensation in the coupon as well

- ◆ Coupon: inflation-adjusted real coupon plus periodic inflation rate
[e.g. (real coupon X yoy inflation) + real coupon + yoy inflation]
- ◆ Principal: par
- ◆ This structure is similar to IIBs, however the latter only pay indexation of the fixed principal (while the coupon is fixed). CPBs pay both an inflation-adjusted coupon as well as periodic indexation in the fixed principal

Current Pay Bonds

Mechanics of inflation-linked bonds

Cash flow structure



Hypothetical July 2020 bond, assuming constant 2.00% yoy inflation

Indexed Annuity Bond

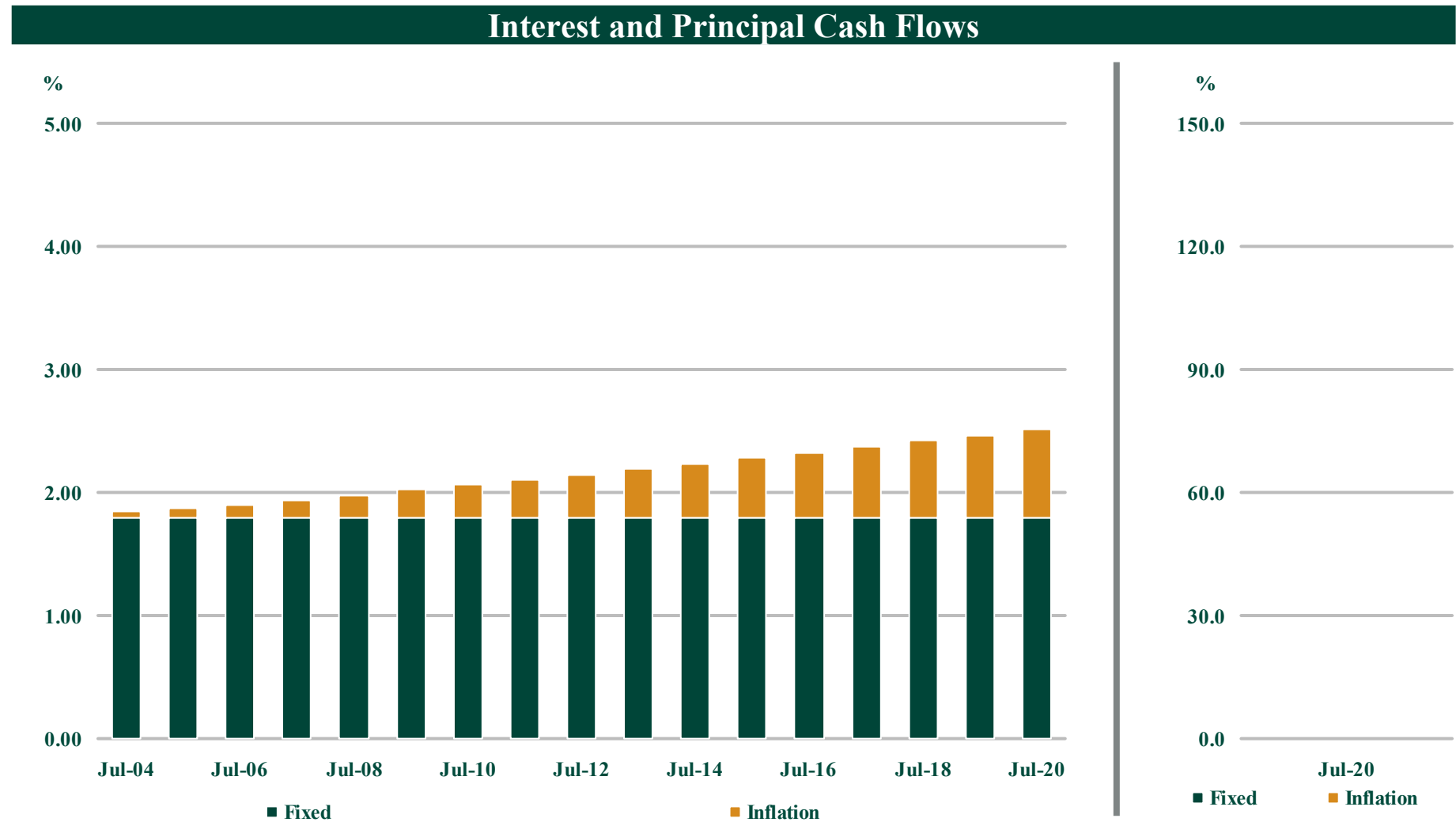
Like CIB, but with no principal

- ◆ Coupon: fixed annuity payment and a variable element to compensate for inflation
- ◆ Principal: none
- ◆ These bonds are similar to CIBs in the interest component of their cash flows, but have no principal repayment

Indexed Annuity Bonds

Mechanics of inflation-linked bonds

Cash flow structure



Hypothetical July 2020 bond, assuming constant 2.00% yoy inflation

Indexed Zero-Coupon Bond

Mechanics of inflation-linked bonds

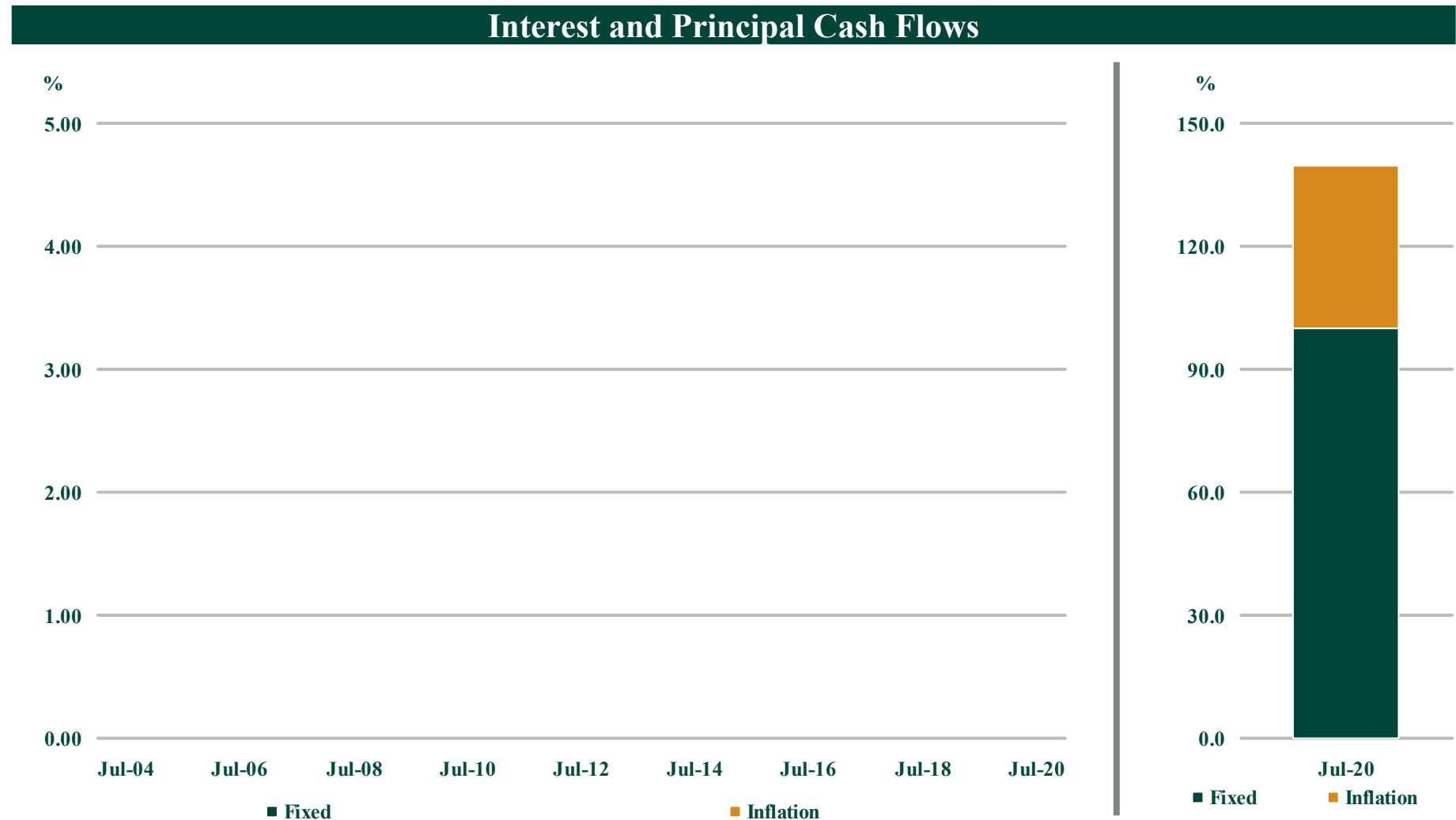
Single final payment, adjusted for inflation

- ◆ Coupon: zero
- ◆ Principal: par times compounded inflation over the period

Indexed Zero Coupon Bonds

Mechanics of inflation-linked bonds

Cash flow structure



Hypothetical July 2020 bond, assuming constant 2.00% yoy inflation

Capital Index Bond Features

The market standard

- ◆ Capital indexed bonds work mostly like nominal bonds:
 - The real coupon works just like any fixed rate security, so one can use the same analytics
 - Price depends only where the yield is relative to 100, just like any normal bond
 - Price is not determined (directly) by inflation, just (real) yield to maturity
- ◆ “Real” yields act just like nominal yield: the main difference is that it is much lower, and the coupon is much lower too
- ◆ A screen like YA works just like for any bond... just some of the figures may have a different interpretation
- ◆ It is as if inflation is “added on” when we come to calculating the gross value, so justifying a lower “real yield”

YA		P114 Corp YA	
Bond Matures on a SATURDAY			
INFLATION-INDEXED YIELD ANALYSIS			
FRANCE 0.A.T./L FRFR1.6 07/25/15 100.4000/100.5300 (1.56/1.54) BGN @15:20			
PRICE	100.53	CUSIP	ED689379
SETTLEMENT DATE	3/18/2005	REAL CPN	1.6
YIELD		REAL CPN ACCRUED INT	1.035000
CALCULATIONS		ECONOMIC FACTORS	
STREET REAL YIELD	1.544	BASE CPI VALUE	7/25/2004 114.93226
EQUIVALENT 2/YR COMPOUND	1.538	REFERENCE CPI	3/18/2005 115.46129
INFLATION ASSUMPTION	1.8351%	CPTFEMU <INDEX>	1/05 115.10000
YIELD W/INFLATION ASSUMPTION	3.366	CPTFEMU <INDEX>	12/04 115.90000
YIELD WITHOUT INFLATION	1.503	CPI @ LAST CPN DATE	114.93226
SENSITIVITY ANALYSIS		FLAT INDEX RATIO	1.00000
FOR VARIOUS REAL vs NOMINAL		ACCURUED RATIO GROWTH	0.00460
YIELD-BETA ASSUMPTIONS (SEE <HELP>)		INDEX RATIO	1.00460
YIELD-BETA ASSUMPTION	0.000 0.500 1.000	PAYMENT INVOICE	
EFFECTIVE DURATION	0.000 4.611 9.222	CURRENCY	EUR Legacy/EUR
RISK	0.000 4.704 9.409	FACE	1000.00 M
CONVEXITY	0.000 0.247 0.988	FLAT	1005300.00
Type <CDVR> for customizable Yield Betas.		INFLATION ACCRUAL	4624.38
Australia 51 2 3277 5500 Brazil 5511 3048 4500 Europe 44 20 7330 7500 Germany 49 69 320410		GROSS AMOUNT	1009924.38
Hong Kong 852 2377 6000 Japan 81 3 3201 8900 Singapore 65 6212 1000 U.S. 1 212 318 2000 Copyright 2005 Bloomberg L.P.		CPN ACCR. 236 DAYS	10397.61
		NET AMOUNT	1020321.99
		Inflation Compensation	4600.00

Yield Analytics

Just like a “normal” bond

- ◆ Actuarial yield is calculated in the same way as with a nominal bond
 - IL bonds are quoted as a percentage of the face value, excluding the inflation accretion
- ◆ So we use standard fixed rate bond yield calculations
 - Replace nominal yield by real yield as follows:

$$P_{\%} = \sum_{i=1}^n \frac{C}{(1+r)^i} + \frac{100}{(1+r)^n}$$

$P_{\%}$ price expressed in percentage

C coupon

r real yield

there is no inflation component that links real yield to clean price

YA		P114 Corp		YA
Bond Matures on a SATURDAY				
INFLATION-INDEXED YIELD ANALYSIS				
FRANCE 0.A.T.I/L FRTR1.6 07/25/15		100.4000/100.5300 (1.56/1.54) BGN @15:20		
PRICE	100.53	CUSIP	ED689379	REAL COUPON 1.6
SETTLEMENT DATE	3/18/2005	REAL CPN	ACCURED INT	1.035000
YIELD CALCULATIONS		ECONOMIC FACTORS		
STREET REAL YIELD 1.544		BASE CPI VALUE 7/25/2004 114.93226		
EQUIVALENT 2/YR COMPOUND 1.538		REFERENCE CPI 3/18/2005 115.46129		
INFLATION ASSUMPTION 1.8351%		CPTFEMU <INDEX> 1/05 115.10000		
YIELD W/INFLATION ASSUMPTION 3.366		CPTFEMU <INDEX> 12/04 115.90000		
YIELD WITHOUT INFLATION 1.503		CPI @ LAST CPN DATE 114.93226		
		FLAT INDEX RATIO 1.00000		
		ACCURED RATIO GROWTH 0.00460		
		INDEX RATIO 1.00460		
SENSITIVITY ANALYSIS		PAYMENT INVOICE		
FOR VARIOUS REAL vs NOMINAL		CURRENCY EUR Legacy/EUR 0.00000		
YIELD-BETA ASSUMPTIONS (SEE <HELP>)		FACE 1000.00 M		
YIELD-BETA ASSUMPTION	0.000 0.500 1.000	FLAT 1005300.00		
EFFECTIVE DURATION	0.000 4.611 9.222	INFLATION ACCRUAL 4624.38		
RISK	0.000 4.704 9.409	GROSS AMOUNT 1009924.38		
CONVEXITY	0.000 0.247 0.988	CPN ACCR. 236 DAYS 10397.61		
Type <COVR> for customizable Yield Betas.		NET AMOUNT 1020321.99		
Australia 61 2 9777 8600 Brazil 5511 3048 4500		Inflation Compensation 4600.00		
Europe 44 20 7330 7500 Germany 49 69 920410		Copyright 2005 Bloomberg L.P.		
Hong Kong 852 2977 6000 Japan 81 3 3201 8900 Singapore 65 6212		1000 U.S. 1 212 318 2000		
		G375-464-1 15-Mar-05 15:20:32		

To access this screen on Bloomberg, call the bond and type YA <Go>

From Clean Price to Dirty Price

Inflation is exogenous

```

BXT                                     P114 Corp  BXT
Enter <1><GO> to send screen via <MESSAGE> System.
3/15/2005 15:21                       TRADE TICKET      AS OF: 3/15/05

TRADER ALBERTO BRONDOLO
A+ LEHMAN BROTHERS, INC.
BUY 100M M OF FRTR 1.6 07/25/15
MIN PIECE= 1 INCREMENT 1 * FRANCE O.A.T.I./I *
PRICE 100.5000000 OR YIELD 1.547000 (to Worst 7/25/15 100 )
OR 100.962300 Inflation Assumption 1.83509 Reference CPI 115.46129
INFLATION COMPENSATION 460,000.00

SETTLEMENT ON 3/18/05 *INDEX RATIO 1.004600 *
Ratings: Moody's: Aaa S&P: AAA FI: AAA Comp: AAA
ISIN FR0010135525

NOTES:

{ED689379 Corp DES<GO>}
VIEW AMOUNTS IN CURRENCY: EUR@ 1.00000(EU/EU)INVERT? Highlights off? Y

TRADE NUMBERS

GROSS AMOUNT € 100,962,300.00
CPN ACCRUAL ( 236 DAYS) 1,039,761.00
NET AMOUNT € 102,002,061.00

Australia 61 2 9777 8600 Brazil 55 1 3048 4500 Europe 44 20 7330 7500 Germany 49 69 920410
Hong Kong 852 2977 6000 Japan 81 3 3201 8900 Singapore 65 6212 1000 U.S. 1 212 318 2000 Copyright 2005 Bloomberg L.P.
6379-464-1 15-MAR-05 15:22:10
    
```

Amount

Clean price
as quoted
on screens

Index ratio

100.50×1.004600

$1.60\% \times \frac{236}{365} \times 1.004600$

To access this screen on Bloomberg, call the bond and type BXT <Go>

Accrued Interest

Like a “normal” bond, but add inflation accretion

- ◆ On a nominal bond accrued interest is:

$$\text{Nominal} \times \text{Coupon}_{\%} \times \frac{\text{Number of days accrued}}{\text{Exact number of days in the coupon period}}$$

- ◆ On an IL bond inflation is added:

$$\text{Accrued interest}_{\%} \times \text{Index ratio}$$

[note the accrued interest is multiplied by the index ratio, and not $\max(\text{index ratio}, 1)$; i.e. there is no deflation floor]

Principal

Like a “normal” bond, but add inflation accretion

- ◆ On a nominal bond the principal is equal to par:

$$\text{Nominal} \times 100\%$$


- ◆ On an IL bond inflation is added:

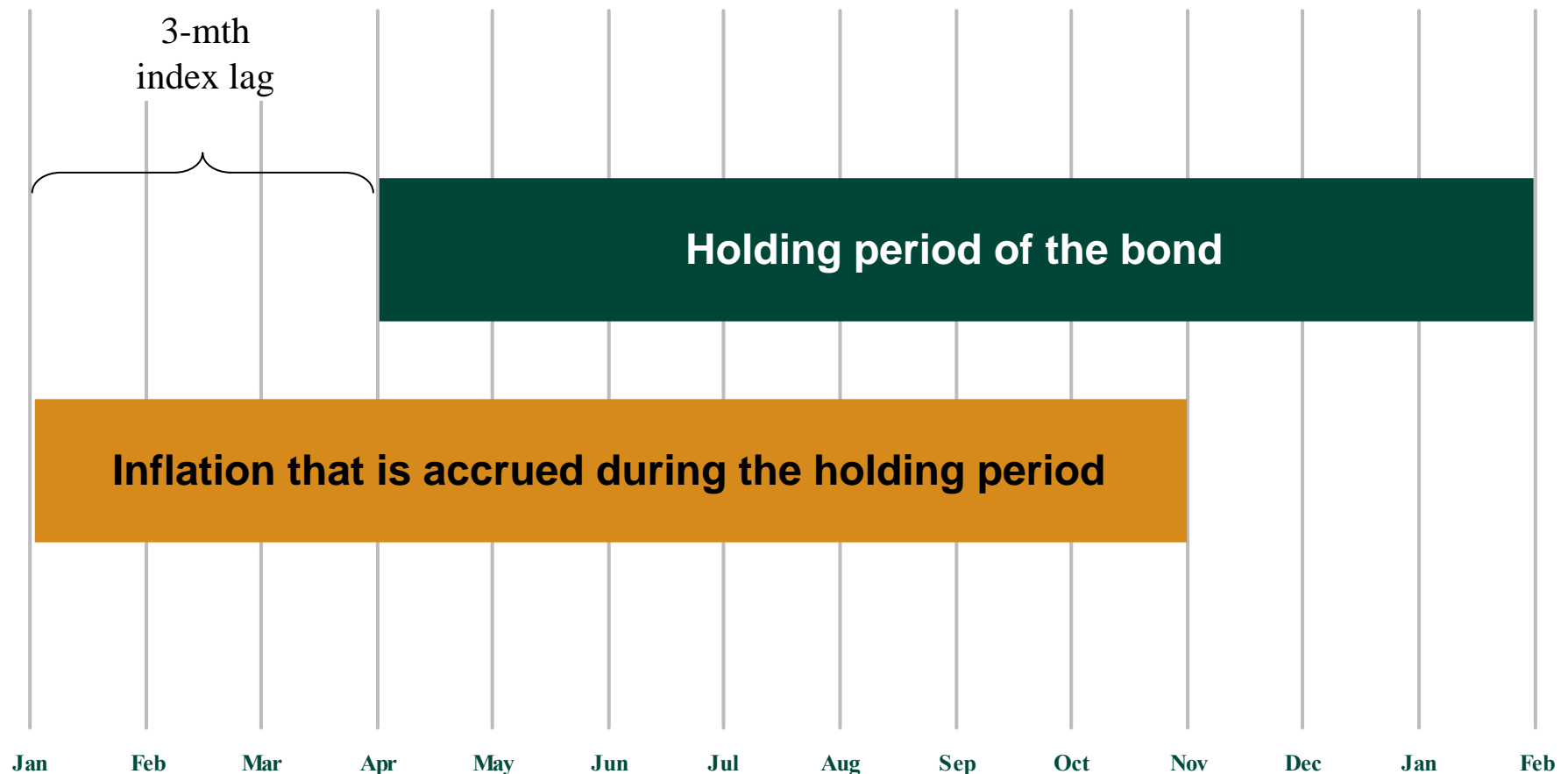
$$\text{Principal} \times \max(\text{Index ratio}, 1)$$

*(note the condition, which
sets the inflation floor)*

The Problem of the Indexation Lag

Cash flow impact of the indexation lag

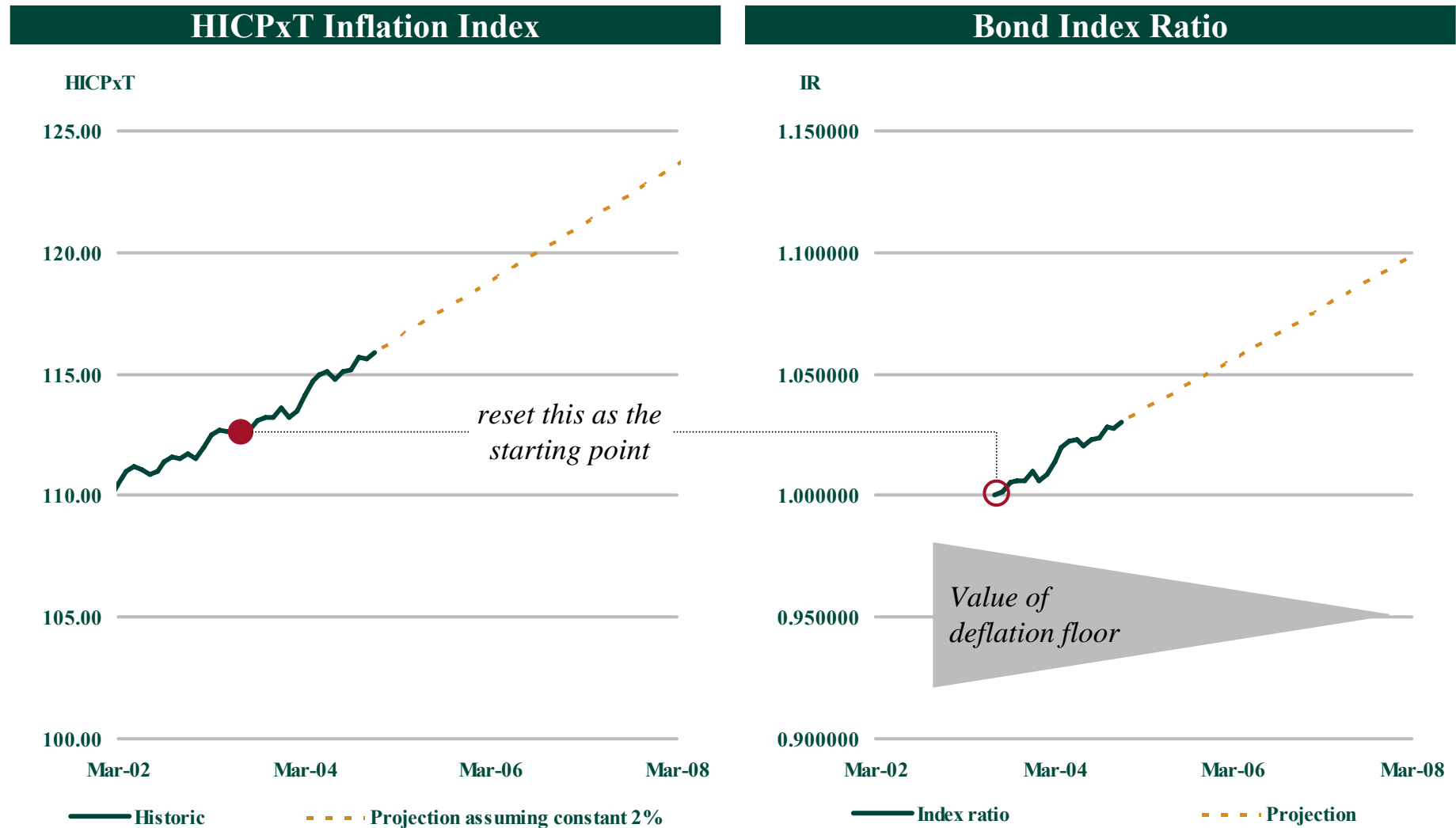
- ◆ Indexation lags exist because it takes time to compile and publish price indices



The Index Ratio Simply Rebases the Inflation Index to One

Mechanics of inflation-linked bonds

Simply reset the inflation index to one at interest accrual date



Assuming forward inflation is constant 2%

Calculating the Index Ratio in Capital Indexed Bonds

Linear interpolation between CPI_{m-3} and CPI_{m-2}

$$\text{Index ratio} = \frac{\text{Daily inflation reference}}{\text{Base index}}$$

- ◆ The daily inflation reference on the date d of month m , is calculated by linear interpolation of two monthly inflation indices

$$\text{Daily inflation reference}_d = CPI_{m-3} + \frac{nb d - 1}{ND_m} \times (CPI_{m-2} - CPI_{m-3})$$

CPI_{m-2} : Price index of month $m - 2$ $nb d$: Actual number of days since start of month

CPI_{m-3} : Price index of month $m - 3$ ND_m : Number of days in month m

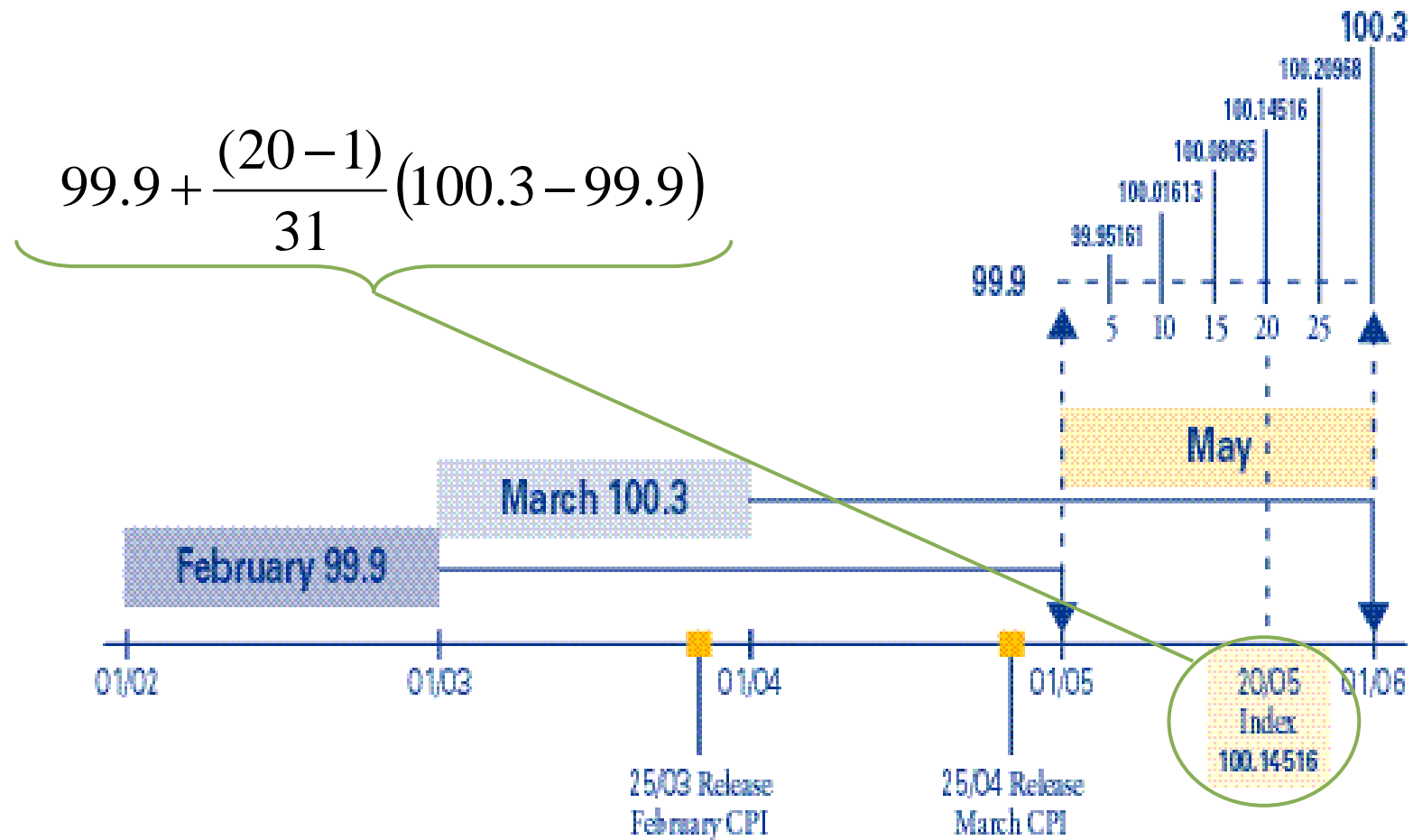
- ◆ Rounding rule: figures rounded to the fifth decimal after truncating the above formula to the sixth decimal value

Calculating the Index Ratio in Capital Indexed Bonds

Mechanics of inflation-linked bonds

A practical example

Linear Interpolation of the Daily Inflation Reference



Source: AFT

Getting Market Data

IL bonds are now actively traded on TradeWeb

TradeWeb v W5.60AS London (ABRONDOL) (LEHMAN BROTHERS)

FileBookmarkCompositeDealersAnalyticsSecListMsgAdminWindowsHelp

LkUp1SecOneSec

EUROILBCN

IFR

Country	Mat	TradeWeb European ILB				Ending Mar 15		
Desc	Cpn	Mty	Price *	Yield	Break Even	Desc	Cpn	Mty
OATi	3.000	07/09	109.11-17	0.858-845	204.50/-206.10	FRTR	4.000	04/0
OATi	1.600	07/11	102.58-65	1.176-164	206.20/-207.50	FRTR	6.500	04/1
OATei	3.000	07/12	112.12-19	1.263-254	212.50/-213.60	FRTR	5.000	04/1
OATi	2.500	07/13	108.36-46	1.431-418	209.60/-211.00	FRTR	4.000	04/1
OATei	1.600	07/15	100.46-54	1.551-543	218.20/-219.30	FRTR	3.500	04/1
OATei	2.250	07/20	106.44-53	1.767-761	218.20/-218.90	FRTR	4.250	04/1
OATi	3.400	07/29	128.89-03	1.906-900	227.10/-227.80	FRTR	5.500	04/2
OATei	3.150	07/32	126.82-99	1.886-879	231.70/-232.40	FRTR	5.750	10/3
BTPei	1.650	09/08	103.33-38	0.684-670	214.50/-216.20	BTPS	3.500	09/0
BTPei	0.950	09/10	99.35-38	1.075-069	214.70/-215.50	BTPS	5.500	11/1
BTPei	2.150	09/14	104.79-87	1.610-601	214.60/-215.60	BTPS	4.250	08/1
BTPei	2.350	09/35	106.30-48	2.081-073	232.70/-233.50	BTPS	5.000	08/3
GGBei	2.900	07/25	114.59-83	2.018-005	220.70/-222.10	GGB	5.900	10/2
UKTi	2.000	07/06	269.49-62	1.522-486	319.50/-323.80	UKT	7.750	09/0
UKTi	2.500	05/09	242.19-31	1.870-857	290.90/-292.40	UKT	4.000	03/0

MainCountryValueGILTILBBills

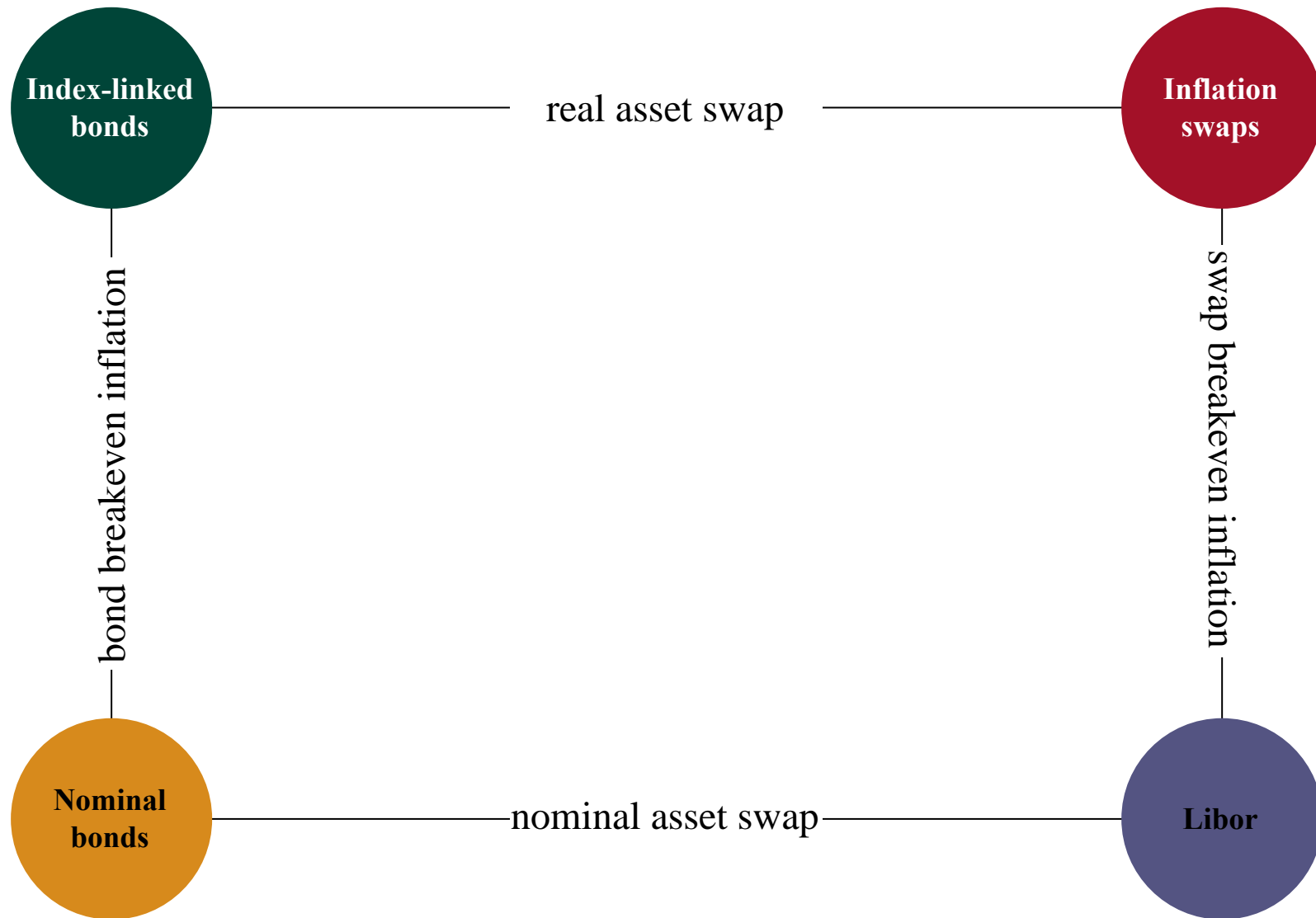
PgUpPg

<>MainTrsyAgcyMBSEugvGiltPfanCPADNSuprECPIRS

Links Between Indexed And Nominal Assets

Mechanics of inflation-linked bonds

Breakevens and asset swaps allow a comparison of IL bonds to nominal bonds



The Fisher Equation

Relates nominal and inflation-linked bonds

The Fisher equation estimates the relationship between nominal and real interest rates:

$$(1+n) = (1+r) (1+f) (1+p)$$

Where: n = yield on nominal bond

f = inflation expectations

p = risk premium

We can approximate the above equation by:

(assuming zero and/or non-measurable risk premium)

$$\begin{aligned} n &= r \times bei \\ bei &= n - r \end{aligned}$$

*breakeven
inflation rate*

The Fisher Equation And Breakeven Inflation

Problems with simplifications

- ◆ The simplification we've done cannot separate inflationary expectations and risk premium
- ◆ In a market where price is the meeting point of supply and demand, the change in supply of IL debt relative to nominal debt can change the breakeven inflation rate, even if the market's inflationary expectations and preference for risk do not change
 - This does not violate the Fisher equation, since breakeven inflation reflects the inflationary expectations and risk preference of the marginal investor, not the market as a whole

Interpreting the breakeven inflation

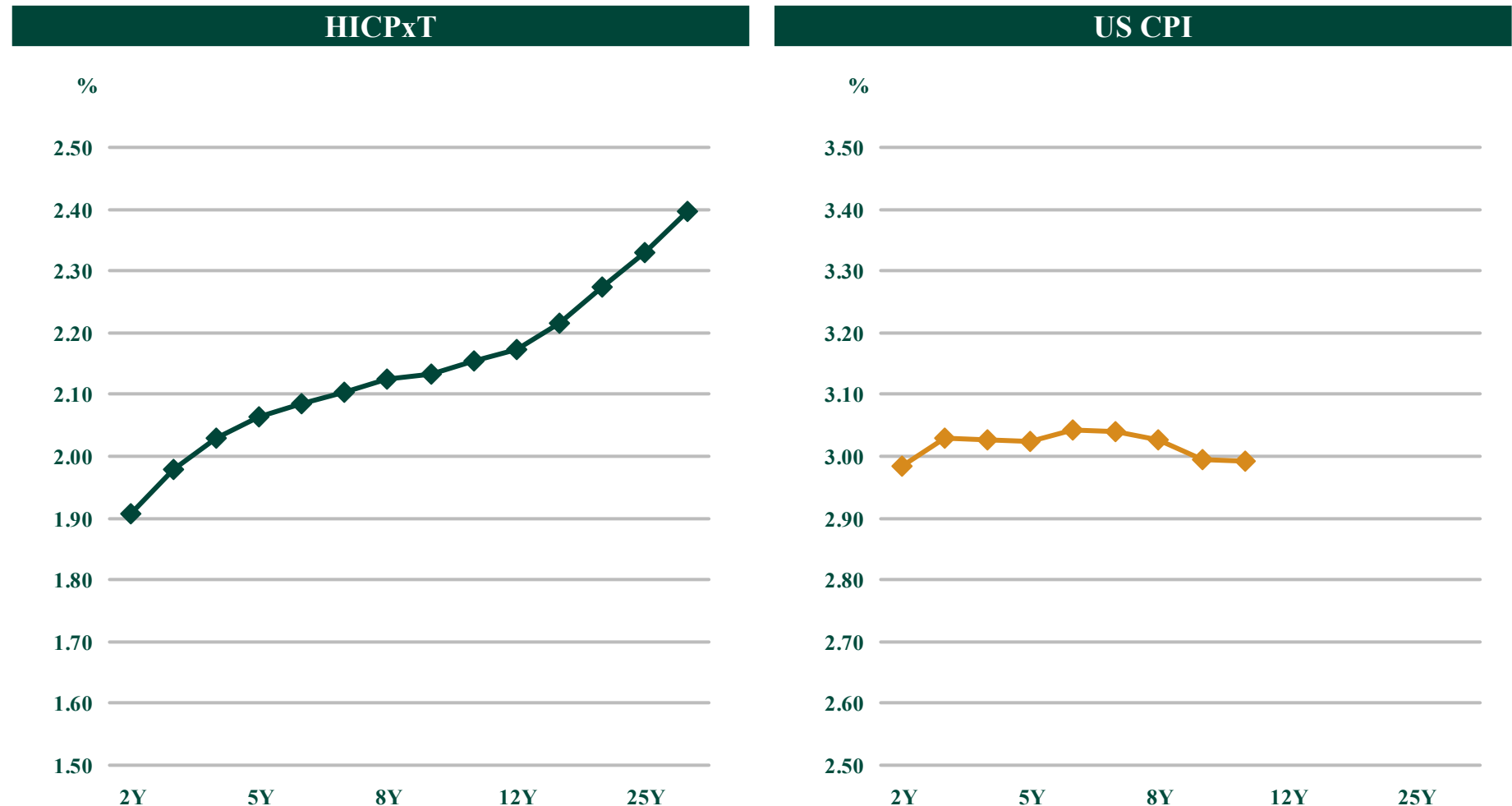
- ◆ As a first approximation, breakeven inflation is the *ex-ante* inflation rate that, if realized, *ex-post* makes an investor indifferent between owning a nominal or index-linked bond

Ex-ante		Ex-post	Investor Preference
Breakeven inflation	=	Actual/realized inflation	Investor is indifferent between an IL bond and a nominal bond
Breakeven inflation	>	Actual/realized inflation	Investors make money by holding nominal bonds as inflation component of payout is less than expected
Breakeven inflation	<	Actual/realized inflation	Investors make money by holding IL bonds as they receive protection from higher than expected inflation

Term Structure of Breakeven Inflation

Mechanics of inflation-linked bonds

Breakeven inflation as priced by inflation swaps



As of 15 March 2005. Source: Lehman Brothers

Calculating Forward Breakeven Inflation

Foreword

- ◆ In the next few slides we will run through the mechanics of calculating forward breakevens
- ◆ As we will see later, seasonality in inflation is an important factor which influences forward breakevens and (both real yield and breakeven) carry
- ◆ Forward breakevens and seasonality have important market implications, which we will look at in Section III

Components to calculating forward breakevens

Current Pricing		Horizon	
Index ratio _t :	1.02535	Index ratio _T :	1.02310
PX _n	103.64 / 120.64	Repo:	2.06%
NY	3.820%	Spot settle:	18-Mar-05
		Term:	18-Apr-05
PX _r	104.14 / 106.78		
RY	1.683%		

If CPI_{T-3} and CPI_{T-2} (i.e. CPIs required at horizon) are not available, then inflation assumptions must be made. This makes forward breakevens a *subjective* calculation

Calculating Forward Breakeven Inflation

Four easy steps

1. Calculate spot breakeven inflation rate:

$$3.820 - 1.683 = 214\text{bp}$$

2. Calculate forward dirty price:

$$\text{Forward dirty price} = \text{Spot dirty price} + \text{Cost of carry}$$

$$106.97 = 106.78 + \left(106.78 \times \frac{2.06}{100} \times \frac{31}{360} \right)$$

3. Calculate forward yields:

(if a forward index ratio is not available, an inflation assumption must be made)

$$106.97 \div 1.02310 = 104.55 \quad (\text{remove inflation accrual})$$

$$104.55 - 0.18 = 104.37 \quad (\text{clean price from "uninflated dirty price"})$$

$$104.37 = 1.653\% \quad (\text{real yield from clean price})$$

4. Calculate the difference between forward nominal yields (which we do not compute here; use FPA function on Bloomberg) and forward real yields:

$$3.840 - 1.653 = 219\text{bp}$$

Calculating Forward Breakeven Inflation

Mechanics of inflation-linked bonds

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-European Derivatives
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-Asian Derivatives
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Mortgages / ABS / CMBS
Municipals
Global Foreign Exchange

Services
Strategic Client Services
Futures Clearing
Client Operations
eTrading

Inflation Products (Keyword: Inflation)

Overview Trade Tracker Live Swaps Swap Calculator EUR USD GBP Bond Calculator

Inflation Bond Calculator: BTPei 2.15% 15-Sep-14 BTPei 2.15% 15-Sep-14

Pricing

Trade Date	15-Mar-2005	Settle Date	18-Mar-2005
Closing Price	104.140	Index Ratio	1.02535

Trade Analysis Cashflows

	Quantity	Price	Accrued	Dirty Price	Inv Amt
Buy BTPei 2.15% 15-Sep-14	100MM	104.14	0.02	106.798	106,797,920
Sell ITIBTP 4.25% 01-Aug-14	115,814,523	103.637	0.53	104.165	120,638,...
Hedge ratio	1.1581			Net	13,840,...

Yield & Sensitives

	Mod Dur	Convexity	PV01	Yield	B/E Inf.
BTPei 2.15% 15-Sep-14	8.513	0.852	8.867	1.683	2.137
ITIBTP 4.25% 01-Aug-14	7.536	0.709	7.850	3.821	

Forward Calculations & Carry Inflation Forecasts

Term	Date	Real Yield	Breakeven	Yield Carry	B/E Carry	Repo (Inf)	Repo (Nom)
1M	18-Apr-2005	1.665	2.175	-1.8	-3.8	2.060	2.060
3M	20-Jun-2005	1.778	2.102	9.5	3.5	2.070	2.070
6M	19-Sep-2005	1.817	2.121	13.3	1.7	2.110	2.110

Option-adjusted analytics

Done.

forward breakeven *breakeven carry* *spot breakeven*

Calculating Forward Breakeven Inflation

Mechanics of inflation-linked bonds

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-US Agencies
-US Derivatives
-Repo
-Futures
-Inflation Products
-European Governments
-European Derivatives
-Asian Governments
-Asian Derivatives
Credit
Mortgages / ABS / CMBS
Municipals
Global Foreign Exchange

Services
Strategic Client Services
Futures Clearing
Client Operations

Inflation Products (Keyword: Inflation)

Overview Trade Tracker Live Swaps Swap Calculator EUR USD GBP Bond Calculator

Inflation Bond Calculator: BTPei 2.15% 15-Sep-14

BTPei 2.15% 15-Sep-14

Pricing

Trade Date 15-Mar-05
Closing Price 104.1

Trade Analysis

Buy BTPei 2.15% 15-Sep-14 100MM
Sell ItIBTP 4.25% 01-Aug-14 115.0
Hedge ratio

Yield & Sensitivities

BTPei 2.15% 15-Sep-14
ItIBTP 4.25% 01-Aug-14

Forward Calculations & Carry

Term	Date	Real Yield	YoY	Lehman	User
1M	18-Apr-2005	1.60	1.76 %	115.5	
3M	20-Jun-2005	1.70	1.84 %	116.2	
6M	19-Sep-2005	1.817	1.72 %	116.7	
			1.60 %	116.8	
			1.66 %	117.0	
			1.86 %	116.9	
			1.63 %	117.0	
			1.85 %	117.3	

Option-adjusted analytics

Done.

Cashflows

Party Price	Inv Amt
106.798	106,797,920
104.168	120,637,693
Net	13,839,773

Inflation Forecasts

Yield	B/E Inf.
1.683	2.137
3.820	

Repo (Inf)

Repo (Inf)	Repo (Nom)
2.060	2.060
2.070	2.070
2.110	2.110

Calculating Forward Breakeven Inflation

Mechanics of inflation-linked bonds

Warning:

Forward yields can be calculated using FPA <Go> on Bloomberg. This function will correctly calculate forward nominal yields. But for inflation-linked securities, when the term index is not available, Bloomberg will extrapolate a horizon index ratio by extrapolating the last 12 months of inflation. **This therefore does not correctly account for seasonality**

```

<HELP> for explanation.                                P114 Corp  FPA
Enter <1><GO> to send screen via <MESSAGE> System.
FORWARD PRICING ANALYSIS                                Page 1 of 2
CUSIP: ED3279921
BTPS I/L          BTPS 2.15 09/14  106.0900/106.1900  (1.46/1.45) BGN  @11:22
* TERMINATION DATE SHIFTED TO MATCH TERM IN DAYS *
ENTER ALL OF THE FOLLOWING FIELDS          Projected CPI used
                                           BUMP ALL DATES FOR WEEKENDS/HOLIDAYS (Y/N) ☒ Y
SETTLEMENT DATE          4/15/05          COMPOUNDING METHOD : 2
PRICE                    106.190000( 1.450 )(1=CD ,2=PROCEEDS ,3=SCIENTIFIC )
FULL PRICE                108.9027420
REPO RATE (ACT/360) 2.14          REINVEST COUPONS (Y/N) ☒ Y
FACE AMOUNT              M 1000
TERMINATION DATE         6/20/05 <OR> TERM (IN CAL. DAYS ) 66

B/E REPO RATE = 2.14000
ENTER ONE OF THE FOLLOWING FIELDS
SPREAD EARNED (BP)
NET PROFIT/LOSS
FORWARD PRICE          105.350637  105-11 1/4
FULL FWD PRICE         109.3300040
DROP                   0.839363  (0-26 7/8 )
YIELD
YYIELD                 1.532  YIELD DROP -8.2739 bps

INVOICE PAYMENT
SETTLEMENT = 1,089,027.42
TERMINATION = 1,093,300.04
NET CHANGE = 4,272.62
INFLATION ASSUMPTION 1.71755
TERM REFERENCE CPI 116.23449
TERM INDEX RATIO 1.03222
YIELD DROP -8.2739 bps

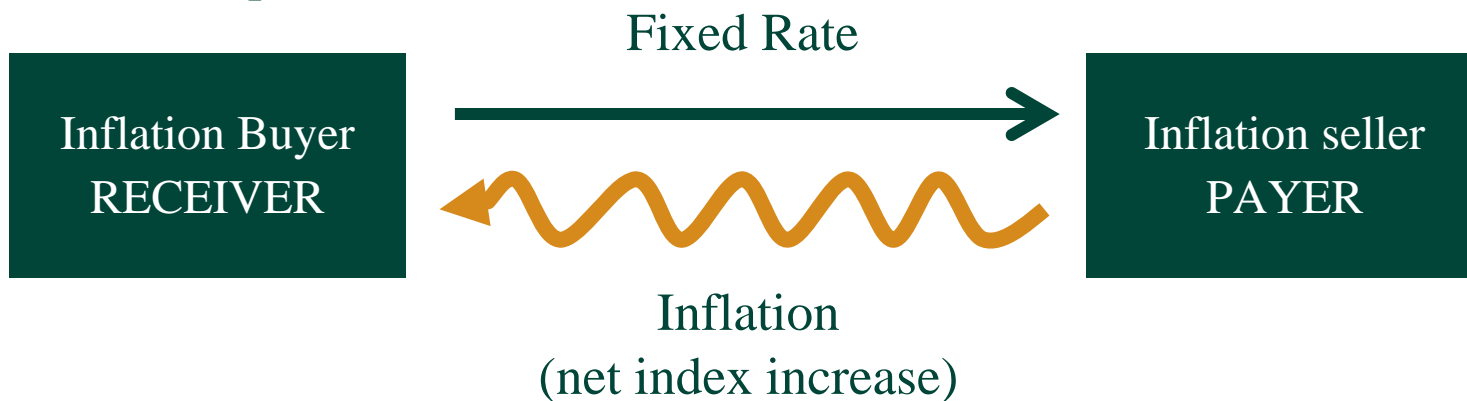
NOTES :
Australia 61 2 9777 8600 Brazil 5511 3048 4500 Europe 44 20 7330 7500 Germany 49 69 920410
Hong Kong 852 2977 6000 Japan 81 3 3201 8900 Singapore 65 6212 1000 U.S. 1 212 318 2000 Copyright 2005 Bloomberg L.P.
G379-464-0 12-Apr-05 11:24:19
  
```

Derivatives: What Is An Inflation Swap?

- ◆ An inflation swap is an exchange of cash flows where:
 - One party pays a predetermined fixed rate or floating interest rate (receiver / buyer)
 - Second party pays a variable rate determined by an inflation index (payer / seller)

Fixed inflation swap

most common



Derivatives: 5-year HICPxT Zero Coupon Swap

Mechanics of inflation-linked bonds

Example termsheet: 3-month lag

Notional:	€100,000,000
Index:	HICPxT (unrevised)
Source:	First publication by Eurostat as shown on Bloomberg CPTFEMU
Trade date:	10-May-04
Start date:	12-May-04
End date:	12-May-09
First fixing:	113.50

Fixed leg: $(1 + 2.25\%)^5 - 1$

Inflation leg:

$$\frac{HICPxT_{Feb09}}{HICPxT_{Feb04}} - 1$$

unknown value today

known value today
note the 3-month lag

Derivatives: 5-year US CPI Zero Coupon Swap

Mechanics of inflation-linked bonds

Example termsheet: interpolated index, like with bonds

Notional:	\$100,000,000
Index:	US CPI-NSA
Source:	First publication by BLS as shown on Bloomberg CPURNSA
Trade date:	10-May-04
Start date:	12-May-04
End date:	12-May-09
First fixing:	186.62581

Fixed leg: $(1 + 2.83\%)^5 - 1$

Inflation leg: $\frac{\text{US CPI NSA}_{12 \text{ May } 09}}{\text{US CPI NSA}_{12 \text{ May } 04}} - 1$

unknown value today

*known value today
note the interpolated index*

Derivatives: Market Quotes for Inflation Swaps

Mechanics of inflation-linked bonds

On LehmanLive we quote live inflation swaps for liquid markets

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Inflation Products (Keyword: Inflation)

Overview Trade Tracker **Live Swaps** Swap Calculator EUR USD GBP Bond Calculator

Subject to market conditions, spot ZC swap prices below are tradable in €100MM up to 10 years, € 50MM beyond 10 years during London trading hours. Please call Lehman Interbank Desk on +44 20 7103 3017.

Fixing Term	HICPXT Dec		FRCPI Dec-Jan		USCPI Dec-Jan		UKRPI Jan	
	Bid	Offer	Bid	Offer	Bid	Offer	Bid	Offer
Spot								
2Y	1.870	1.930	1.957	2.038	3.091	3.271		
3Y	1.940	1.980	2.005	2.085	3.103	3.243		
4Y	1.993	2.022	2.063	2.103	3.070	3.170		
5Y	2.028	2.057	2.087	2.118	3.038	3.138	2.715	2.785
6Y	2.050	2.090	2.097	2.138	3.053	3.153		
7Y	2.067	2.107	2.110	2.150	3.049	3.149		
8Y	2.090	2.120	2.122	2.162	3.034	3.134		
9Y	2.097	2.138	2.130	2.170	3.013	3.113		
10Y	2.120	2.140	2.145	2.175	2.990	3.090	2.830	2.890
12Y	2.142	2.183	2.152	2.213			2.882	2.952
15Y	2.190	2.230	2.190	2.250			2.950	3.020
20Y	2.248	2.307	2.240	2.320			3.000	3.070
25Y	2.300	2.380	2.300	2.380			3.025	3.085
30Y	2.370	2.430	2.368	2.427			3.030	3.090

interpolated
3-mth lag

Live Inflation Swap Curves

Derivatives: ICAP As An Alternative for Quotes

Mechanics of inflation-linked bonds

ICAPINFLATION on REUTERS

08:02 24MAY04 ICAP Plc UK69580 ICAPINFLATION

Please call +44 (0)20 7532 3050 for further details

HICPXT		HICP		FRCPI		UKRPI		USCPI	
	BID ASK		BID ASK		BID ASK		BID ASK		BID ASK
1y	1.82-1.96	1y	1.96-2.10	1y	1.78-1.92	1y	3.09-3.33	1y	2.21-2.45
2y	2.03-2.17	2y	2.15-2.29	2y	1.92-2.06	2y	2.87-3.11	2y	2.49-2.73
3y	2.13-2.27	3y	2.24-2.38	3y	2.04-2.18	3y	2.83-3.07	3y	2.61-2.85
4y	2.21-2.35	4y	2.32-2.46	4y	2.12-2.26	4y	2.81-3.05	4y	2.70-2.94
5y	2.25-2.39	5y	2.37-2.51	5y	2.19-2.33	5y	2.80-3.04	5y	2.78-3.02
6y	2.29-2.43	6y	2.42-2.56	6y	2.23-2.37	6y	2.80-3.04	6y	2.86-3.10
7y	2.31-2.45	7y	2.44-2.58	7y	2.26-2.40	7y	2.80-3.04	7y	2.94-3.18
8y	2.33-2.47	8y	2.45-2.59	8y	2.29-2.43	8y	2.80-3.04	8y	3.01-3.25
9y	2.36-2.50	9y	2.47-2.61	9y	2.31-2.45	9y	2.82-3.06	9y	3.06-3.30
10y	2.38-2.52	10y	2.50-2.64	10y	2.34-2.48	10y	2.83-3.07	10y	3.09-3.33
12y	2.38-2.62	12y	2.48-2.72	12y	2.34-2.58	12y	2.86-3.10	12y	3.14-3.38
15y	2.45-2.69	15y	2.53-2.77	15y	2.41-2.65	15y	2.87-3.11	15y	3.20-3.44
20y	2.53-2.77	20y	2.61-2.85	20y	2.50-2.74	20y	2.91-3.15	20y	3.33-3.57
25y	2.58-2.82	25y	2.66-2.90	25y	2.56-2.80	25y	2.93-3.17	25y	3.40-3.64
30y	2.61-2.85	30y	2.69-2.93	30y	2.59-2.83	30y	2.95-3.19	30y	3.41-3.65

FEB	FEB	INT	MAR	INT
-----	-----	-----	-----	-----

3-month lag interpolated 2-month lag interpolated

Derivatives: Constructing A Forward Inflation Curve

Mechanics of inflation-linked bonds

Step one....

- ◆ We know that the index for February 2004 equals 113.50. With the breakeven curve from LehmanLive or ICAP, we can then construct the forward inflation index levels using the formula below:

$$\text{projected index level} = \text{current index level} \times (1 + \text{breakeven})^{\text{maturity}}$$

- ◆ Given the limited market information we need to make restrictive assumptions to construct a forward inflation curve: we assume a piece-wise constant forward inflation rates

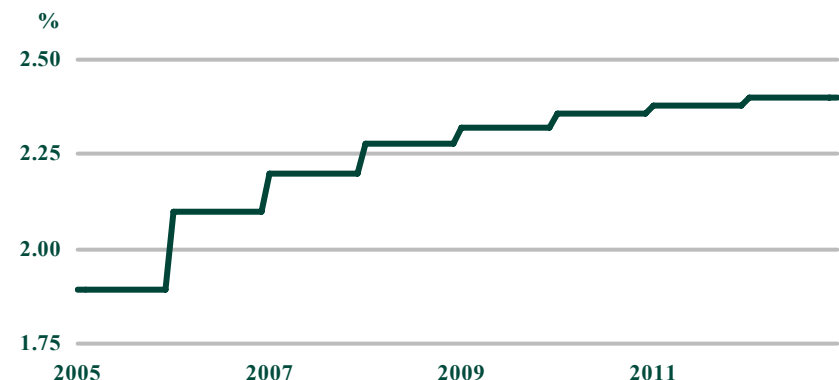
113.50 Feb 04 index

$113.50 \times (1.0189)^1 = 115.65$ Feb 05 index

$113.50 \times (1.0210)^2 = 118.32$ Feb 06 index

$113.50 \times (1.0220)^3 = 121.16$ Feb 07 index...

Assume Piece-Wise Constant Forward Inflation



Derivatives: Constructing A Forward Inflation Curve

Mechanics of inflation-linked bonds

... adding seasonality

- ◆ The simplest approach is to use continuous compounding zero coupon rates. This allows to simply add/subtract seasonal components:

$$\text{forward} = \log\left(\frac{\text{projected index}}{\text{current index}}\right) / \text{time}$$

Seasonal Adjustments

	MOM	YOY		MOM	YOY
Jan	-0.20%	-2.35%	Jul	-0.13%	-1.51%
Feb	0.19%	2.23%	Aug	-0.10%	-1.19%
Mar	0.19%	2.34%	Sep	0.04%	0.43%
Apr	0.11%	1.31%	Oct	-0.09%	-1.08%
May	0.04%	0.48%	Nov	-0.11%	-1.28%
Jun	-0.07%	-0.79%	Dec	0.12%	1.42%

Adding Seasonal Adjustments

Feb-04	113.50	113.50
Mar-04		113.90
Apr-04		114.20
May-04		114.43
Jun-04		114.53
...		...
Jan-05		115.25
Feb-05	115.65	115.65

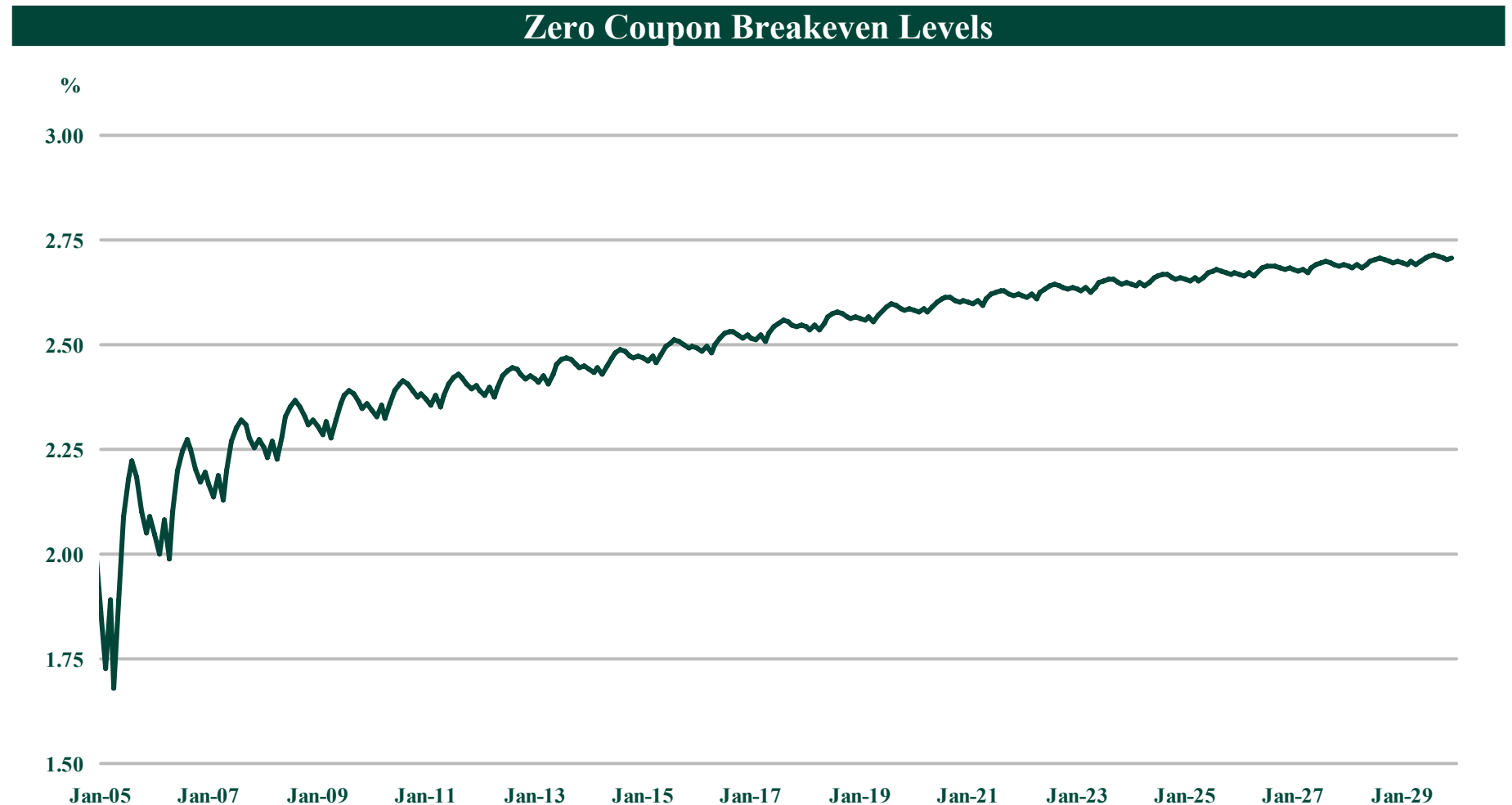
$$114.20e^{\left(\frac{1.88\% + 0.48\%}{12}\right)} = 114.43$$

$\log\left(\frac{115.65}{113.50}\right) = 1.88\%$

Derivatives: Constructing A Forward Inflation Curve

Mechanics of inflation-linked bonds

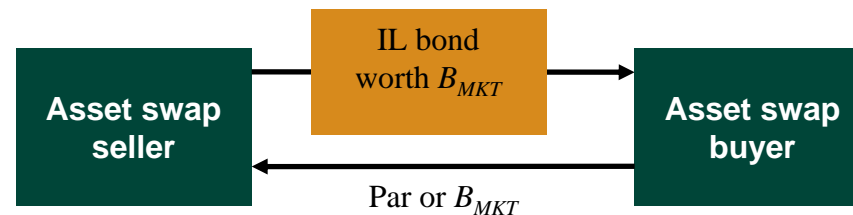
Example of forward inflation curve



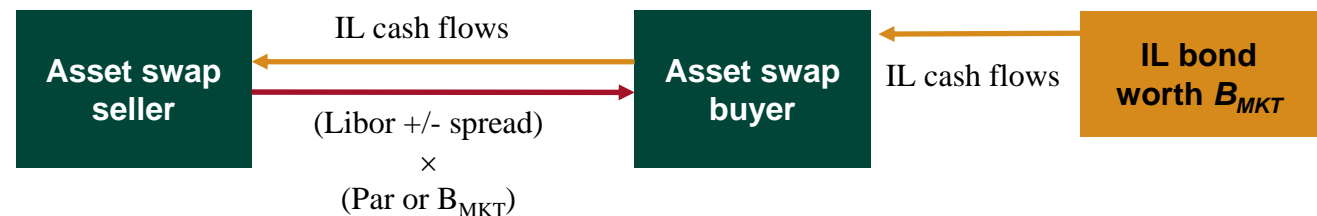
Derivatives: Asset Swapping Inflation-linked Bonds

Mechanics of the trade

At inception the asset swap buyer purchases an index-linked bond worth B_{MKT} in return for par or a cash payment of B_{MKT} (market asset swap)



During the life of the trade the investor pays the bond's index-linked cash flows in return for Libor plus/minus the asset swap spread times par or B_{MKT} (market asset swap)



At maturity there is an exchange of principal



Derivatives: How Is Risk Distributed in Asset Swaps?

Different options available

- ◆ Risk with respect to the issuer:
 - buyer of bond holds credit risk with respect to the issuer (e.g. investor holds French or Italian credit risk)
- ◆ **Counterparty risk:** Notional on the inflation leg grows over time leading to big counterparty exposure at maturity
 - e.g. for a ten-year bond with average inflation of 2%, the principal in ten years is worth 122% versus 100% on the floating leg of a par asset swap
- ◆ **Solutions:**
 - **Collateralisation:** CSA
 - **Accreting:** let *floating leg* notional grow over time at a predetermined rate (e.g. 2%), so that final notional is roughly equal to the inflation notional at maturity
 - **Early redemption asset swap:** the accrual in the inflation accreting principal is paid at each coupon date

Derivatives: Computing Asset Swap Spreads

Pricing for par and market asset swaps

Par asset swap spread:

$$\underbrace{1 - B_{MKT}}_{\text{Upfront payment to purchase asset in return for Par}} + \underbrace{B_{Libor} - (1 + sPV01)}_{\substack{\text{Floating payments} \\ \text{Portfolio inflation swaps}}} = 0$$

solve for s

$$\text{par asset swap spread} = \frac{B_{Libor} - B_{MKT}}{PV01}$$

Market asset swap spread:

$$\underbrace{B_{MKT} - B_{MKT}}_{\text{Upfront payment to purchase asset in return for Par}} + \underbrace{B_{Libor} - B_{MKT}(1 + sPV01)}_{\substack{\text{Floating payments} \\ \text{Portfolio inflation swaps}}} = 0$$

solve for s

$$\text{market asset swap spread} = \frac{B_{Libor} - B_{MKT}}{B_{MKT} \times PV01}$$

Derivatives: Computing Asset Swap Spreads

Mechanics of inflation-linked bonds

A worked out example

Forward Inflation & Libor

EUR XTOB	EFM
15-Jan-01	107.10
15-Feb-01	
15-Mar-01	
15-Apr-01	DEPOSITS
15-May-01	1D 2.094
15-Jun-01	1W 2.094
15-Jul-01	1M 2.104
15-Aug-01	2M 2.123
15-Sep-01	3M 2.143
15-Oct-01	
15-Nov-01	FUTURES
15-Dec-01	JUN2005 9775
15-Jan-02	SEP2005 9760
15-Feb-02	DEC2005 9742
15-Mar-02	MAR2006 9725
15-Apr-02	JUN2006 9709
15-May-02	SEP2006 9697
15-Jun-02	DEC2006 9686
15-Jul-02	MAR2007 9680
15-Aug-02	
15-Sep-02	SWAPS
15-Oct-02	3Y 2.943
15-Nov-02	4Y 3.112
15-Dec-02	5Y 3.261
15-Jan-03	6Y 3.397
15-Feb-03	7Y 3.521
15-Mar-03	8Y 3.630
15-Apr-03	
15-May-03	
15-Jun-03	
15-Jul-03	
15-Aug-03	
15-Sep-03	
15-Oct-03	
15-Nov-03	
15-Dec-03	
15-Jan-04	
15-Feb-04	
15-Mar-17	151.17
15-Apr-17	151.81
15-May-17	152.05
15-Jun-17	152.30

Discount Curve	
24-Mar-05	1.00
30-Mar-05	1.00
6-Apr-05	1.00
29-Apr-05	1.00
30-May-05	1.00
15-Jun-05	1.00
21-Sep-05	0.99
21-Dec-05	0.98
21-Mar-06	0.98
21-Jun-06	0.97
21-Sep-06	0.96
20-Dec-06	0.96
21-Mar-07	0.95
21-Jun-07	0.94
31-Mar-08	0.92
30-Mar-09	0.88

Cash Flow & Discount Factor Layout

A	B C	C P	D IR	(B+C)*D Inf CF	E DF	F D CF
25-Jul-05	1.60	0.00	1.016160	1.63	0.99	1.61
25-Jul-06	1.60	0.00	1.037670	1.66	0.97	1.61
25-Jul-07	1.60	0.00	1.059140	1.69	0.94	1.59
25-Jul-08	1.60	0.00	1.081550	1.73	0.91	1.57
25-Jul-09	1.60	0.00	1.104960	1.77	0.87	1.55
25-Jul-10	1.60	0.00	1.129250	1.81	0.84	1.52
25-Jul-11	1.60	0.00	1.154350	1.85	0.81	1.49
25-Jul-12	1.60	0.00	1.180210	1.89	0.77	1.46
25-Jul-13	1.60	0.00	1.206750	1.93	0.74	1.43
25-Jul-14	1.60	0.00	1.233970	1.97	0.70	1.40
25-Jul-15	1.60	100.00	1.262220	128.24	0.67	86.76
Present value of cashflows						102.0
Bloomberg dirty price						102.0

$$P = c \sum_{i=1}^n d(t_i) e^{-\alpha t_i} + d(t_n) e^{-\alpha t_n}$$

$\alpha = -5bp$

(For reference, the Apr-15 OAT trades at L -7bp)

Risk: Duration And Present Value of A Basis Point

Lower actuarial yields (generally) imply higher duration

- ◆ Modified duration and PV01 on an IL bond is computed like a nominal bond
- ◆ The two durations are calculated using:
 - Nominal rates for fixed-rate bonds
 - Real rates for IL bonds
- ◆ Lower coupons mean higher price sensitivity for IL bonds than for similar maturity nominal bonds. This is because real yields are approximately 200bp lower than nominal yields. Because of the lower rate of discounting, the longer term cash flows of inflation-indexed securities contribute a greater share of present value, thus making durations and convexities larger

PV01 of IL Bonds & Nominal Bonds Compared

	PV01		PV01	Δ
3.00% Jul-09 OATi	5.315	4.00% Apr-09 OAT	3.921	1.394
1.60% Jul-15 OATei	9.449	3.50% Apr-15 OAT	8.194	1.255
2.25% Jul-20 OATei	14.322	4.25% Apr-19 OAT	10.875	3.447
3.15% Jul-32 OATei	26.185	5.75% Oct-32 OAT	18.975	7.210

Risk: Duration And The Concept of Beta

Limits in duration as a risk measure

- ◆ Duration is not a very useful measure to compare nominal bonds to inflation-linked bonds. Duration in a nominal bond is with respect to nominal yields. Duration in an IL bond is with respect to real yields
- ◆ From the variance of the simplified Fisher equation we can make interesting observations:

$$n = r + bei$$
$$\text{Variance}(n) = \text{Variance}(r) + \text{Variance}(bei) + 2\text{Cov}(r, bei)$$

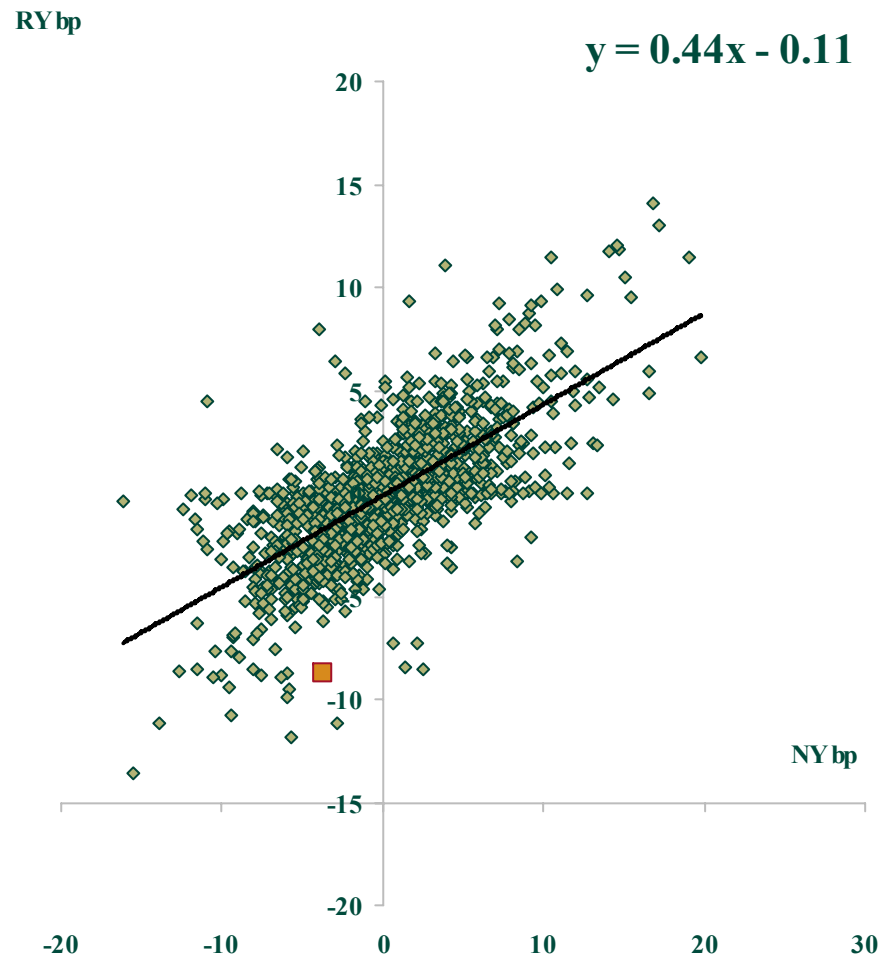
- Unless the covariance between real yields and breakeven inflation is sharply negative, real yields will be less volatile than nominal yields - i.e. the beta of real yields to nominal yields will be less than one
- If the beta were stable, then it would be straightforward to calculate a nominal duration for an inflation-linked bond - i.e. there would be no diversification benefit in IL bonds
- From a theoretical standpoint, the only way to calculate durations for a mixed portfolio of nominal and IL bonds is to calculate:
 - duration with respect to real yields
 - duration with respect to inflation expectations

Risk: Duration And The Concept of Beta

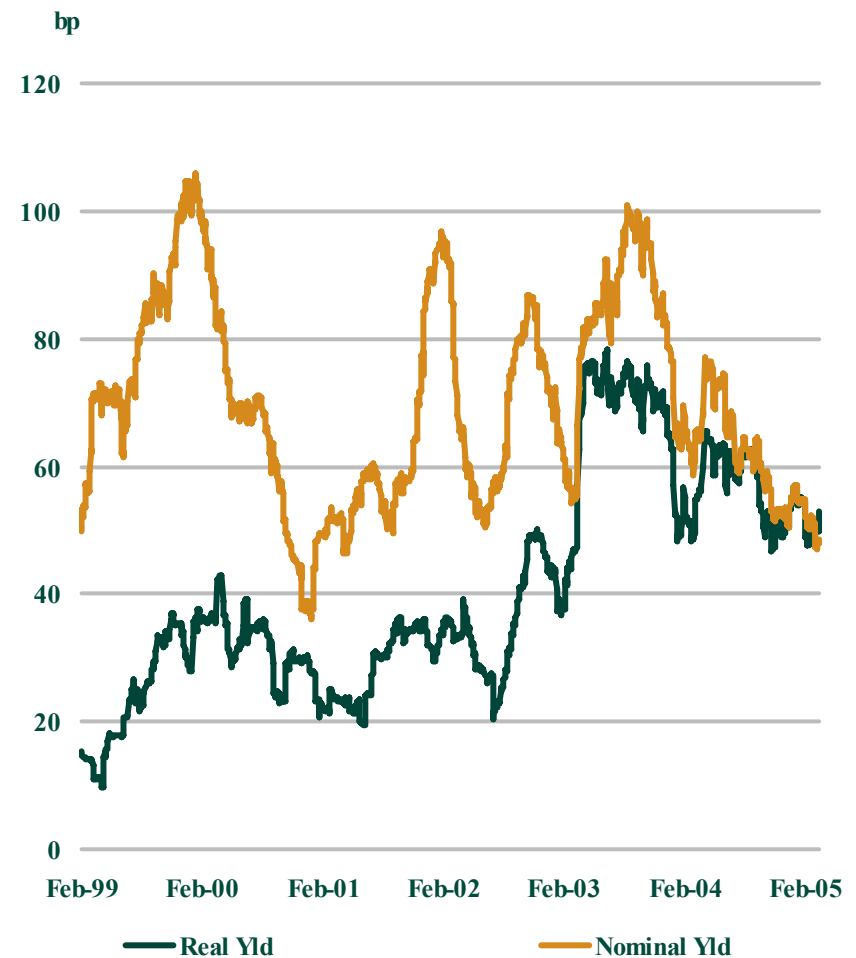
Mechanics of inflation-linked bonds

A stable beta would solve the problem. But betas are unstable

Daily Δ in Real Yld vs Daily Δ Nominal Yld



Annualized Volatility in Yld Changes



Using full history of Apr-09 OAT and Jul-09 OATi

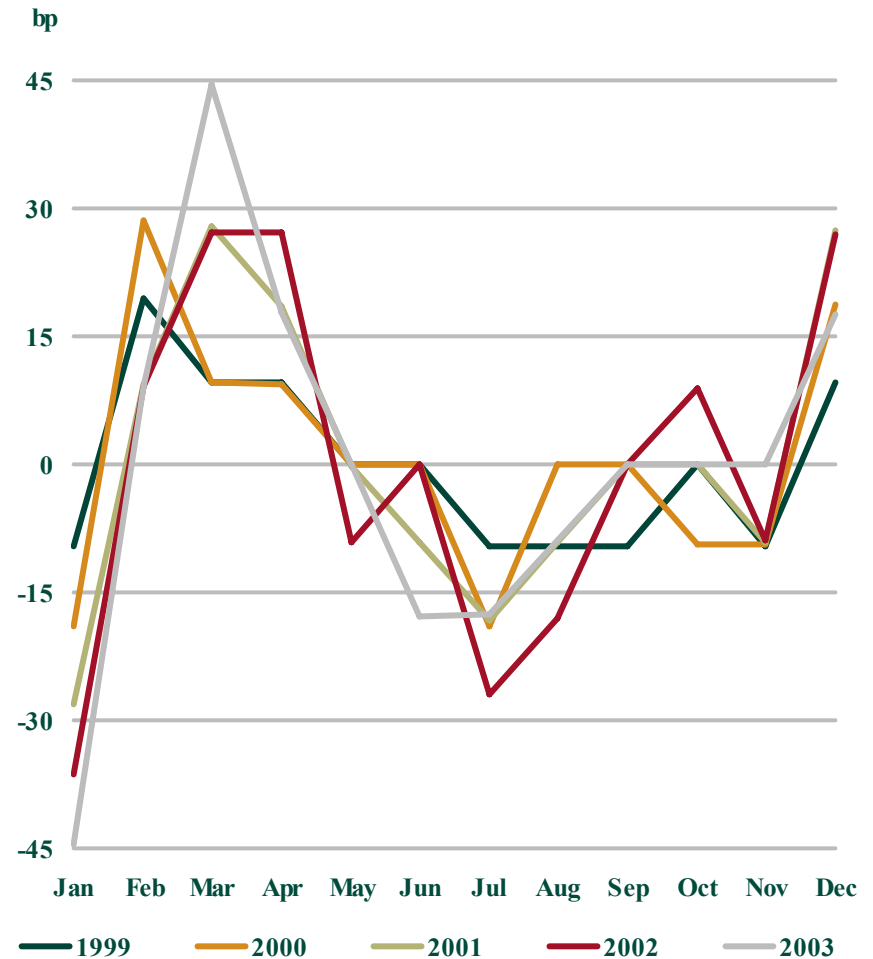
Seasonality in Inflation

Patterns are persistent

Driving Factors in Seasonals

- ◆ Reasons:
 - food prices varying during the year
 - sales prices affecting clothes or consumer durables
 - tax changes in the same month of each year (even if strictly speaking not a seasonal factor)
 - price increases at fixed intervals of the year (packaged holidays in Easter and Christmas, etc.)
- ◆ National series more volatile than euro aggregate due to different, often contrasting, behaviour of national patterns:
- ◆ Seasonality can differ significantly from one country to another. This is because different weights are given to different items in the various national indices. Also, there is a lack of harmonization in the treatment of seasonal items

HICP: NSA - SA Index

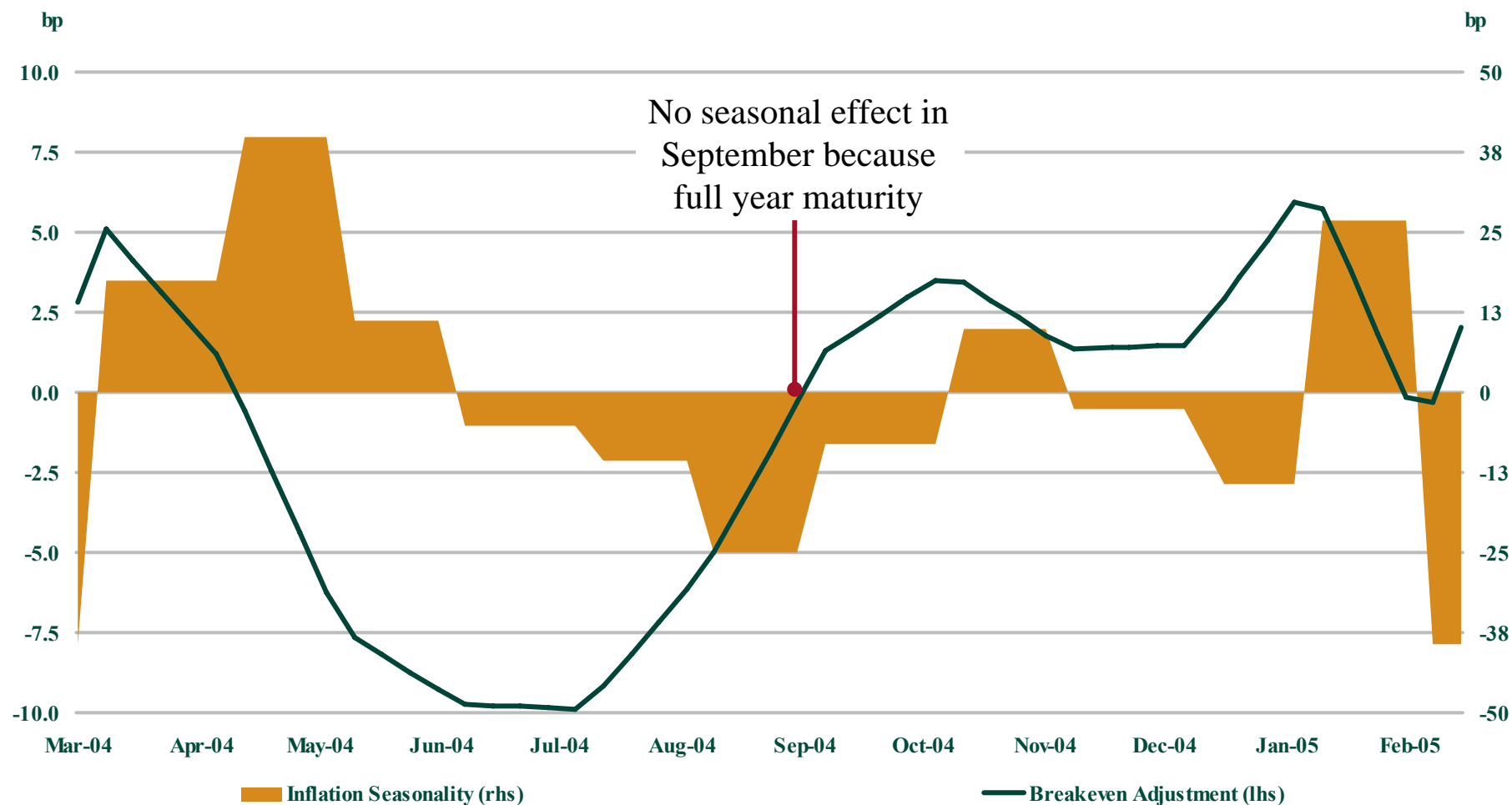


Breakevens Should Move to Compensate for Seasonality

Mechanics of inflation-linked bonds

1.65% Sep-08 BTPei

Breakeven Inflation Adjustment & Seasonality in HICPxT



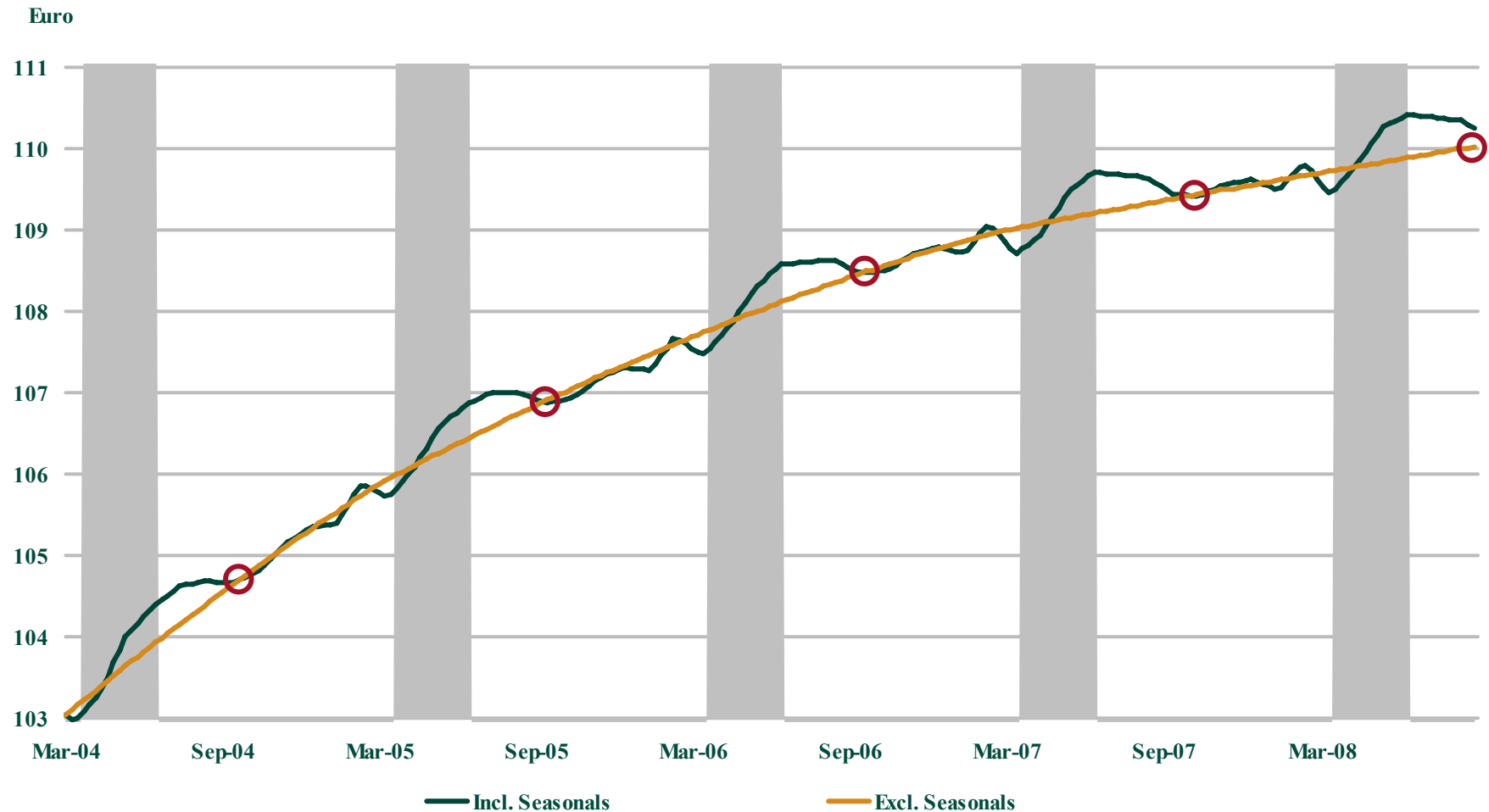
Assuming constant 2% inflation

This Would Smooth the Price Evolution of Inflation Bonds

Mechanics of inflation-linked bonds

1.65% Sep-08 BTPei

Price With Inflation Accrual: Including & Excluding Seasonality Effects



April, May, June highlighted

Understanding the IL market

Summary

Learning to read the market

- ◆ Inflation-linked bonds should be of interest to a wide range of investors and issuers, and even to non-investors such as central bank policy makers. The comparison of nominal and inflation bonds can give powerful insights into the drivers of fixed income
- ◆ Even investors that are not allowed to buy inflation have a responsibility to track this compartment of fixed income, if only to complete an understanding of the drivers of bonds
- ◆ In this section we review some examples of market behaviour to learn lessons from the past. The list is by no means exhaustive. We simply want to show that IL bonds add a layer to understanding the market and that this reading can be done with different degrees of rigor. We also want to warn that sometimes things are not what they appear

Inflation-linked Bonds Are Less Risky Than Nominals

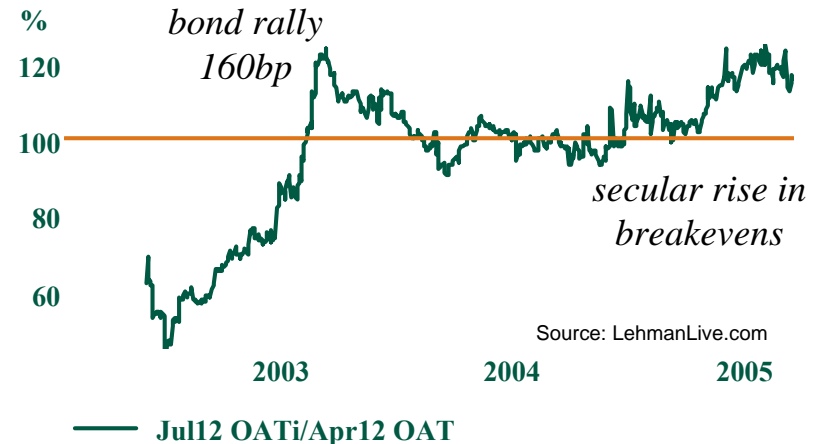
Understanding the IL market

Inflation bonds are not always less risky than same maturity nominal bonds

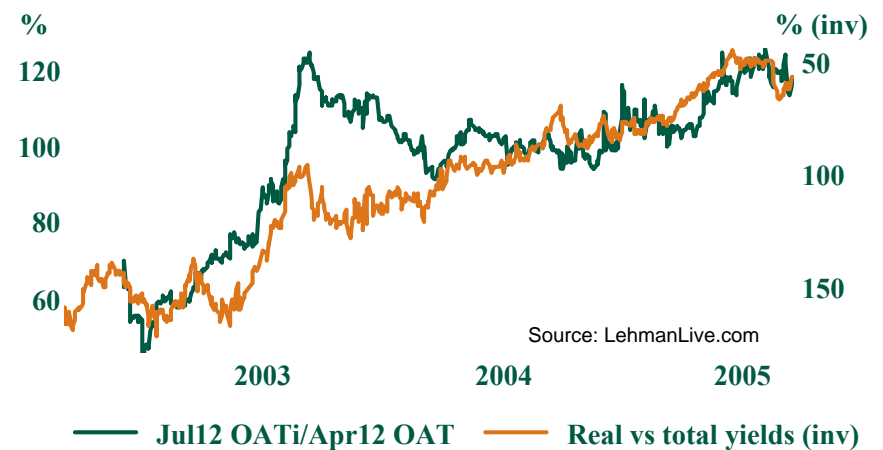
Make Price, Not Yield Comparisons

- ◆ Some will argue that IL bonds are a less risky asset class than nominal bonds. In this context, the argument suggests inflation bonds should be compared to much shorter maturity nominal bonds, not the same maturity nominal bonds
- ◆ The outright level of nominal yields must also be considered when making risk comparisons. In the context of low yields globally, real yields become a much bigger proportion of nominal yields and betas rise

3m Price Volatility Ratio



Price Vol Ratio vs Real As % of Total Yields



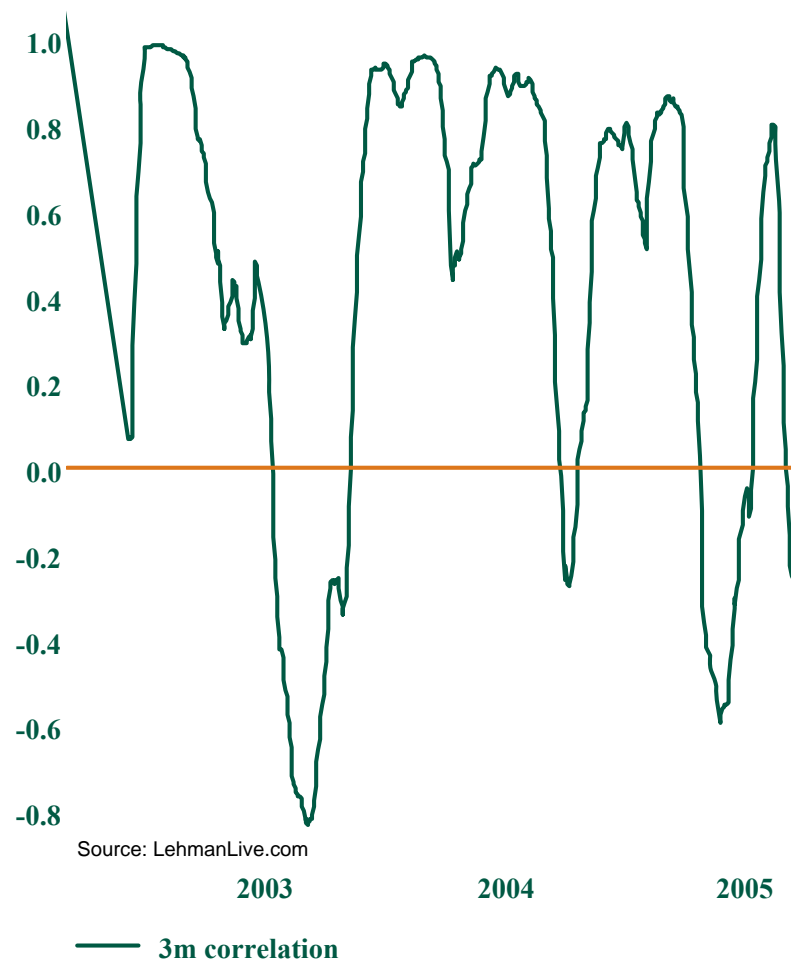
Price comparisons in the charts include inflation accrual in the 2012 OATei (i.e. clean price x index ratio)

Breakevens Are Only A View on Inflation Expectations

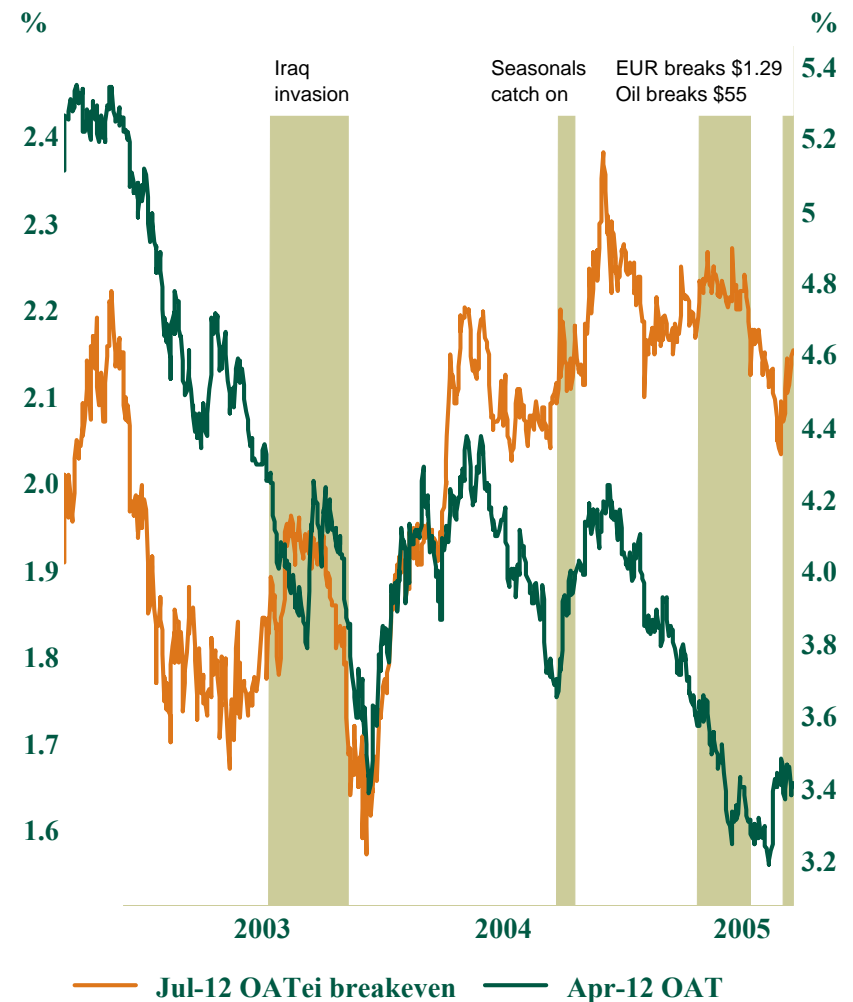
Understanding the IL market

Moves in breakeven inflation are typically directional

Correlation 2012 Nominal Yields & Breakevens



The Macro Context



Removing Directionality Is Easier Said Than Done

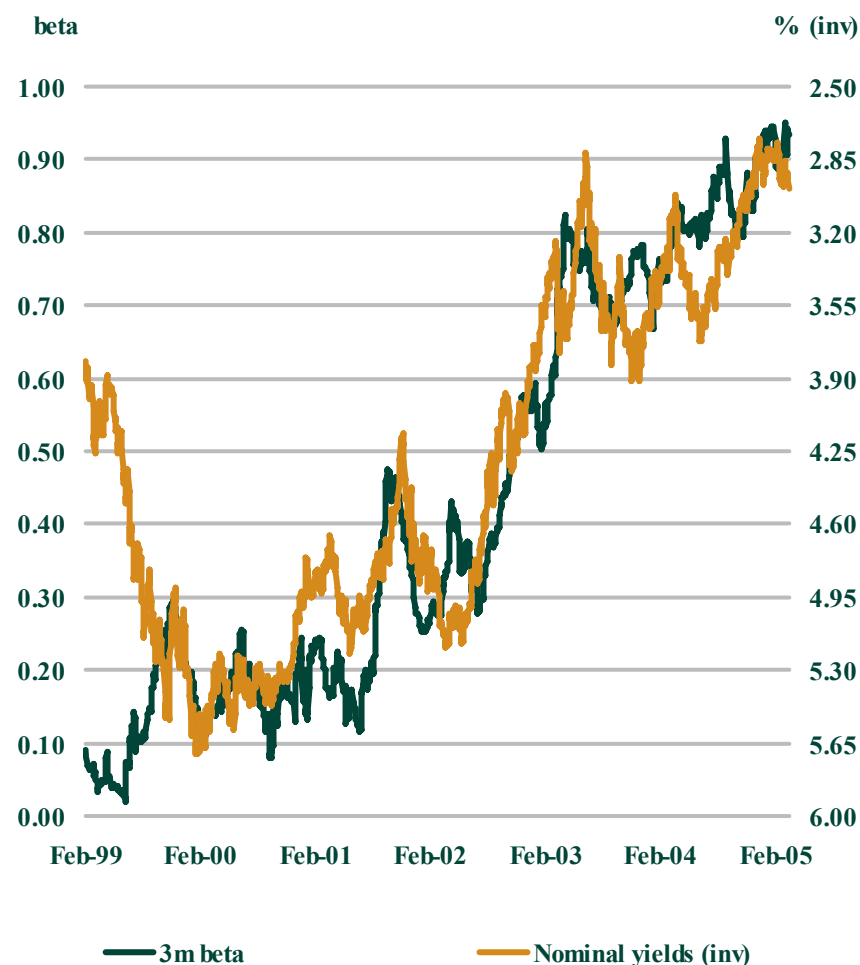
Understanding the IL market

Betas are a moving target

Beta A Useful Concept... In Theory

- ◆ Beta weighting a trade (i.e. dividing the simple PV01 of the real leg by its yield beta) is an attempt to remove directionality
 - It is more correct to calculate betas on changes, but typically investors that use betas will calculate them on levels for simplicity
- ◆ Betas are an effective means of removing directionality only to the extent that they are stable. But history teaches us that they are a moving target, and this leaves us wondering if they don't *add*, rather than remove, risk
- ◆ We prefer to look at breakeven trades using PV01 weights, accepting directionality
 - See *LehmanLive* inflation bond calculator for hedge ratios

3m Betas Using Yield Changes



In the chart we calculate 3m rolling betas using daily changes on 2009 OAT and OATi yields

I Make Money If Breakevens Rise

Understanding the IL market

Appearance is not everything, and rising breakevens don't always make money

	A	B	C	D	E	F
12	<i>Start</i>			<i>Horizon</i>		
13	Trade	8-Mar-05	Index Ratio		18-Mar-05	Index Ratio
14	Settle	11-Mar-05	1.00593		23-Mar-05	1.00324
15	Exposure	100K/bp	100K/bp			
16	Amt	189m	186m			
17						
18	Yield	1.12%	3.21%		1.10%	3.26%
19	Breakeven		210bp			216bp
20						
21	Clean px	99.12	111.83		99.22	111.52
22	Cash	187,217,182	208,189,027		187,395,219	207,603,506
23	Change				178,037	-585,521
24	Profit/loss					763,559
25						
26	Dirty px	100.18	113.81		99.56	113.68
27	Coupon pmt				0.48	
28	Cash	189,209,919	211,865,990		188,943,190	211,619,880
29	Change				-266,728	-246,111
30	Profit/loss					-20,618

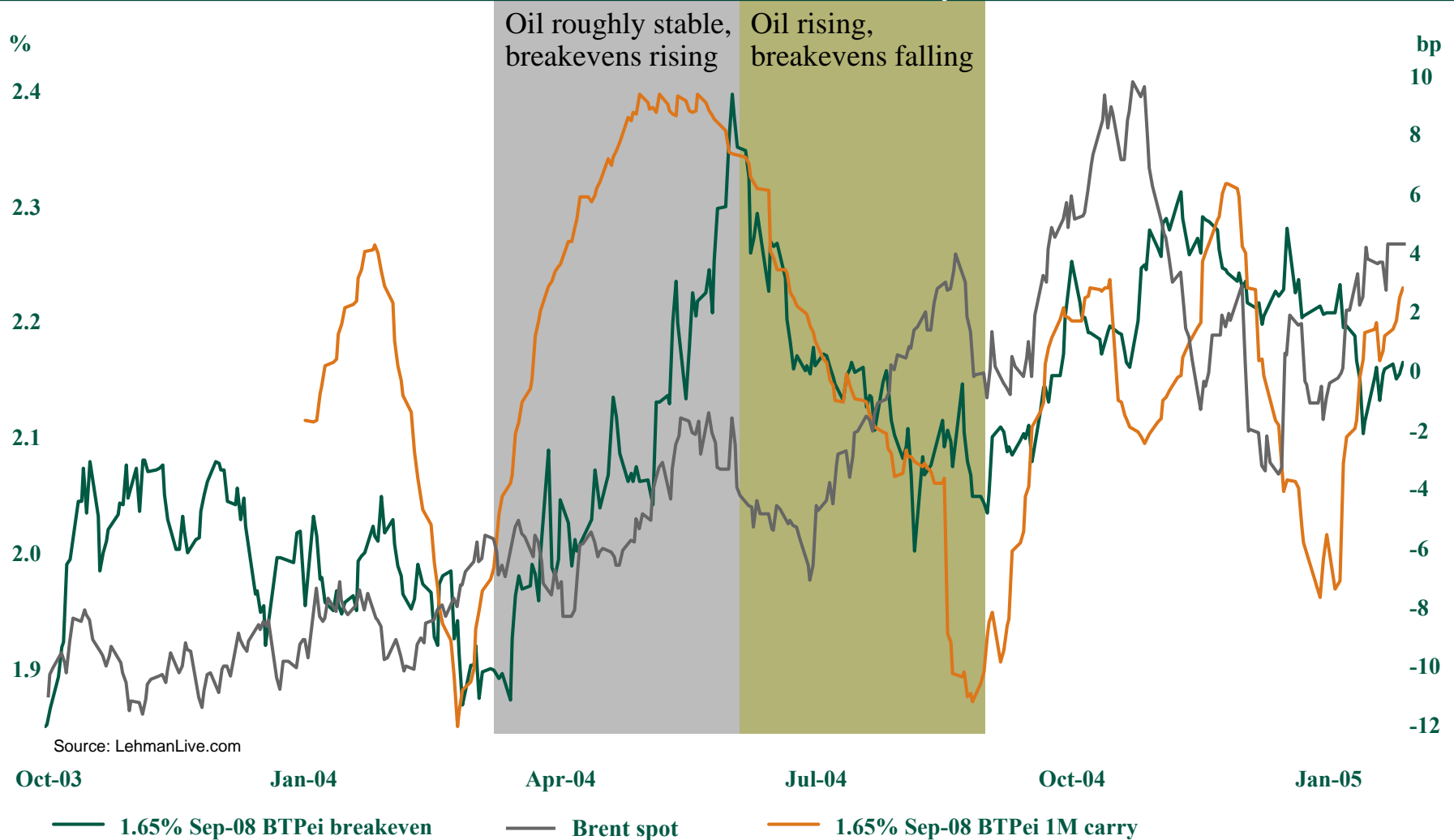
Long 2010 BTPei breakeven trade

Commodity Prices Drive Breakevens

Understanding the IL market

In euro, investors “ride the wave” and buy inflation bonds for carry

2008 BTPei Breakevens, 1-mth Breakeven Carry, Brent Crude Oil



Seasonality Is Interpreted Differently In Dollar Market

Understanding the IL market

Flattening curve indicates that breakevens are compensating for negative accruals

Seasonal Flattening in TIPS During Negative Accruals



Real Yields As The Other Side Of The Coin

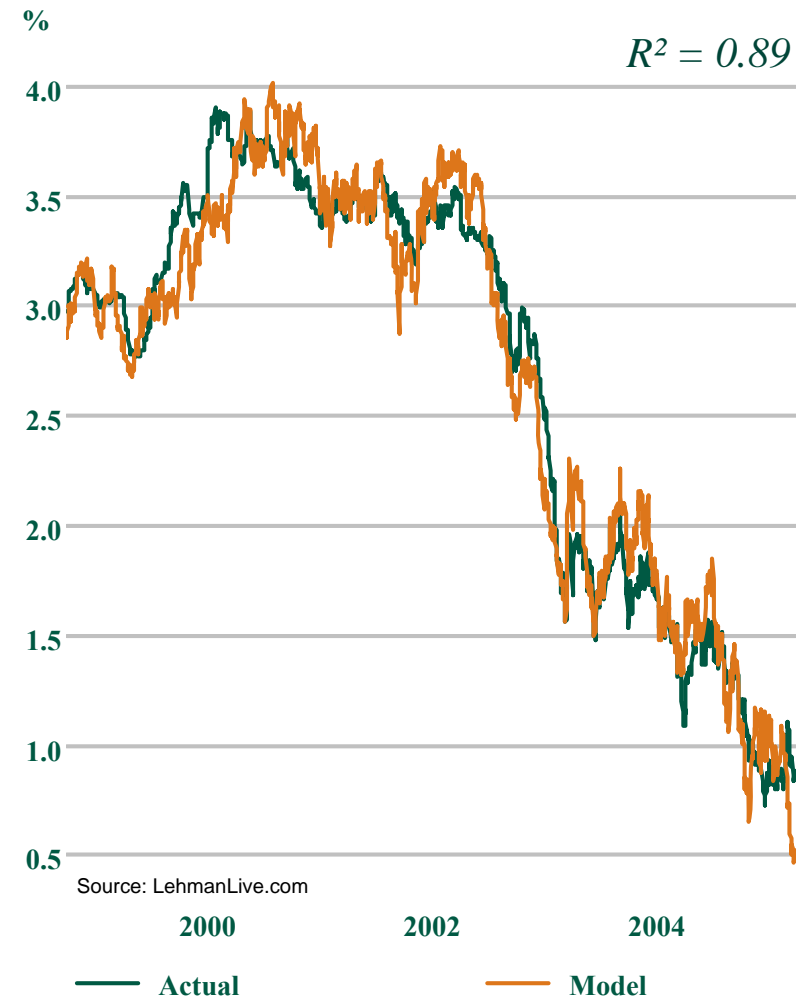
Understanding the IL market

In the context of medium term inv., monetary policy is the most important influence

Real Yields Show Pessimism About Growth

- ◆ If we view real yields as the market's barometer to the health of the economy, it is unsurprising that there is a high correlation between real yields, official rates and the expected path of short rates
- ◆ It is therefore equally unsurprising that nominal yields (and thus breakevens) have a greater freedom to maneuver than real rates
- ◆ We model real yields as a function of:
 - 3m rates (+ coefficient)
 - 3m1y fwd (+ coefficient)
 - EUR exchange rate (- coefficient)
 - Oil and commodity prices (- coefficient)

2009 Real Yields Actual & Model

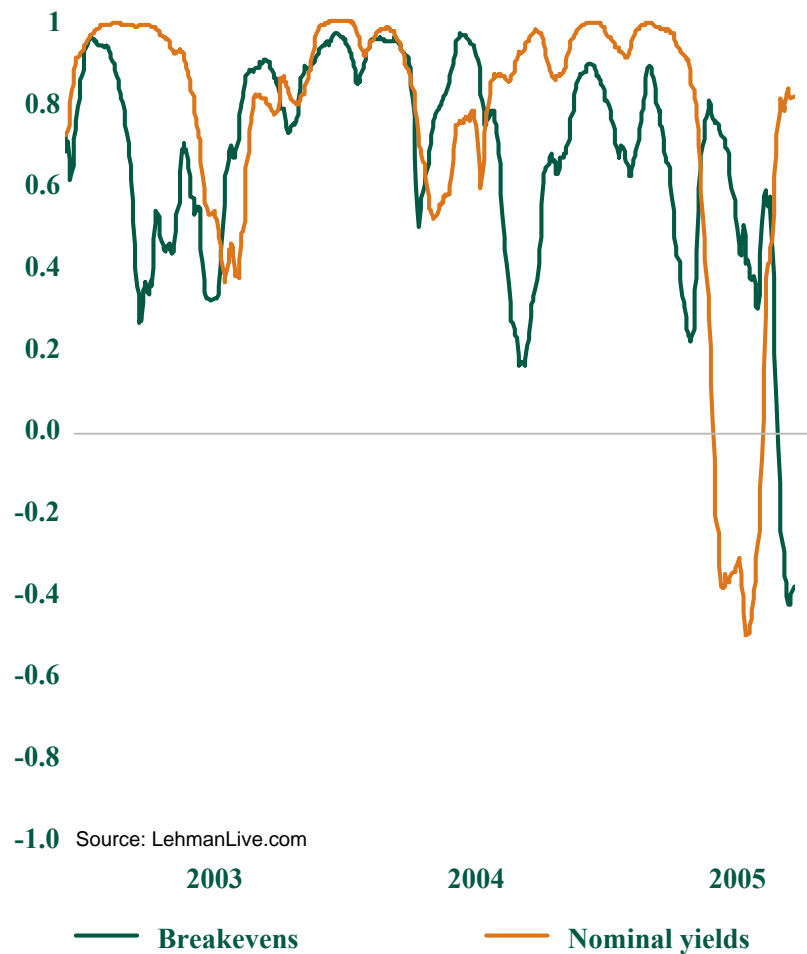


Cross Atlantic Breakevens Generally Well Correlated

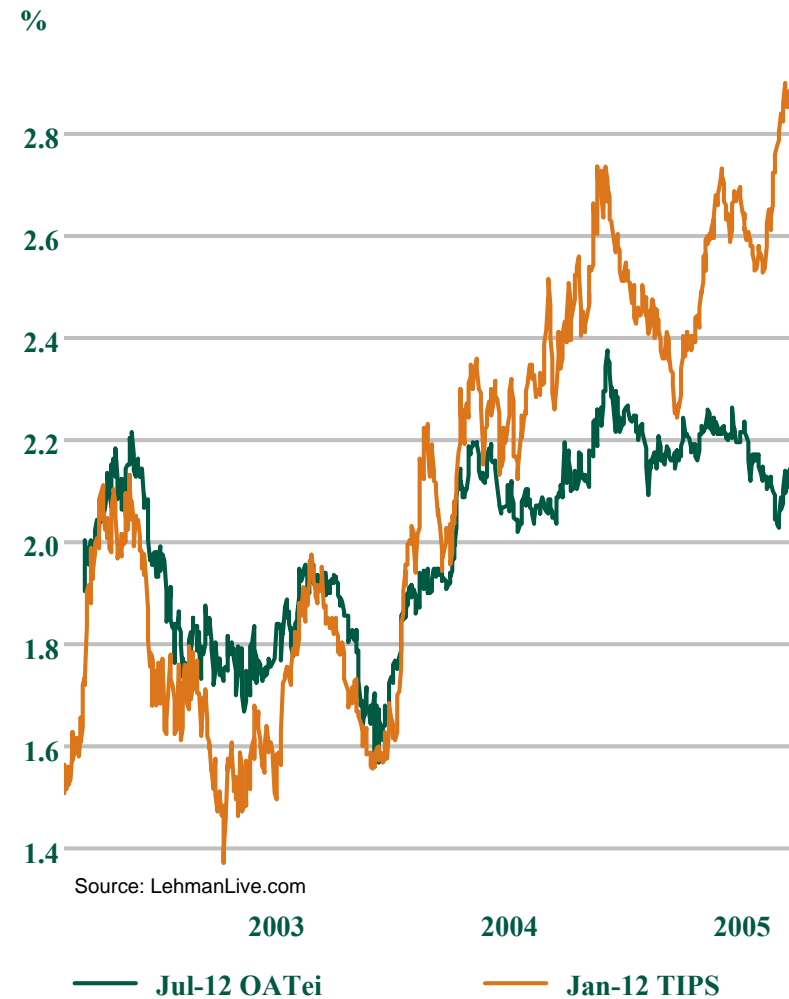
Understanding the IL market

Like with bonds, breakevens usually move in sync

3m Rolling Correlation



2012 TIPS & OATei Breakevens

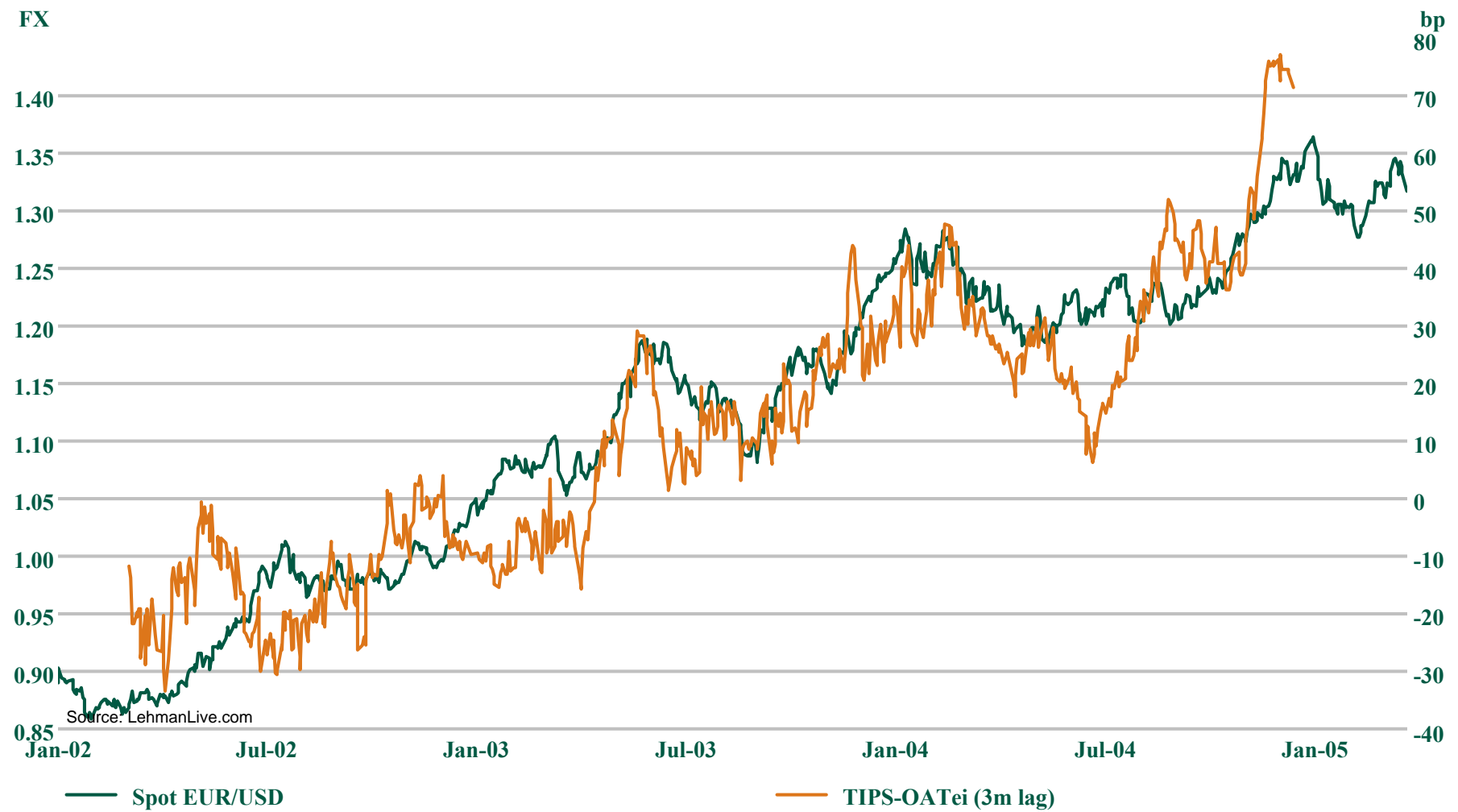


Breakeven Inflation & The Exchange Rate

Understanding the IL market

Exchange rate trends tend to lead moves in breakevens by 3m

2012 TIPS-OATei Breakeven Inflation Spread & USD-EUR Exchange Rate

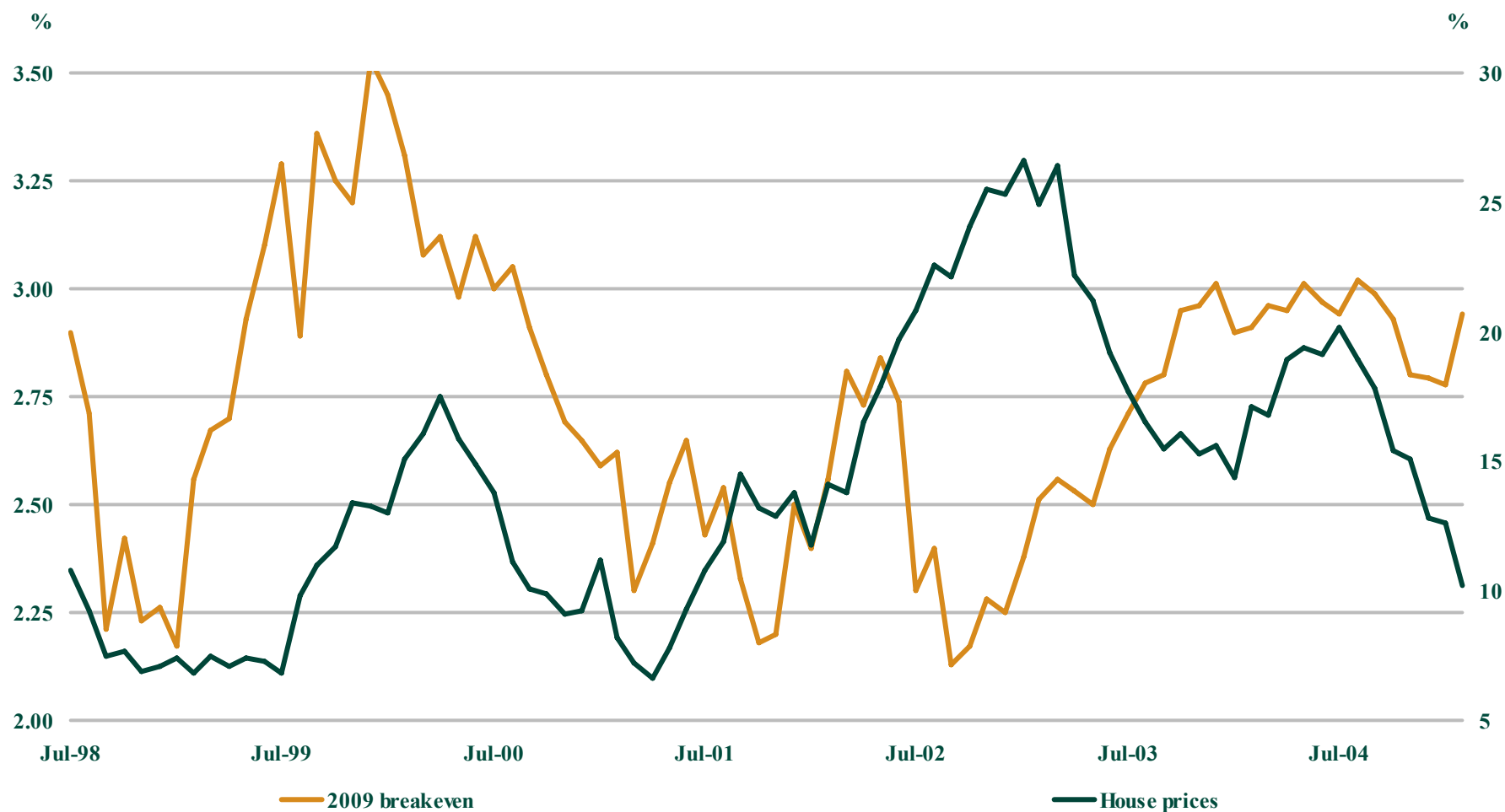


Country Specific Dynamics Important Too

Understanding the IL market

In the UK, housing is an important factor when looking at RPI

UK House Prices & 2009 UK IL Gilt Breakeven



The only period of significant divergence was July 2002. But this is explained by the sharp rally in nominal yields globally as sentiment around a recovery faded. This was not matched by a fall in UK real yields which were in fact rising. In the chart, house prices are using the Nationwide House Prices but other indices will show similar results

The institutional context

Summary

Why sell and buy inflation?

- ◆ **Why issue inflation?** There are numerous practical reasons why sovereigns look to issue inflation-linked bonds. These include their properties as a natural hedge and their cash flow structure which allows backdating payments. Tapping into a broader investor base can also be important
- ◆ **Why buy inflation?** Interest for purchasing inflation-linked bonds varies according to type. The greater certainty in future purchasing power is the main reason for investors who transfer wealth through time to buy IL debt. Alpha generation is instead more important for investors with shorter horizons

Why Issue: Natural Hedge

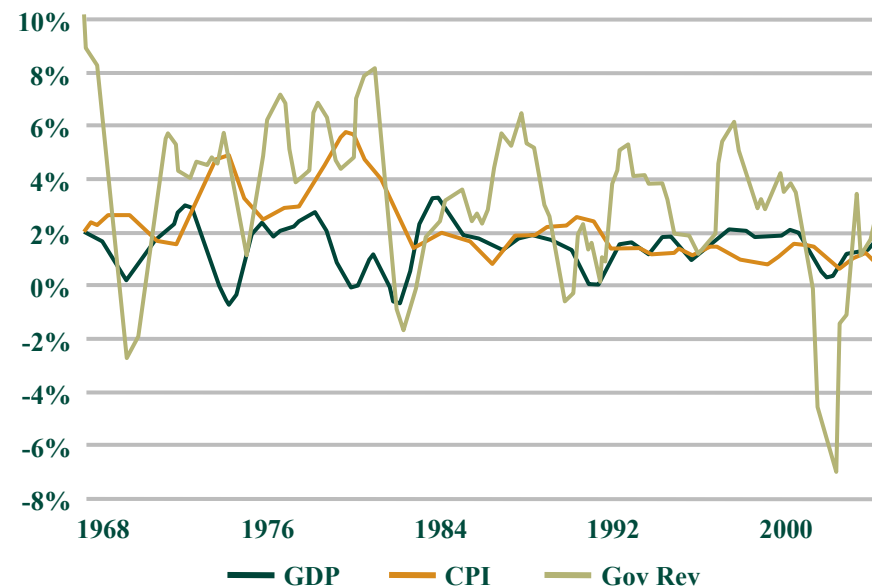
The institutional context

Fiscal revenues expose sovereigns to inflation risk

- ◆ From an asset-liability perspective inflation-indexed debt allows natural receivers of inflation, such as sovereigns, to minimize their inflation exposure
- ◆ The elasticity of fiscal revenues to inflation is estimated to be around 0.5-1. The short-run effect can be below that and the modal effect might lag by up to a year, but the long-run effect, which builds up over the business cycle, is unity
- ◆ IL debt therefore allows a reduction in both high and low frequency exposition to inflation

Government Revenues Move With Inflation...

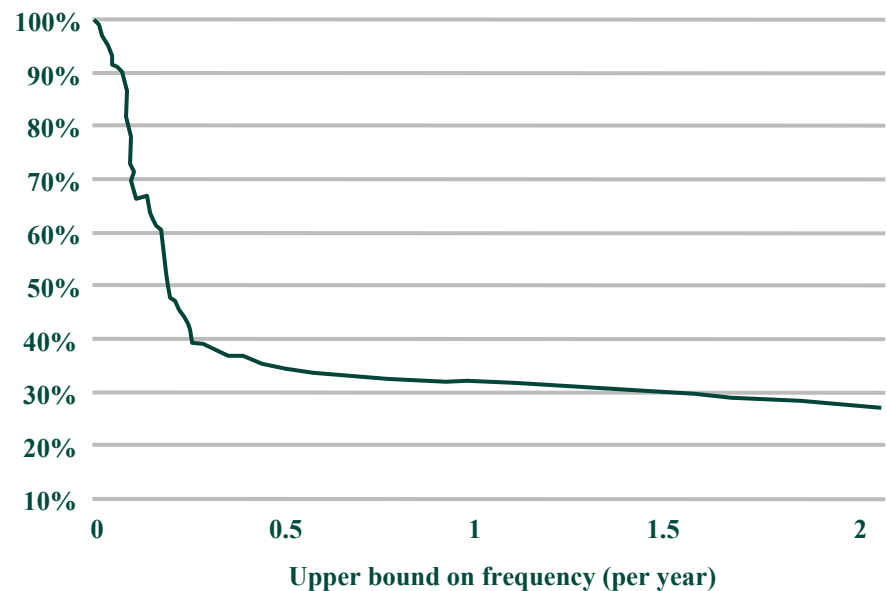
Annual average of yearly changes



Source: BLS, US Treasury

...With Unit Elasticity in the Long-Run

Correlation



Why Issue: Natural Hedge

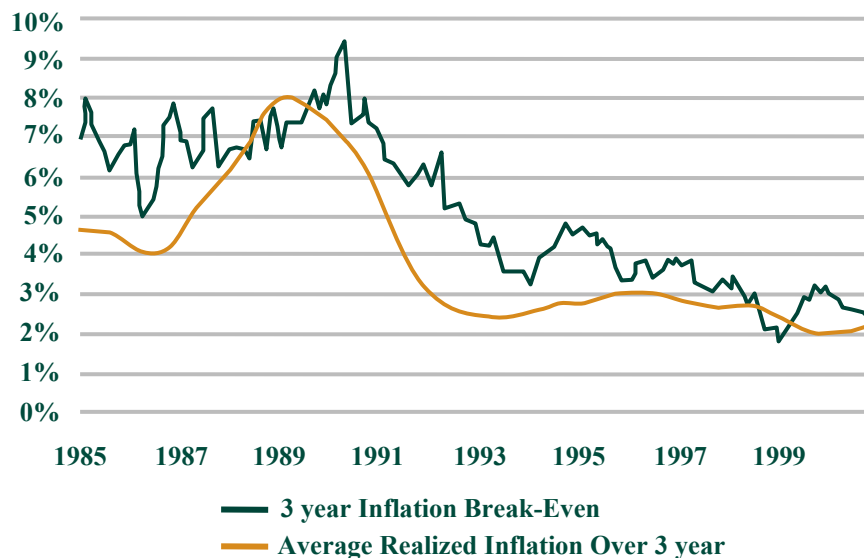
The institutional context

Inflation-linked funding is on average less costly than fixed-rate funding

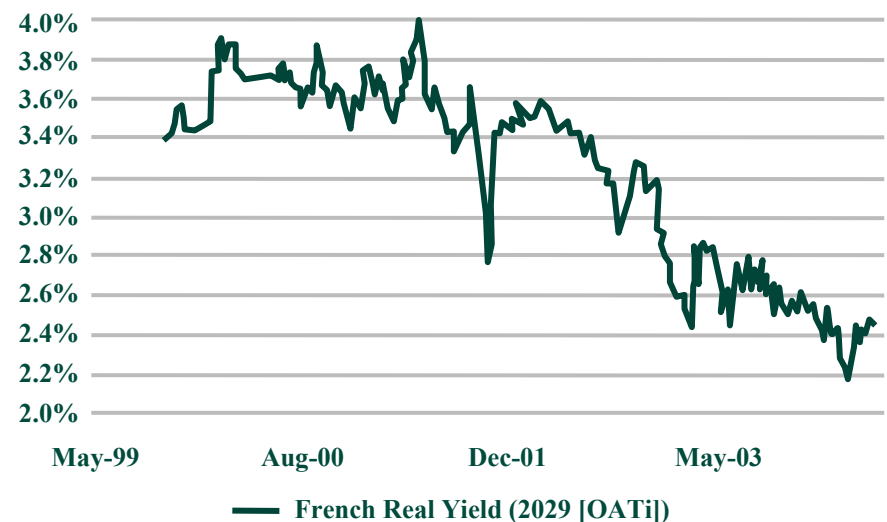
- ◆ Long-term nominal debt is well-known to carry a compensation for risk to investors. This risk is primarily due to the long-run uncertainty around inflation. By issuing inflation indexed-debt sovereigns can therefore reduce their cost of capital. Numerous empirical academic studies have studied the presence of risk premia for nominal relative to real or inflation-indexed bonds (e.g. Barr and Campbell [(1996)], Sartre (1998))
- ◆ When compared to floating-rate funding, inflation-linked gives issuers the opportunity to pay a less volatile rate
- ◆ In addition, inflation-linked funding allows issuers to lock in the low level of real yields. The recent drop in long nominal rates has indeed occurred at the same time as a significant drop in the real rates, which implies that inflation-linked funding is a plausible solution from a relative value perspective

Historical Break-Even / Realized Inflation Differential

UK Inflation Rate



Historical Level of the Real Yield

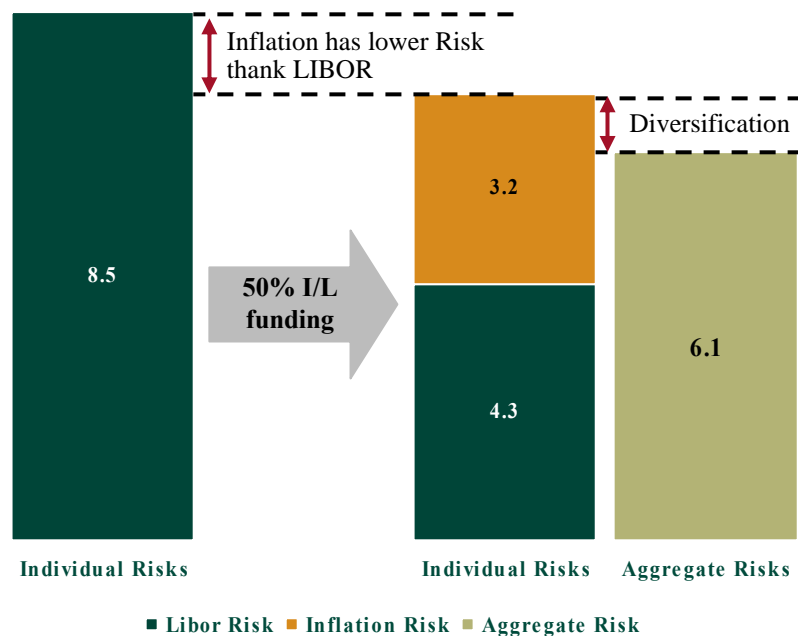


Why Issue: Natural Hedge

Inflation-linked funding can be used as a liability portfolio diversification tool

- ◆ In the absence of inflation-linked revenues or operating expenses, it is beneficial to index some of a company's liabilities to inflation as a risk diversification benefit
- ◆ Indexing part of the liability portfolio to inflation will in general reduce aggregate risk, as interest rates are only imperfectly correlated with inflation
- ◆ In addition, inflation is less volatile than nominal rates, which reduces risk even in the absence of diversification

Impact of Inflation Funding on Debt Cost Risk



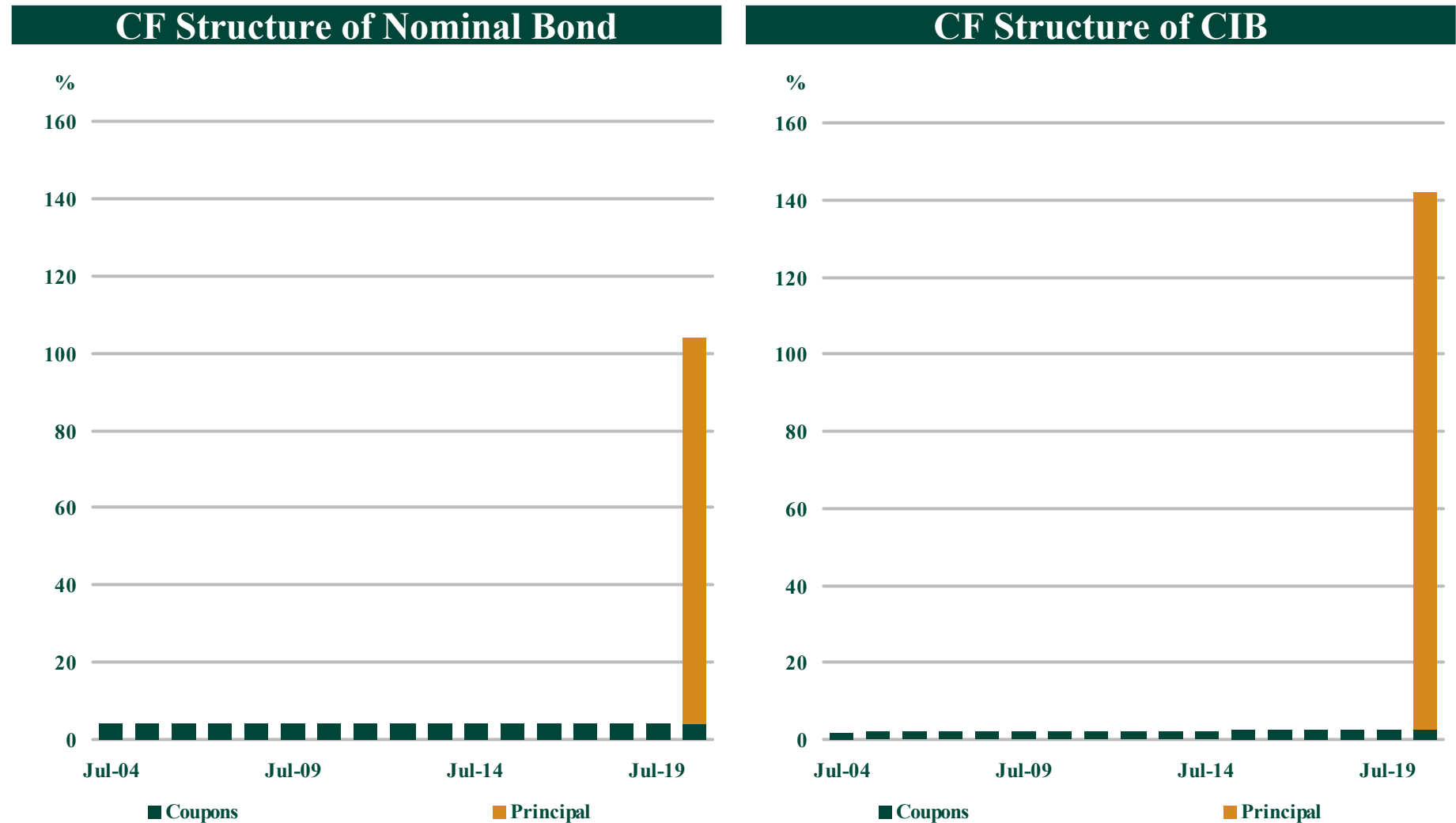
◆ Methodology

- We compare the stand deviation of the financing cost of 10-year debt under two alternative scenarios
 - 100% nominal funding
 - 50% nominal and 50% inflation-linked funding
- The second strategy has a lower risk, due to two effects
 - Lower volatility of inflation; and
 - Diversification of risks

Why Issue: Take Advantage of Cash Flow Structure

The institutional context

The structure of capital indexed bonds back dates cash flows



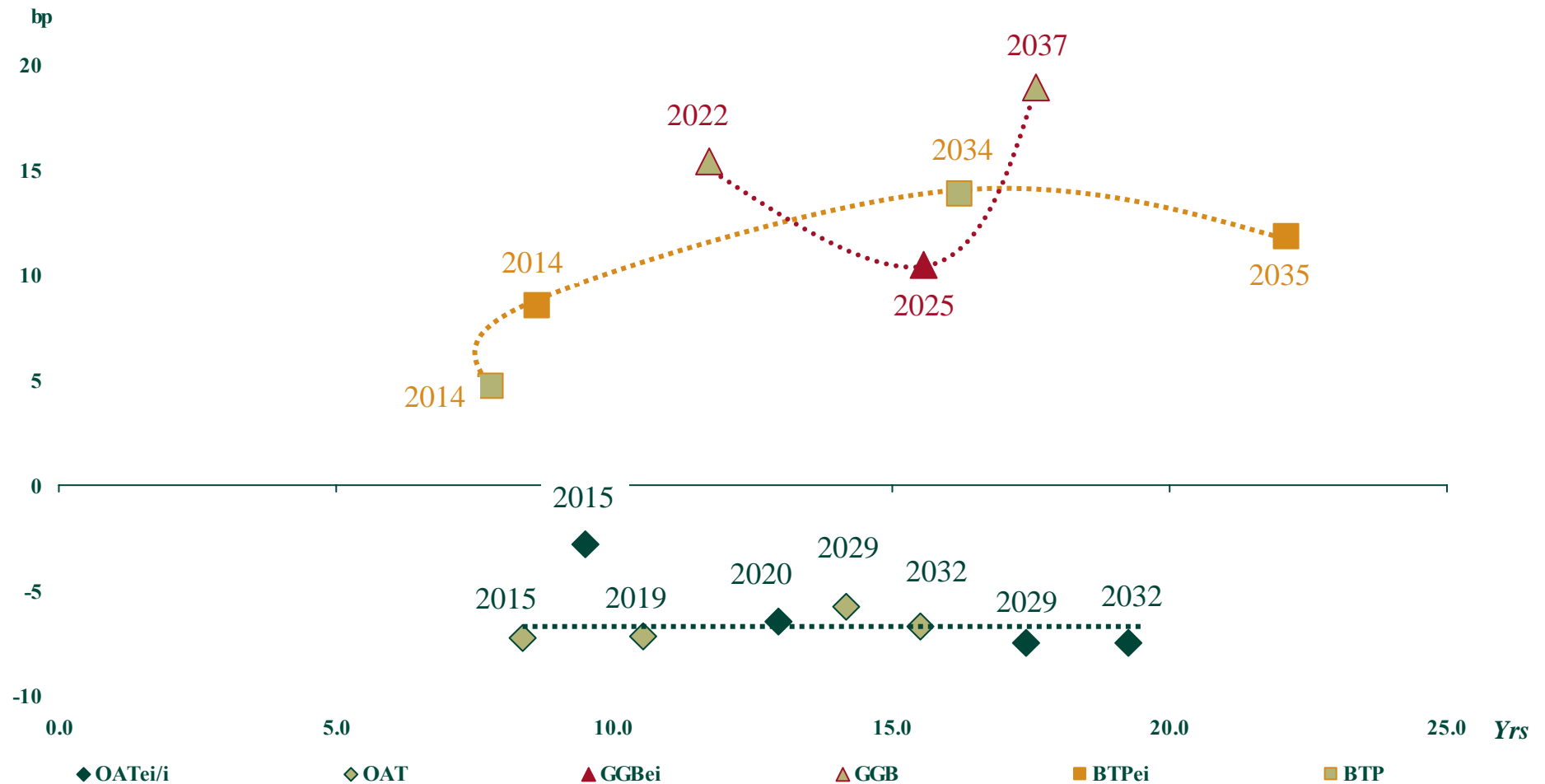
Assuming Jul-20 bond with constant 2% inflation

Why Issue: Mispricing of Credit Risk

The institutional context

The market tends to look at breakeven inflation, and not so much cash flow structure

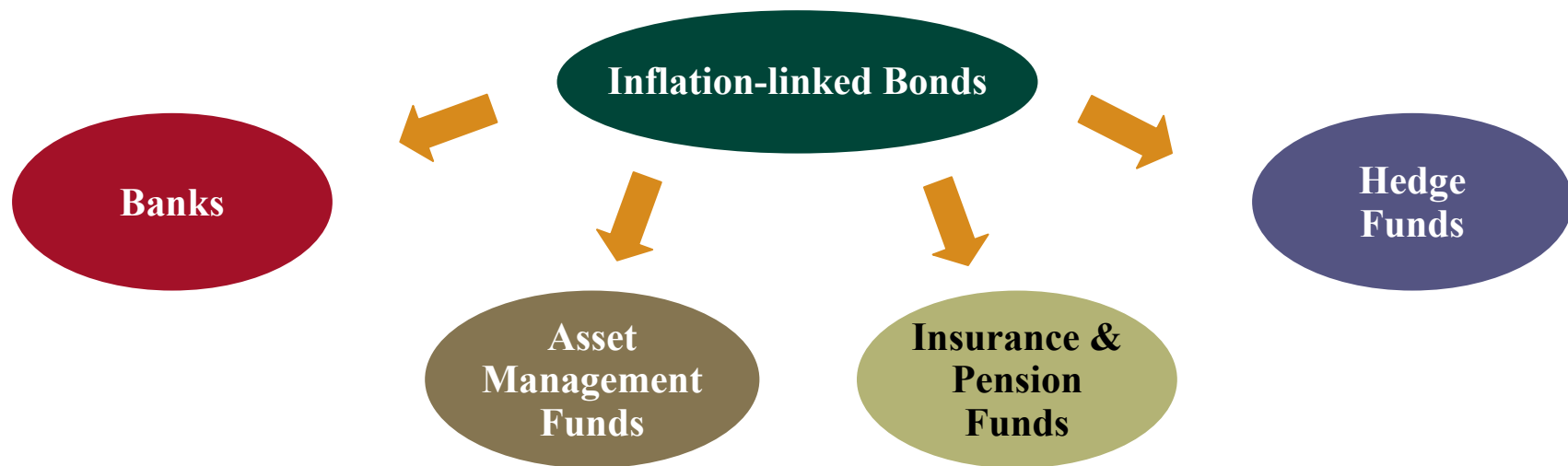
Nominal Duration of Nominal & IL Bonds vs. Asset Swap Spreads



Why Buy Inflation?

The institutional context

A diverse number of investors buy inflation-linked bonds for various reasons



Why Buy?

- ◆ Offer inflation linked products to retail customer base. Buy inflation as hedge
- ◆ Typically medium term maturities

Why Buy?

- ◆ Add alpha to portfolio or have real return funds
- ◆ Exposure to all parts of the curve

Why Buy?

- ◆ Manage inflation-linked liabilities
- ◆ Typically buy medium and long term maturities

Why Buy?

- ◆ Add a trading dimension and take advantage of asymmetries
- ◆ Short and medium term maturities, but will also do long term

Why Buy: Asset-Liability Matching

The institutional context

Real value certainty

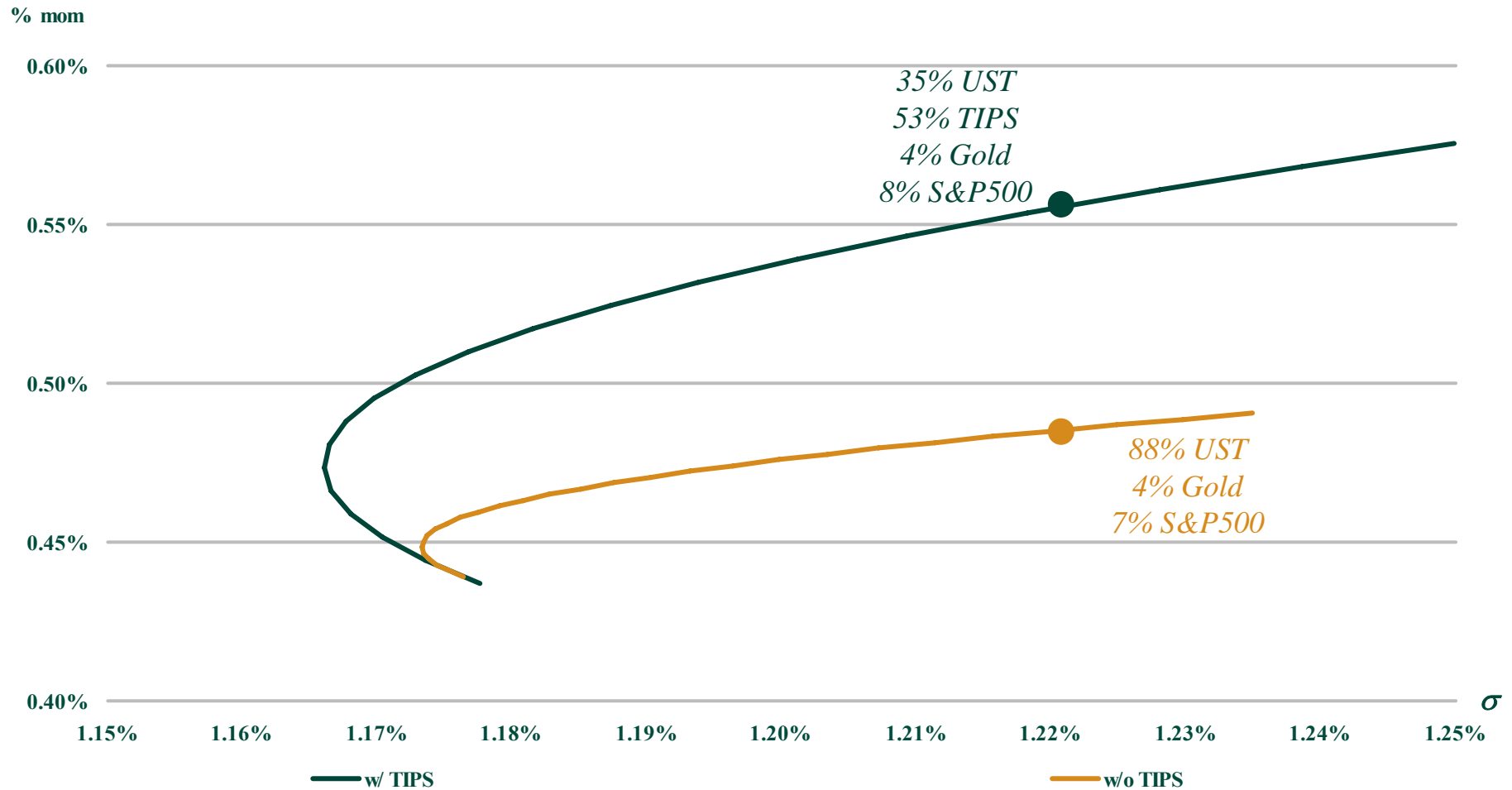
- ◆ Inflation-linked debt offers protection against an unexpected change in the level of prices. Many investors purchase fixed-income securities for stable income in the form of coupons and principal repayment. However, the purchasing power of these future cash flows decreases as inflation rises
- ◆ Assets that provide protection against inflation include:
 - inflation-linked bonds: explicit link to inflation
 - floating rate notes: imperfectly correlated to inflation
 - commodity-based assets: influenced by other commodity-specific events (e.g. fall in stocks of oil)
- ◆ As IL bonds reduce real risk of portfolio (and increase nominal risk), inflation bonds appeal most to investors that want real value certainty. Therefore, the investment must be valued also in the context of the future liabilities it must cover, e.g.
 - banks may prefer nominal value certainty,
 - pension funds may prefer real value certainty

Why Buy: Portfolio Diversification

The institutional context

Asset diversification helps improve the risk-return profile of a portfolio

Markowitz Efficient Frontier With And Without TIPS



Why Buy: Alpha Generation

Many ways to generate alpha when adding new trading dimensions

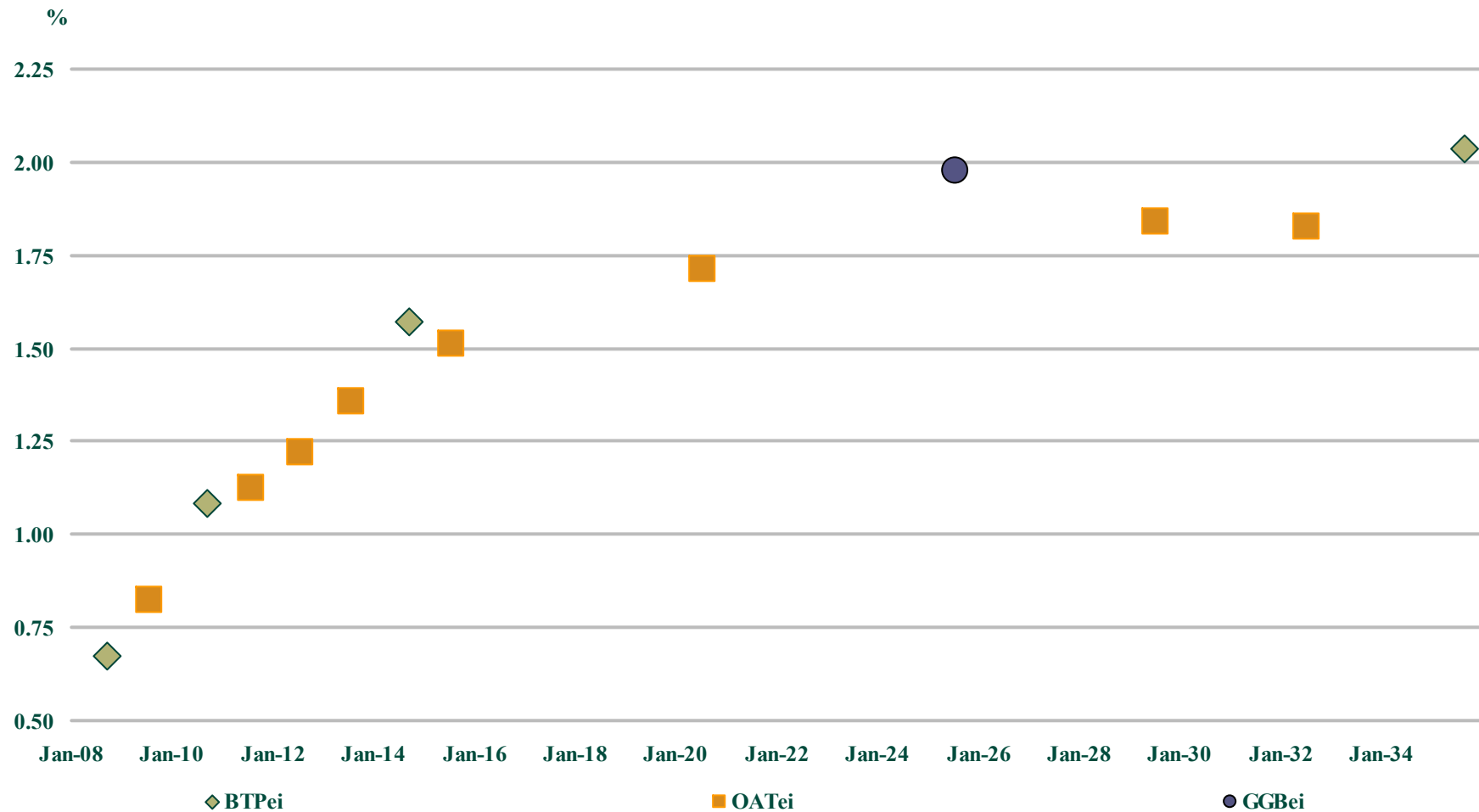
- ◆ Relative value within IL bond universe
(2014 BTPei vs 2015 OATei)
- ◆ Relative value between different inflation indices
(HICPxT vs FR CPI, etc.)
- ◆ Index-linked bonds vs nominal bonds
(“breakeven inflation”)
- ◆ Curve trades
(real yield steepener/flattener, breakeven inflation steepener/flattener)
- ◆ IL bonds of other currencies
(TIPS, JGBi)
- ◆ Asset swaps
- ◆ Inflation swaps
(5-year, or 5y5y, etc.)
- ◆ Non “standard” inflation
(FOI, Dutch, Swiss)
- ◆ Inflation strips

Why Buy: Real Yield Pick-up

The institutional context

Like in nominal space, also within IL bonds investors look for yield

Term Structure of Real Yields



Lehman Brothers and inflation

Lehman Brothers Inflation Team

Lehman Brothers and inflation



LehmanLive Inflation Products Page

Lehman Brothers and inflation

Summary page

bond
overview

Bond Benchmarks: 5-, 10-, 30-year sectors									
Issue	Clean	Price		Current	Yield		Breakeven		
		Dirty			1D	1W	Current	1D	1W
FR CPIxT									
3.000% Jul-09 OATi	118.39	118.99	1.17	-4	-10		2.02	-0	2
2.500% Jul-13 OATi	110.05	110.52	1.73	-3	-7		2.12	-0	0
3.400% Jul-29 OATi	133.70	134.38	2.19	-3	-7		2.37	-0	-1
HICPxT									
1.650% Sep-08 BTPei	104.64	104.71	0.97	-4	-11		2.15	0	3
2.150% Sep-14 BTPei	104.52	104.61	1.88	-3	-6		2.22	-0	-1
3.150% Jul-32 OATei	124.62	125.21	2.16	-3	-8		2.42	-0	-0
UK RPI									
2.500% May-09 IL gilt	241.50	243.59	1.78	-3	-12		2.98	-0	2
2.500% Aug-13 IL gilt	216.95	217.56	1.89	-1	-9		2.91	-3	-1
2.000% Jan-35 IL gilt	115.65	116.02	1.62	-1	-4		2.93	-2	-2
US CPI									
3.875% Jan-09 TIPS	112.55	113.34	0.89	-8	-3		2.27	3	6
2.000% Jan-14 TIPS	102.69	103.10	1.69	-5	-7		2.29	2	1
3.375% Apr-32 TIPS	127.22	128.75	2.07	-3	-6		2.70	0	-3

global swap
overview

Inflation Swap Rates									
Index	2Y	5Y	10Y	15Y	20Y	30Y	2-10	5-10	5-10-30
Euro HICPxT	2.31	2.46	2.53	2.63	2.70	2.79	22	7	-9
French CPIxT	2.13	2.38	2.50	2.60	2.68	2.78	37	12	-8
Italian FOI	2.72	2.95	2.88	2.88	2.90	2.95	16	-6	-7
US CPI	2.58	2.98	3.18	3.38	3.43	3.51	59	19	-7
UK RPI	3.34	3.11	3.09	3.07	3.07	3.11	-25	-2	-2

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Publications	
Weekly	
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European Interest Rate Strategies	archive
Daily	
US Treasury Relative Value Report - TIPS	
Research papers	
A Guide to Inflation-Linked Government Bonds in the Euro Area	

Trader Commentary [More](#)

☒ Europe ☐ US

Inflation Daily 23-Sep-04

Borut Miklavcic

September 23, 2004 12:47:50

Market Overview

A bit of a reversal from yesterday's move in break-even land. The short end lost some of its bid and the long end finally found a few buyers. The net effect was a steeper B/E curve with OATei32s particularly well supported and the 08s under some pressure. While the shape of the curve has been moving around quite a bit lately the overall level of break-evens has been remarkably stable given the size of the moves in the nominal market. Presumably the market thinks it will be difficult to push B/E's much lower given spot inflation, oil, and general

Inflation-Linked Index Analysis

The Lehman Brothers family of global indices includes these groups of inflation-linked securities.

Global Inflation-Linked	Eurozone
U.S. TIPS	Pan-Euro
Canada	U.S. TIPS
UK	1-10 Year
Sweden	10+ Year
France	5+ Year
Italy	

daily
comments
from our
euro and
US traders

bond indices

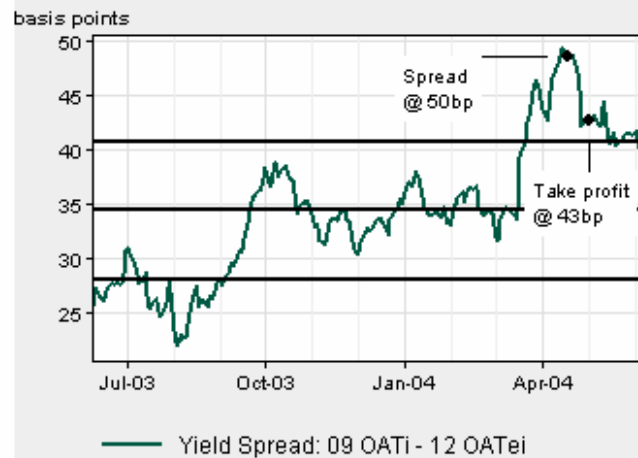
LehmanLive Inflation Products Page

Lehman Brothers and inflation

Our Analyst's trade ideas

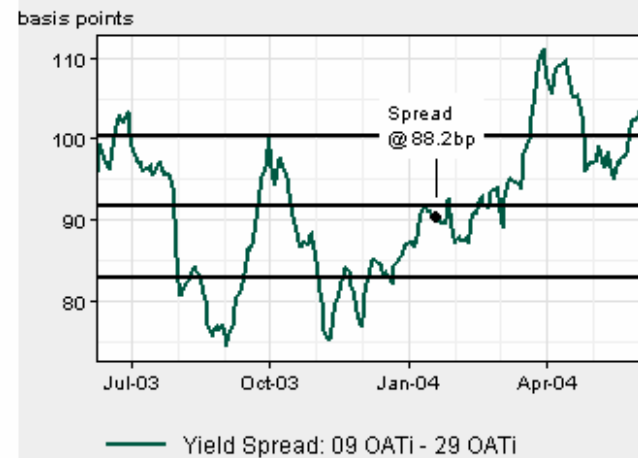
2012 OATe vs 2009 OATi yield spread

[Modify Plot Input](#)



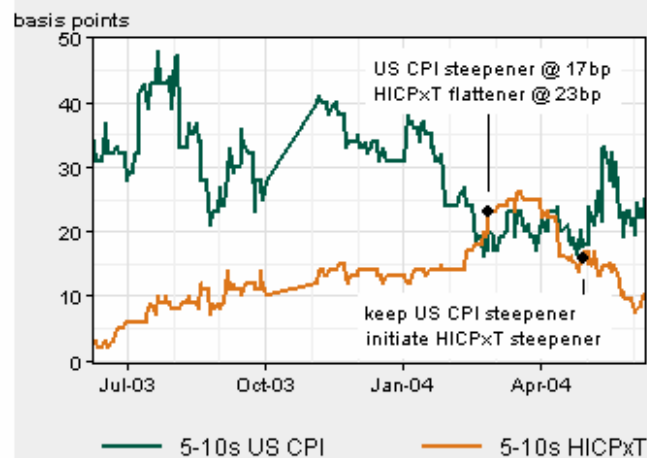
2029 OATi vs 2009 OATi yield spread

[Modify Plot Input](#)



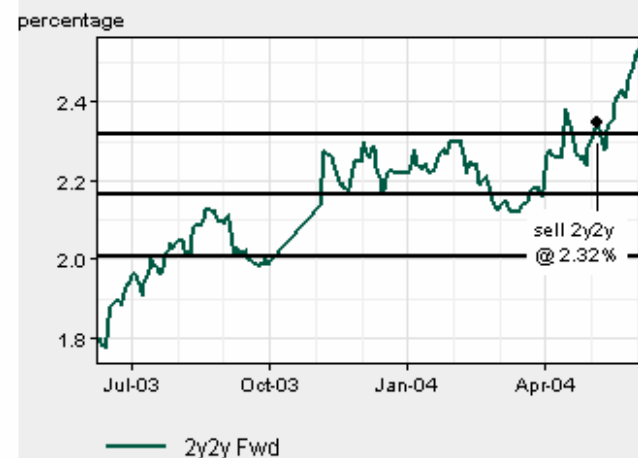
5-10s US CPI & HICPxT swap curve

[Modify Plot Input](#)



2y2y HICPxT

[Modify Plot Input](#)



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Lehman Brothers and inflation

Live ZC swap pricing and forward inflation swap curve calculator

Overview Trade Tracker Live Swaps EUR USD GBP Calculator

value your
positions

Inflation Swap Calculator					
Contract Details			Index Levels		Cashflows
Pay	EuroZone Ex-Tobacco		Start	Oct 2004	Leg Amount PV
Lag	3M	Rate	2.105	115.700	Inflation 10,977,529 9,422,318
Term	5Y	Notional	100MM	End Oct 2009	Fixed 10,977,529 9,422,318
Start	27-Jan-2005	End	27-Jan-2010	128.401	Net 0 0
Swap Rates		Seasonals		Curve	
Done.				Historic Fixings	

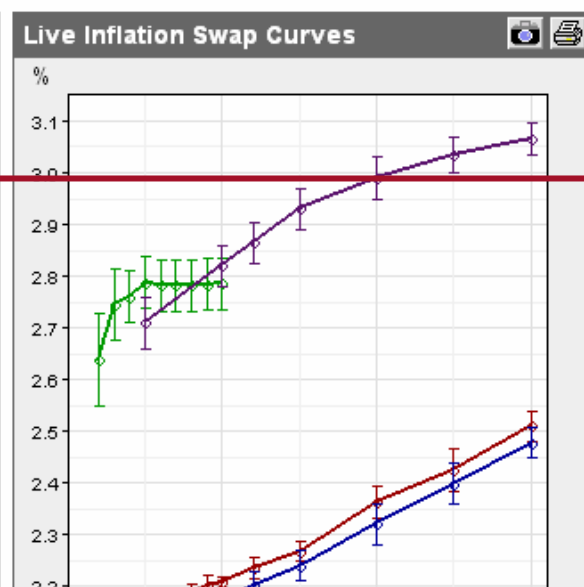
Subject to market conditions, spot ZC swap prices below are tradable in €100MM up to 10 years, €50MM beyond 10 years during London trading hours.
Please call Lehman Interbank Desk on +44 20 7103 3017.



tight
bid-offer

all major
markets
live

Fixing Term	HICPXT Sep		FRCPI Sep-Oct		USCPI Sep-Oct		UKRPI Oct	
	Bid	Offer	Bid	Offer	Bid	Offer	Bid	Offer
Spot								
2Y	2.005	2.065	1.930	2.010	2.547	2.727		
3Y	2.050	2.090	1.973	2.053	2.675	2.815		
4Y	2.080	2.110	2.018	2.057	2.710	2.810		
5Y	2.105	2.135	2.040	2.070	2.737	2.837	2.660	2.760
6Y	2.120	2.160	2.057	2.097	2.732	2.832		
7Y	2.148	2.188	2.080	2.120	2.733	2.833		
8Y	2.173	2.203	2.105	2.145	2.732	2.832		
9Y	2.180	2.220	2.130	2.170	2.733	2.833		
10Y	2.197	2.217	2.155	2.185	2.736	2.836	2.780	2.860
12Y	2.215	2.255	2.170	2.230			2.825	2.905
15Y	2.247	2.287	2.210	2.270			2.890	2.970
20Y	2.332	2.393	2.280	2.360			2.950	3.030
25Y	2.385	2.465	2.358	2.438			3.000	3.070
30Y	2.480	2.540	2.447	2.507			3.035	3.095
Term	Mid		Mid		Mid		Mid	



you can now
detach it, to
have it
always on
your desk

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Lehman Brothers and inflation

Carry analysis on 1M, 3M & 6M horizon for all markets

Overview Trade Tracker Live Swaps **EUR USD GBP** Calculator

TIPS Relative Value Monitor

Inflation Bond	Price Clean	Price Dirty	Yield Current	Yield 1D	Yield 1W	Nominal Comparator	Breakeven Current	Breakeven 1D	Breakeven 1W	Infl ASW	Nom ASW	Pick up to Nominal
TIPS 3.375% 15-Jan-07	105.15	105.26	0.73	0	-4	T 6.250% Feb-07	2.54	4	6	-22	-36	15
TIPS 3.625% 15-Jan-08	108.00	108.12	0.89	-1	-3	T 5.500% Feb-08	2.54	4	5	-18	-40	22
TIPS 3.875% 15-Jan-09	111.00	111.13	1.04	-1	-3	T 3.000% Feb-09	2.56	3	2	-18	-37	20
TIPS 4.250% 15-Jan-10	114.95	115.09	1.14	-1	-3	T 6.500% Feb-10	2.59	3	2	-17	-37	21
TIPS 3.500% 15-Jan-11	112.70	112.82	1.28	-1	-1	T 5.000% Feb-11	2.58	3	2	-17	-36	20
TIPS 3.375% 15-Jan-12	112.95	113.07	1.42	-2	1	T 4.875% Feb-12	2.56	3	-0	-15	-34	20
TIPS 3.000% 15-Jul-12	110.83	110.93	1.46	-2	1	T 4.375% Aug-12	2.55	3	-0	-14	-35	22
TIPS 1.875% 15-Jul-13	102.28	102.34	1.59	-2	2	T 4.250% Aug-13	2.54	3	-1	-14	-32	19
TIPS 2.000% 15-Jan-14	103.00	103.07	1.64	-2	2	T 4.000% Feb-14	2.53	3	-1	-14	-33	19
TIPS 2.000% 15-Jul-14	102.78	102.85	1.68	-2	2	T 4.750% May-14	2.50	3	-1	-14	-33	19
TIPS 2.375% 15-Jan-25	106.42	106.50	1.98	-1	3	T 7.625% Feb-25	2.72	1	-3		-27	
TIPS 3.625% 15-Apr-28	130.41	131.44	1.98	-1	4	T 5.500% Aug-28	2.76	0	-4		-27	
TIPS 3.875% 15-Apr-29	136.47	137.58	1.97	-1	4	T 6.125% Aug-29	2.76	0	-4		-29	
TIPS 3.375% 15-Apr-32	131.45	132.42	1.89	-1	4	T 5.375% Feb-31	2.77	0	-5		-37	

Dig further into bonds for betas, etc.

Indicative asset swap levels

Forward Yields & Breakeven Carry vs Funding

Inflation Bond	Yield (%) Current	Yield (%) 1M	Yield (%) 3M	Yield (%) 6M	Carry (bp) 1M	Carry (bp) 3M	Carry (bp) 6M	Breakeven (%) Current	Breakeven (%) 1M	Breakeven (%) 3M	Breakeven (%) 6M	BE Carry (bp) 1M	BE Carry (bp) 3M	BE Carry (bp) 6M
US CPI														
TIPS 3.375% 15-Jan-07	0.73	0.46	0.71	0.96	-28	-2	23	2.54	2.85	2.63	2.39	31	9	-14
TIPS 3.625% 15-Jan-08	0.89	0.71	0.89	1.06	-18	0	17	2.54	2.74	2.60	2.45	21	6	-8
TIPS 3.875% 15-Jan-09	1.04	0.90	1.05	1.18	-13	1	15	2.56	2.71	2.60	2.50	16	4	-6
TIPS 4.250% 15-Jan-10	1.14	1.04	1.16	1.28	-11	2	13	2.59	2.72	2.63	2.55	13	4	-4
TIPS 3.500% 15-Jan-11	1.28	1.20	1.30	1.40	-9	2	12	2.58	2.69	2.62	2.55	11	3	-3
TIPS 3.375% 15-Jan-12	1.42	1.34	1.44	1.53	-7	2	11	2.56	2.66	2.59	2.54	9	3	-3
TIPS 3.000% 15-Jul-12	1.46	1.40	1.49	1.57	-7	2	11	2.55	2.64	2.58	2.52	9	3	-3
TIPS 1.875% 15-Jul-13	1.59	1.53	1.61	1.69	-6	2	10	2.54	2.62	2.57	2.53	7	2	-2
TIPS 2.000% 15-Jan-14	1.64	1.59	1.66	1.74	-5	2	10	2.53	2.60	2.55	2.51	7	2	-2
TIPS 2.000% 15-Jul-14	1.68	1.63	1.70	1.78	-5	2	10	2.50	2.57	2.53	2.49	7	3	-1
TIPS 2.375% 15-Jan-25	1.98	1.96	2.00	2.04	-3	2	6	2.72	2.76	2.74	2.73	4	2	1
TIPS 3.625% 15-Apr-28	1.98	1.96	2.00	2.04	-2	2	6	2.76	2.80	2.78	2.77	4	2	1
TIPS 3.875% 15-Apr-29	1.97	1.95	1.99	2.03	-2	2	5	2.76	2.80	2.78	2.77	4	2	1

Carry analysis on real yield & breakven inflation

LehmanLive Inflation Products Page

Lehman Brothers and inflation

Overview Trade Tracker Live Swaps EUR USD GBP Trader Commentary **Calculator**



Inflation Bond Calculator: TIPS 4.250% 15-Jan-10 TIPS 4.250% 15-Jan-10

Pricing

Trade Date	28-Sep-2004	Settle Date	29-Sep-2004
Closing Price	130.713	Index Ratio	1.12586

Trade Analysis ► Cashflows

		Quantity	Price	Accrued	Dirty Price	Inv Amt
Buy	TII 4 1/4 01/15/10	100MM	130.71	0.88	148.152	148,152,224
Sell	T 6 1/2 02/15/10	135,804,560	115.303	0.79	116.098	157,666,158
	Hedge ratio	1.3580			Net	9,513,934

Yield & Sensitivites

	Mod Dur	Convexity	PV01	Yield	B/E Inf.
TII 4 1/4 01/15/10	4.871	0.276	6.410	-1.330	4.695
T 6 1/2 02/15/10	4.577	0.252	5.314	3.364	

Forward Calculations & Carry ► Inflation Forecasts

Term	Real Yield	Breakeven	Yield Carry	B/E Carry	Repo (Inf)	Repo (Nom)
1M	-1.377	4.768	-4.7	7.3	1.840	1.840
3M	-1.386	4.827	-5.6	13.2	1.970	1.970
6M	-1.551	5.050	-22.1	35.6	2.170	2.170

Option-adjusted analytics

calculate
correct
hedge ratio

analyse effects of
your own inflation
forecasts over
whichever term

POINT - Lehman's Portfolio & Index Analysis Tool

Lehman Brothers and inflation

POINT portfolio analytics platform for the global fixed income

Global Risk Model

- ◆ Provides risk analysis in isolation or relative to a benchmark regardless of index provider
- ◆ Intuitive and relevant risk factors across global cash and derivative markets
- ◆ Currency, yield curve, swap curve, volatility, credit spread and idiosyncratic risk factors
- ◆ Applications for portfolio optimisation, risk budgeting and market risk monitoring

Performance Attribution

- ◆ Model attempts to explain the investment decisions which contributed to outperformance
- ◆ Attribution across FX, yield curve, volatility and credit factors
- ◆ Accounts for full effects of intra-period transactions

Scenario Analysis

- ◆ Stress testing of portfolios under a customisable range of instantaneous or horizon scenarios

Index/Portfolio Analysis

- ◆ Advanced reporting to analyse index and portfolio structure
- ◆ Customised index creation
- ◆ Portfolio market exposure reports to highlight issue specific swap and treasury curve sensitivities

POINT- Viewing Portfolios and Indices

Lehman Brothers and inflation

Portfolio constituents view

- ◆ Customisable views of Portfolio/Index constituents
- ◆ Extensive menu of descriptive fields
- ◆ Inflation specific analytics and measures
- ◆ Market structure reports easy to design according to user choice of attributes e.g Empirical OAD

CPI Type /											
Identifier	Position Amount	Description	Coupon	Maturity Date	Price	Yield to Worst	Real Yield to Worst	OAS	OAD	Empirical OAD	CPI Type /
+ CPI Type: Canadian (4 positions)											
- CPI Type: EuroZone (9 positions)											
IT0003745541	7,054,025	ITALY (REPUBLIC OF) I/L	2.350	9/15/2035	109.450	3.644	1.938	-208.3	22.34	19.645	EuroZone
FR0000188799	8,713,645	FRANCE (REPUBLIC OF) ...	3.150	7/25/2032	130.570	3.433	1.727	-231.1	19.70	17.365	EuroZone
GR03380015...	4,360,670	GREECE (REPUBLIC OF) ...	2.900	7/25/2025	116.800	3.626	1.886	-207.4	15.91	14.057	EuroZone
FR0010050559	8,277,578	FRANCE (REPUBLIC OF) ...	2.250	7/25/2020	108.800	3.301	1.591	-221.8	13.14	10.455	EuroZone
FR0010135525	6,853,947	FRANCE (REPUBLIC OF) ...	1.600	7/25/2015	102.040	3.094	1.381	-213.1	9.51	6.681	EuroZone
IT0003625909	16,031,875	ITALY (REPUBLIC OF) I/L	2.150	9/15/2014	106.320	3.149	1.432	-198.9	8.62	5.924	EuroZone
FR0000188013	18,589,280	FRANCE (REPUBLIC OF) ...	3.000	7/25/2012	113.470	2.789	1.069	-207.9	6.57	4.269	EuroZone
IT0003805998	6,412,750	ITALY (REPUBLIC OF) I/L	0.950	9/15/2010	100.210	2.635	0.910	-196.7	5.28	3.270	EuroZone
IT0003532915	17,186,170	ITALY (REPUBLIC OF) I/L	1.650	9/15/2008	103.930	2.240	0.497	-192.9	3.33	2.093	EuroZone
- CPI Type: French (4 positions)											
FR0000186413	7,119,620	FRANCE (REPUBLIC OF) ...	3.400	7/25/2029	132.430	3.376	1.742	-227.6	17.83	13.561	French
FR0000188955	17,016,873	FRANCE (REPUBLIC OF) ...	2.500	7/25/2013	110.070	2.877	1.214	-206.6	7.51	5.733	French
FR0010094375	7,924,876	FRANCE (REPUBLIC OF) ...	1.600	7/25/2011	103.870	2.637	0.962	-204.8	5.96	4.566	French
FR0000571424	17,703,053	FRANCE (REPUBLIC OF) ...	3.000	7/25/2009	109.900	2.367	0.658	-195.2	4.00	3.102	French
+ CPI Type: Swedish (5 positions)											
- CPI Type: UK (9 positions)											
GB0031790826	11,560,218	UNITED KINGDOM I/L	2.000	1/26/2035	117.390	4.609	1.607	-283.4	21.70	14.037	UK
GB0008932666	7,340,504	UNITED KINGDOM I/L	4.125	7/22/2030	208.610	4.650	1.648	-282.6	16.82	10.851	UK
GB0008983024	10,766,447	UNITED KINGDOM I/L	2.500	7/17/2024	215.040	4.736	1.732	-276.7	14.94	9.598	UK
GB0009081828	10,423,853	UNITED KINGDOM I/L	2.500	4/16/2020	245.260	4.817	1.812	-268.2	11.92	7.465	UK
GB0009075325	12,739,641	UNITED KINGDOM I/L	2.500	7/26/2016	244.200	4.829	1.824	-262.5	9.55	5.816	UK
GB0009036715	11,975,824	UNITED KINGDOM I/L	2.500	8/16/2013	219.740	4.854	1.849	-254.4	7.32	4.319	UK
GB0009063578	8,128,658	UNITED KINGDOM I/L	2.500	8/23/2011	259.920	4.858	1.852	-245.3	5.72	3.272	UK
GB0009071563	5,799,766	UNITED KINGDOM I/L	2.500	5/20/2009	243.580	4.793	1.789	-233.5	3.77	2.032	UK
GB0009061317	3,813,468	UNITED KINGDOM I/L	2.000	7/19/2006	270.270	4.499	1.499	-164.3	1.23	0.442	UK
+ CPI Type: US (16 positions)											
912810FQ	4,771,647	US TREASURY BONDS I/L	3.375	4/15/2032	133.320	4.806	1.811	-287.5	18.23	13.659	US
912810FH	16,830,600	US TREASURY BONDS I/L	3.875	4/15/2029	138.121	4.890	1.893	-286.9	16.39	12.318	US
912810FD	14,246,371	US TREASURY BONDS I/L	3.625	4/15/2028	132.027	4.900	1.901	-288.2	16.13	12.135	US
912810FR	18,886,408	US TREASURY BONDS I/L	2.375	1/15/2025	107.949	4.890	1.891	-294.0	15.98	12.004	US
912828DH	10,000,000	US TREASURY NOTES I/L	1.625	1/15/2015	98.734	4.777	1.766	-263.4	8.98	5.562	US
912828CP	19,001,956	US TREASURY NOTES I/L	2.000	7/15/2014	102.332	4.739	1.727	-261.5	8.41	5.146	US
912828BW	20,461,190	US TREASURY NOTES I/L	2.000	1/15/2014	102.547	4.699	1.687	-260.4	7.99	4.830	US
912828BD	19,715,748	US TREASURY NOTES I/L	1.875	7/15/2013	101.965	4.634	1.620	-261.7	7.60	4.534	US
912828AF	20,975,734	US TREASURY NOTES I/L	3.000	7/15/2012	110.281	4.523	1.503	-260.4	6.50	3.776	US

Inflation Risk in the Global Risk Model

Lehman Brothers and inflation

TEV= Tracking Error Volatility

TEV due to exposure to inflation-linked factors

Tracking Error, 12/17/2004

Portfolio : Inflation Linked UK

Benchmark : Global Treasury United Kingdom

Global Risk Factor	Isolated TEV (bps)	Cumulative TEV (bps)	Difference in cumulative (bps)	Percentage of tracking error variance (%)	Systematic beta
Global:					
Yield Curve	43.14	43.14	43.14	-6.8	1.29
Inflation	121.21	106.04	62.89	103.24	
Volatility	0.04	106.03	-0.0	-0.0	0.0
Systematic risk	106.03	106.03	0.0	96.44	0.81
Idiosyncratic risk	20.36	107.97	1.94	3.56	
Credit default risk	0.0	107.97	0.0	0.0	
Total risk		107.97	0.0	100.0	
Portfolio volatility (bps/month)					152.37
Benchmark volatility (bps/month)					136.55

Tracking Error Report

Overall TEV estimate

KEY RATES AND CONVENTION:	Portfolio	Benchmark	Net	Factor	TE impact of an isolated 1 std.	TE impact of a correlated 1 std.	Marginal	Percentage of
GBP 6M key rate KRD (Yr)	0.0090	0.015	-0.0060	15.31	0.1	31.43	-4.457	0.03
GBP 2Y key rate KRD (Yr)	0.023	0.488	-0.465	24.98	11.61	32.02	-7.41	3.19
GBP 5Y key rate KRD (Yr)	0.72	1.038	-0.318	22.98	7.3	26.06	-5.541	1.63
GBP 10Y key rate KRD (Yr)	3.042	1.993	1.049	19.35	-20.39	25.39	-4.549	-4.42
GBP 20Y key rate KRD (Yr)	5.644	1.957	1.686	16.07	-30.31	22.48	-3.345	-5.85
GBP 30Y key rate KRD (Yr)	2.961	2.481	0.48	15.27	-7.34	24.71	-3.071	-1.37
GBP Convexity OAC (Yr ² /100)	1.611	1.202	0.41	1.93	0.79	-2.27	-0.04	-0.03
INFLATION:								
UK Realized Inflation MWH	100.0	0.0	100.0	0.29	29.46	19.08	0.052	4.92
UK Expanded Inflation Short OASD (Yr)	3.538	0.0	3.538	14.36	50.82	88.59	11.782	28.62
UK Expanded Inflation Long OASD (Yr)	7.527	0.0	7.527	10.5	79.01	88.24	9.579	59.8

Risk Exposures to £ 5yr Breakeven Inflation Rate

Historical volatility of £ 5yr Breakeven Inflation Rate (bp/m)

'scenario' return for correlated 1 standard deviation movement in £ 5yr Breakeven Inflation Rate (bp)

Factor Exposures Report

Inflation Risk Report

Empirical duration estimates incorporating correlation of nominal and real yields

Principal component	Nominal portfolio exposure	Nominal benchmark exposure	Nominal net exposure	Empirical portfolio exposure	Empirical benchmark exposure	Empirical net exposure
EUR Parallel Shift	2.28	2.38	-0.1	1.66	2.38	-0.72
EUR Twist	0.27	0.2	0.07	0.03	0.2	-0.16
EUR Butterfly	-0.09	-0.14	0.05	-0.15	-0.14	-0.01
GBP Parallel Shift	2.78	0.37	2.41	1.81	0.37	1.44
GBP Twist	0.39	0.03	0.36	0.06	0.03	0.03
GBP Butterfly	0.2	0.01	0.19	-0.95	0.01	-0.96

Lehman Brothers' Inflation-Linked Indices

Lehman Brothers and inflation

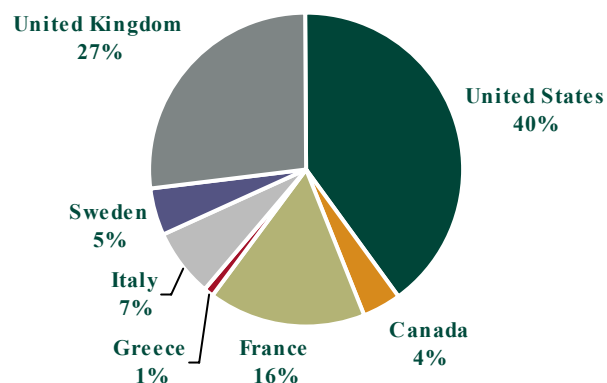
Inflation Index Overview

- The Global Inflation-linked Index was launched on October 1st, 1997.
- The Global Inflation Linked Index is composed only by inflation-linked bonds, issued by an investment-grade Sovereign state in its local currency.
- The index is linked to local market CPI for the currency of issue, but for €zone, both €zone HICP ex-Tobacco and domestic CPI.
- Inclusion of new currencies is reviewed annually.
- The Global Inflation-linked represents a standalone multi-currency index exposed to the real yield-curve for each of the relevant currencies. As such, it does not contribute to nominal multi-currency indices such as the Global Aggregate.

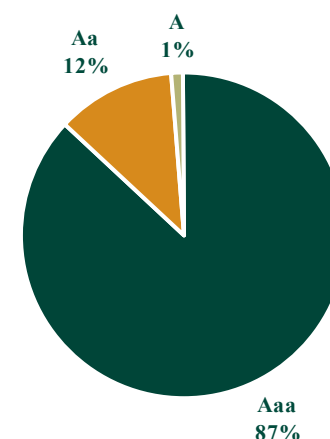
Inflation Index Rebalancing Rules

- In order to qualify for inclusion in the index, the securities must have an outstanding equivalent amount of US\$250 mm for US and Canadian issues, €300 mm for European issues, £200 for UK issues.
- The securities also need to have a minimum bond level rating of Baa3 or BBB-
- All indicative changes to securities are reflected in both the statistics universe and returns universe of the index on a daily basis. This includes changes to ratings, amounts outstanding, or sector.
- Changes affect the qualification of securities in the statistics universe on a daily basis, but only affect the qualification of bonds for the returns universe at the end of the month.

Inflation Index Breakdown by Country



Inflation Index Breakdown by Credit Quality



Appendices

What is behind inflation?

Summary

A macroeconomic perspective on inflation drivers

- ◆ In this section we give a brief overview of the economic framework usually applied in modelling inflation, providing a hint of some relevant estimated inflation elasticities from our own macroeconomic model for the euro area
- ◆ A schematic summary of the main drivers of current euro-area inflation is also provided. Domestically these include labour costs and profit margins. Drivers of imported inflation are foreign prices and exchange rates
- ◆ Our central scenario is for inflation to fall in the euro area but we see risks to these forecasts, mainly from fresh food and administered prices

A Macroeconomic Perspective

What is behind inflation?

Inflation dynamics can be thought as the combination of two different effects

Domestically Generated Inflation

- ◆ Price increases building throughout the domestic production process. These can be generally imputed to:

Unit Labour Costs

- ◆ They are the most relevant measure of labour cost dynamics for firms, that is compensation per employee growth relative to productivity growth

Profit Margins

- ◆ Depending on
 - Cost of financing
 - [Firms'] pricing power to charge a return in excess of their cost of capital. Such ability is strictly related to the amount of spare capacity in the economy, ie to the output gap

Imported Inflation

Foreign Prices

- ◆ International prices are generally driven by commodity prices. The impact of commodity prices shocks depend on one country' relative dependence on imported commodities as a share of national income
- ◆ Among the commodities, oil price is the most relevant for consumer inflation as it has an immediate and direct impact on petrol and heating prices. In the euro are they account for about 8% of consumer inflation basket

Exchange Rate

- ◆ Exchange rate appreciation implies lower prices paid for imported goods and services (direct impact)
- ◆ Reduced imported inflation also tends to put downward competitive pressures on domestic prices (indirect effect)

Some Simulations

What is behind inflation?

Shocks simulations: impact on headline inflation

Shocks (vs Baseline Scenario)	Impact on Inflation	
	After 1 Year	After 2 Year
Unit labour cost (+/- 1% in ULC growth)	+/- 0.05%	+/- 0.1%
Brent price (+/- \$10/bn)	+/- 0.2%-0.3%	+/- 0.2%-0.3%
Effective exchange rate (+/- 10%)	+/- 0.8%	+/- 0.8%

Current Euro-Area Inflation Drivers

What is behind inflation?

Domestic Inflation

- ◆ Labour cost growth is still on a marked long-run downward trend, notwithstanding recent acceleration in productivity and stubborn past inflation should have induced some pass through into wages
- ◆ Given our forecast on euro-area to remain subdued and output gap to widen further, [firm's] pricing power is expected to remain well contained

Exchange Rate

- ◆ Since mid-2002 euro trade-weighted exchange rate appreciated by around 20% and we expect it to strengthen further in the months ahead
- ◆ Given the necessary time lag (at least 2 years) for the exchange rate movements to pass through into prices, this will continue to put downward pressures on inflation well into 2006

Commodity Prices

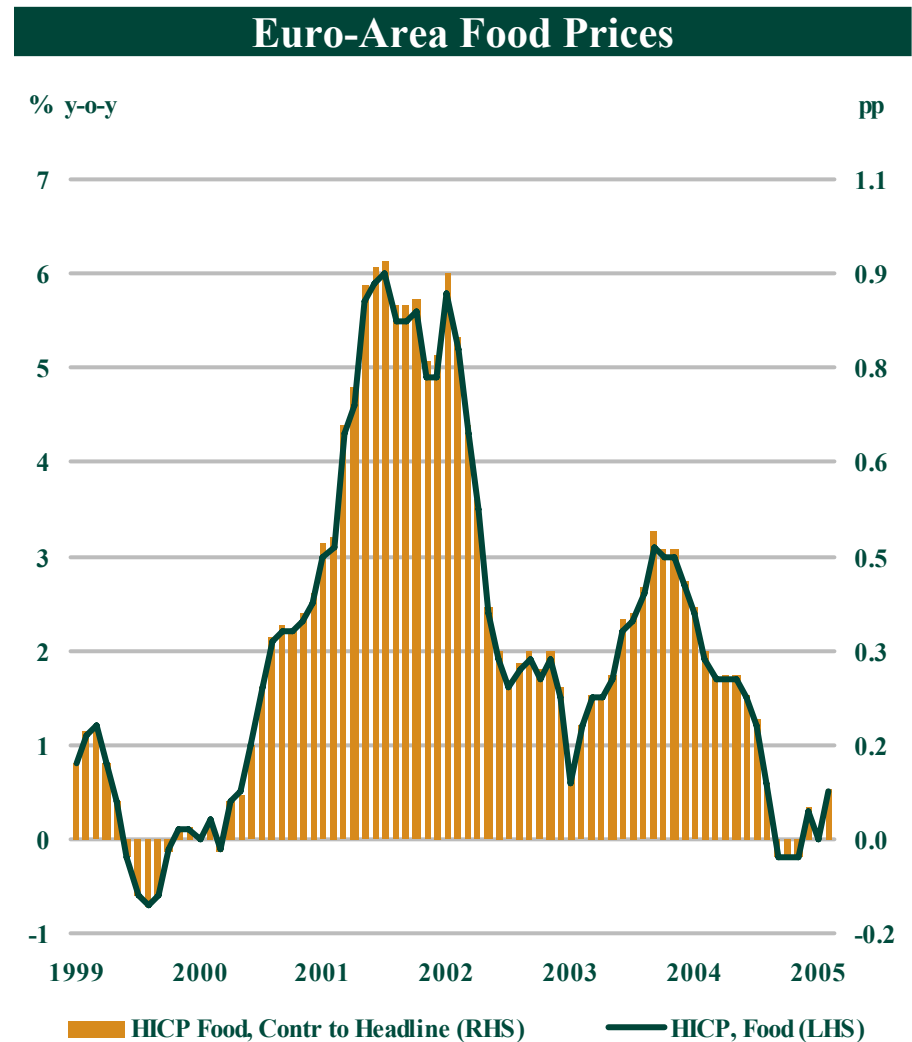
- ◆ In 2004 the increase in oil prices added around 0.4pp to the headline index. [Though] we expect oil price to slow in 2005 from the recent peak, risks of new spikes in the oil market remain very significant

Potential Upside Risks

What is behind inflation?

Fresh food prices shocks

- ◆ Over the past three years, shocks to fresh food prices strongly boosted inflation figures. The recent downward trend significantly contributed to containing headline inflation
- ◆ Given the relatively high weight in the consumer price basket (around 15%) for the euro area, renewed pressures in food prices may represent a significant risk to price stability

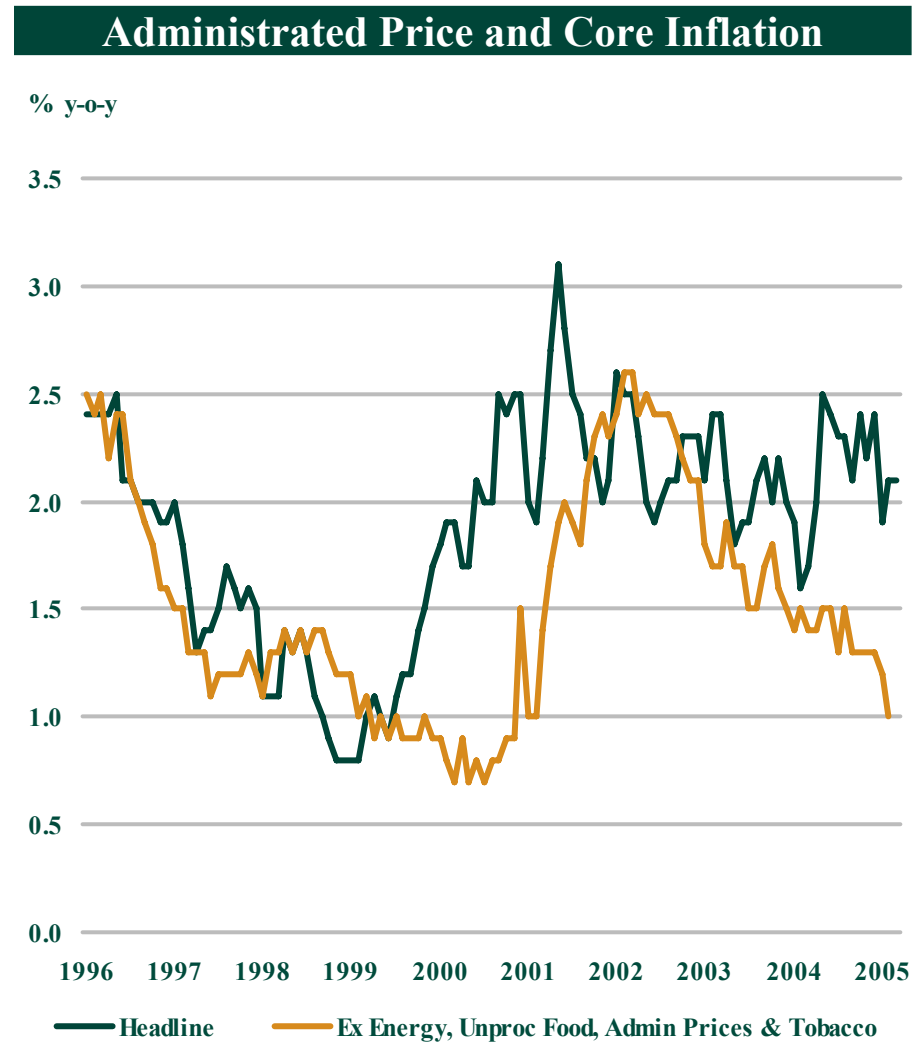


Potential Upside Risks

What is behind inflation?

Administrated prices

- ◆ Constantly deteriorating public finances in the euro area create strong incentives for governments to raise indirect taxes and administrated prices
- ◆ In 2004 increases in administered prices and tobacco taxes, added 0.3pp on average to the headline index
- ◆ Public finance situation is not going to improve any time soon and the risks of further increases in administered price are always relevant
- ◆ However, from the actual budget drafts we can infer that in 2005 the contribution from administrative measures should reduce to 0.2pp (as January and February figures have already shown)

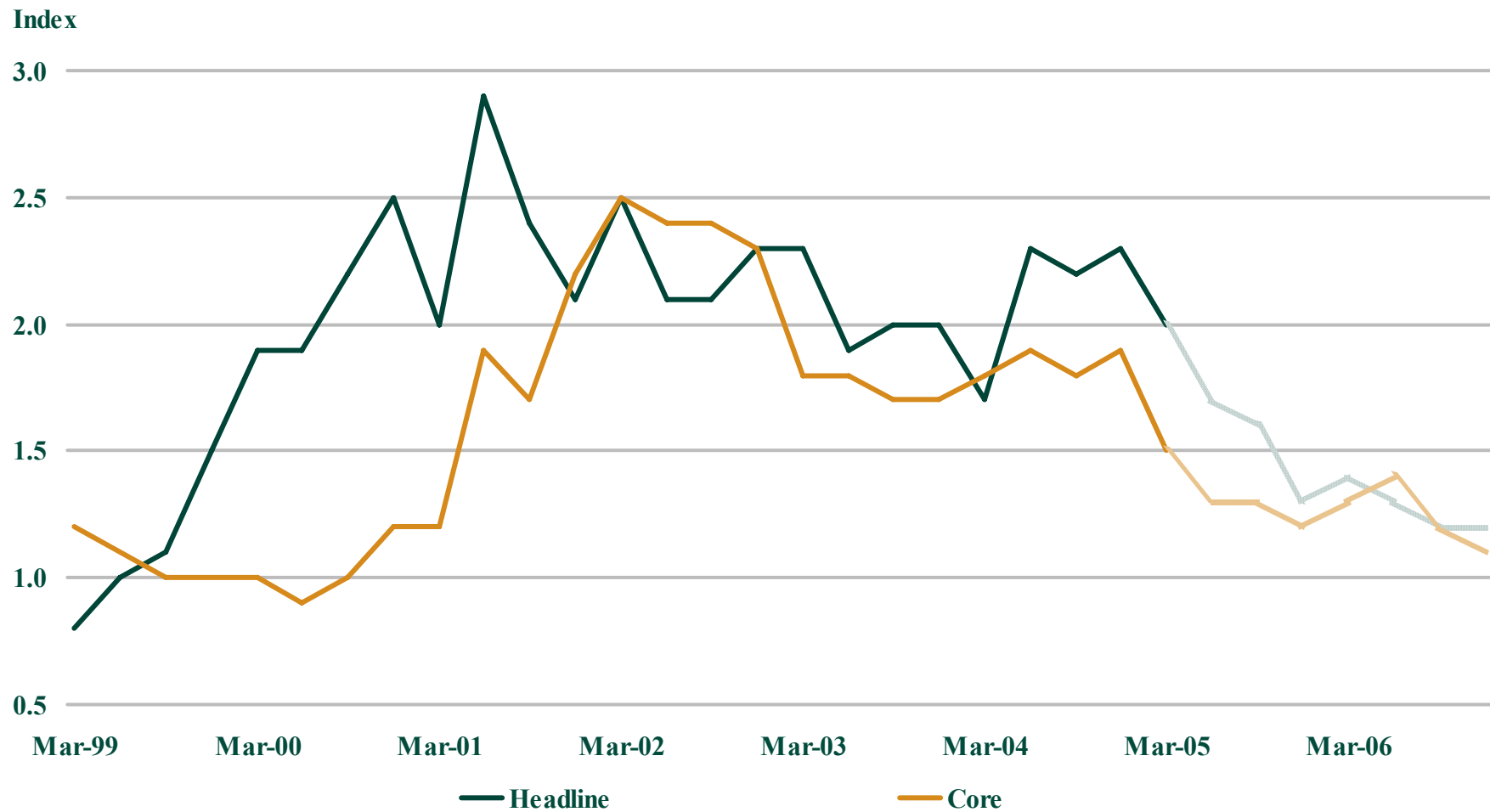


Euro-Area Inflation Heading Significantly Below 2%

What is behind inflation?

Inflation expected to average at 1.7% in 2005 and at 1.3% in 2006

Headline and Core Inflation Forecasts



The need for inflation derivatives

Inflation Derivatives Fill The Gap

The need for inflation derivatives

◆ Flexibility

- Tailor-made cash flows
 - Choose maturity, fixing months
 - Define pay-out format
 - Add floors, caps, etc.
 - Easy to incorporate into other financial structures
- Choice of index
 - HICP, HICPxT, French CPI, Italian FOI, Spanish HICP, etc.

◆ Liquidity

- tight bid-offer for liquid maturities (2, 5, 7, 10)

◆ No use of balance sheet

◆ Useful also for central bankers, forecasters, etc.

- “cleaner” way of estimating inflation expectations

◆ Hybrid structures

- Equity linked, Credit Linked, ...

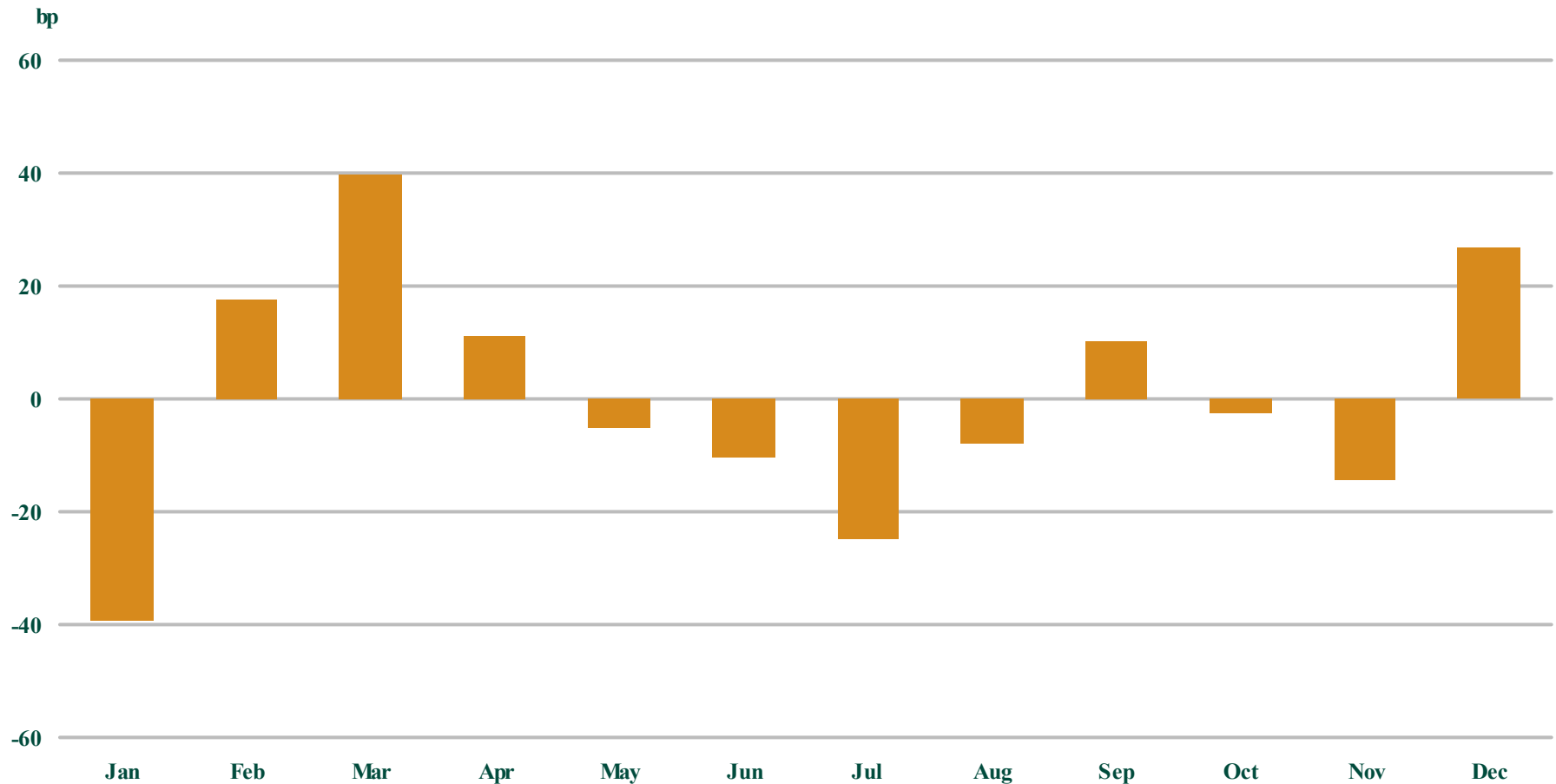
Seasonality in the major indices

Seasonality in European Inflation

Seasonality in the major indices

Difference between non-seasonally adjusted and seasonally adjusted m-o-m changes

HICPxT Seasonal Dummies

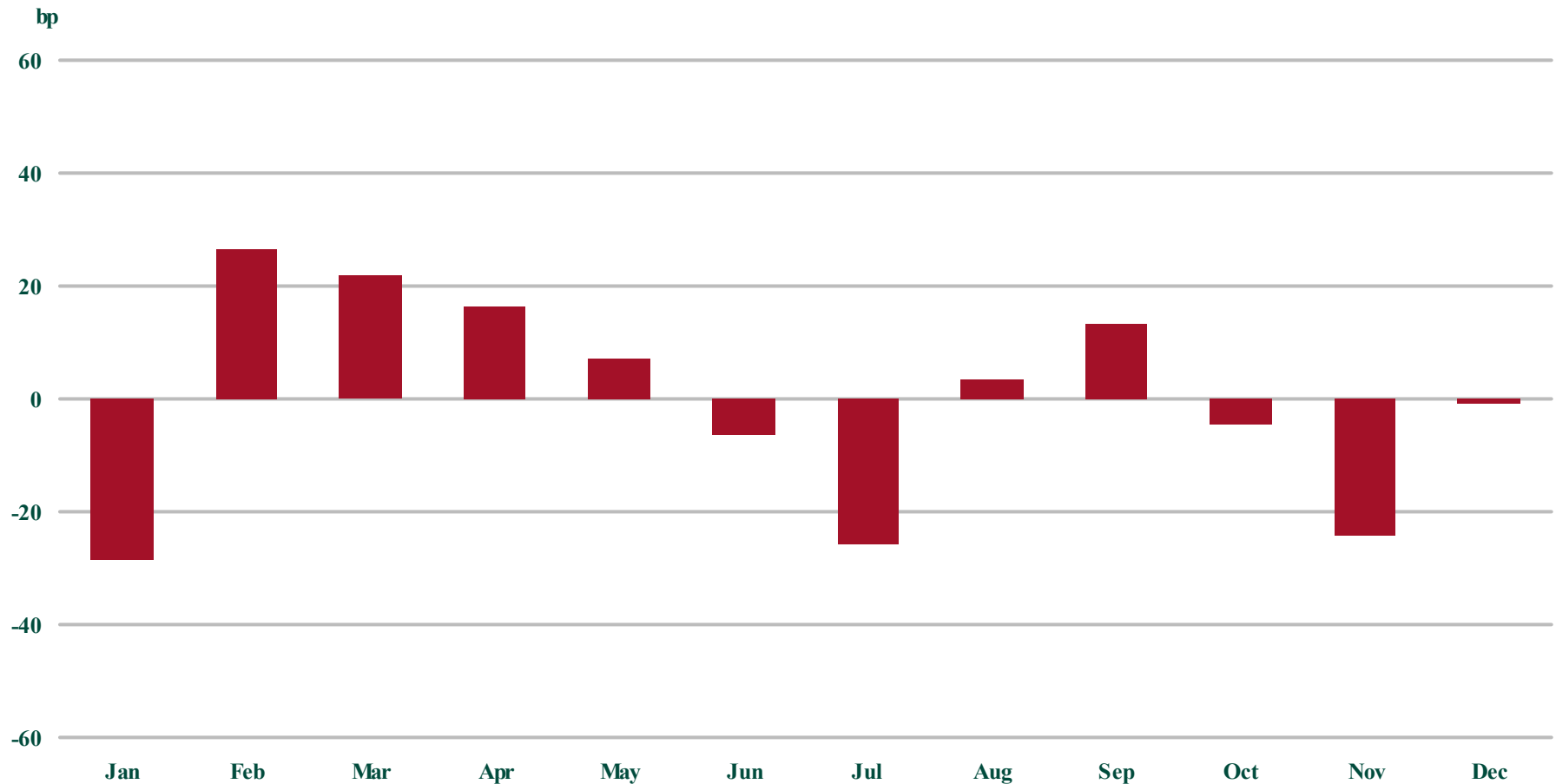


Seasonality in French Inflation

Seasonality in the major indices

Difference between non-seasonally adjusted and seasonally adjusted m-o-m changes

FR CPIxT Seasonal Dummies

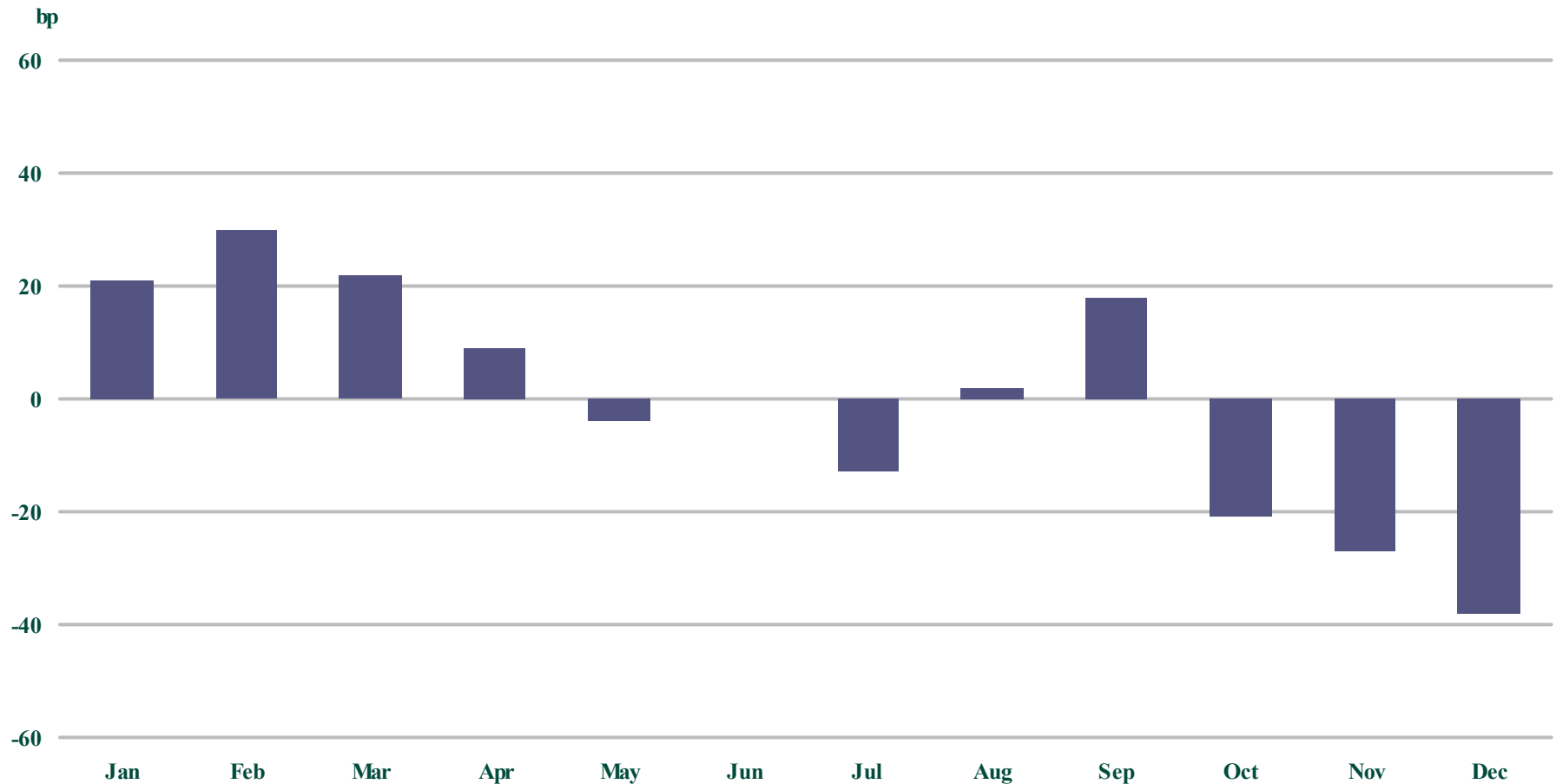


Seasonality in US Inflation

Seasonality in the major indices

Difference between non-seasonally adjusted and seasonally adjusted m-o-m changes

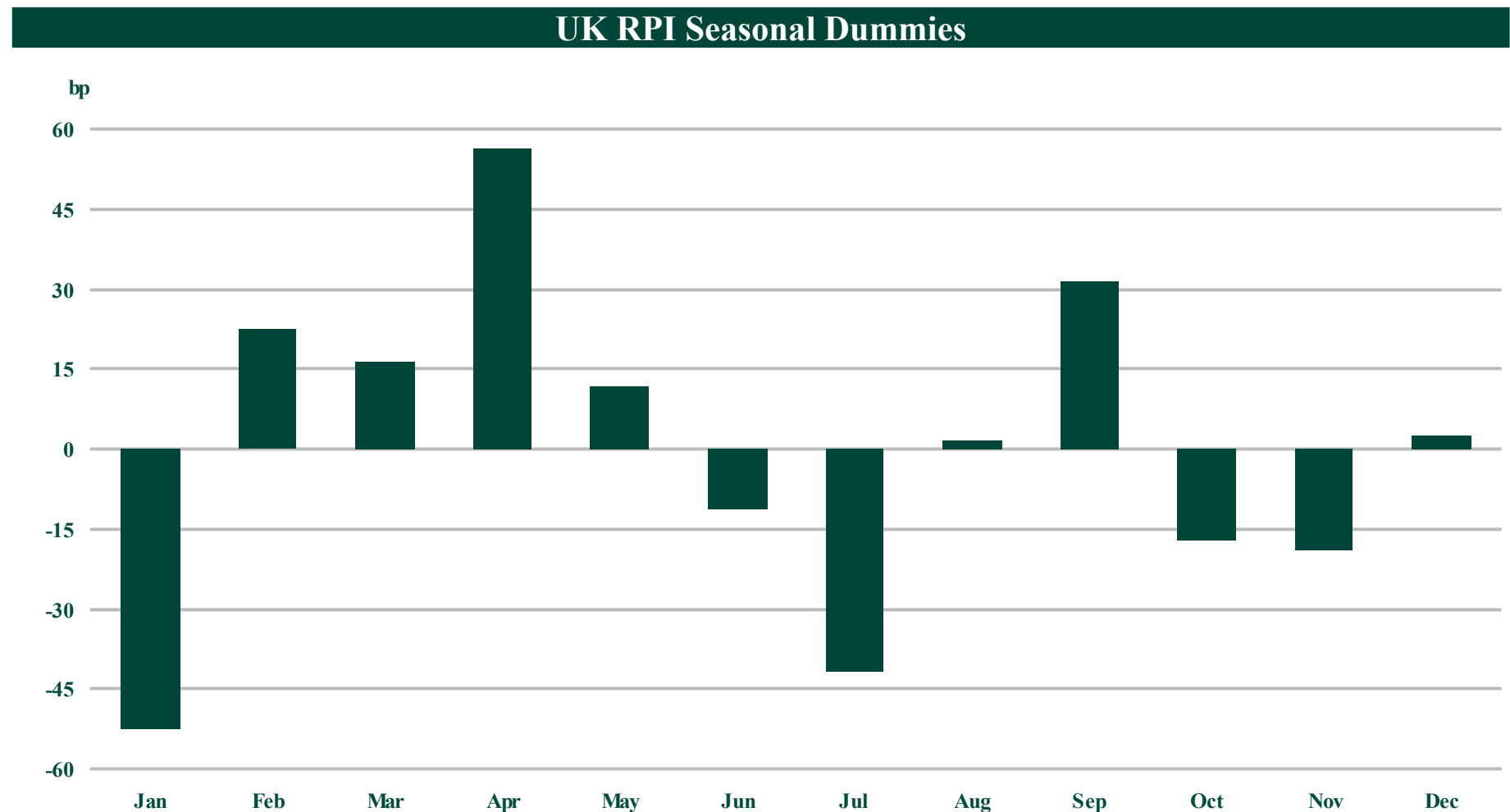
US CPI Seasonal Dummies



Seasonality in UK Inflation

Seasonality in the major indices

Difference between non-seasonally adjusted and seasonally adjusted m-o-m changes



Syndications of BTPei

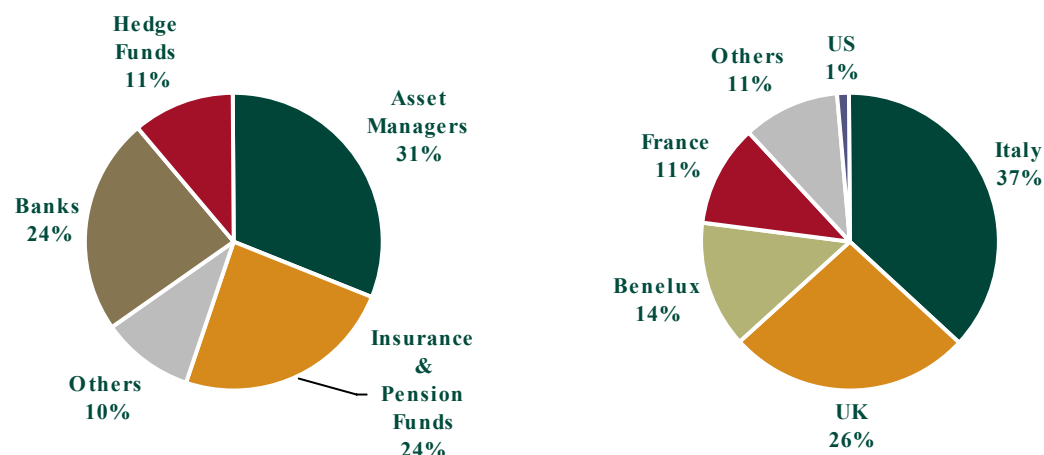
2.35% Sep-2035 BTPei

Syndications of BTPei

Transaction Details

- ◆ Issue date: 27-Oct-2004
- ◆ Initial announced issue size of €3 billion
- ◆ High demand as orderbook reached €7.6 billion from 111 accounts
- ◆ Issue size is upped to €4 billion
- ◆ Re-offer price of €99.684 equivalent to 2.378% gross real yield

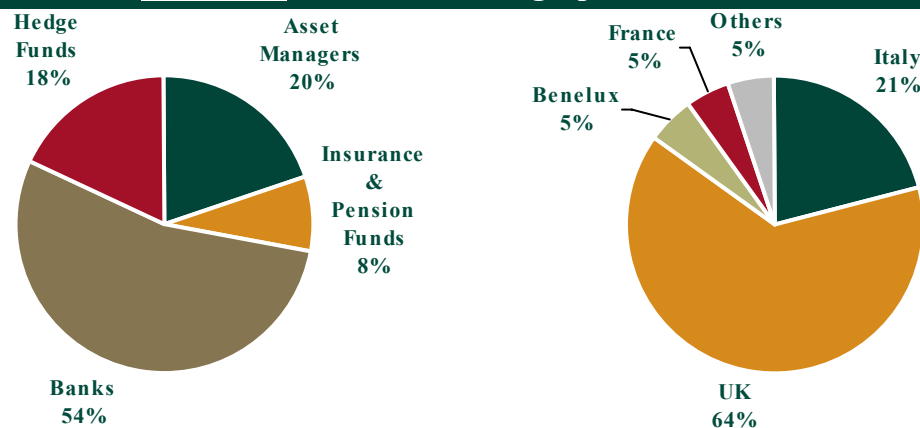
New Issue Investor and Geographic Distribution



Transaction Details

- ◆ Re-opening date: 10-Mar-2005
- ◆ Amount issued was €1.5 billion
- ◆ Re-offer price of €104.53 equivalent of 2.158% gross real yield

Reopening Investor and Geographic Distribution



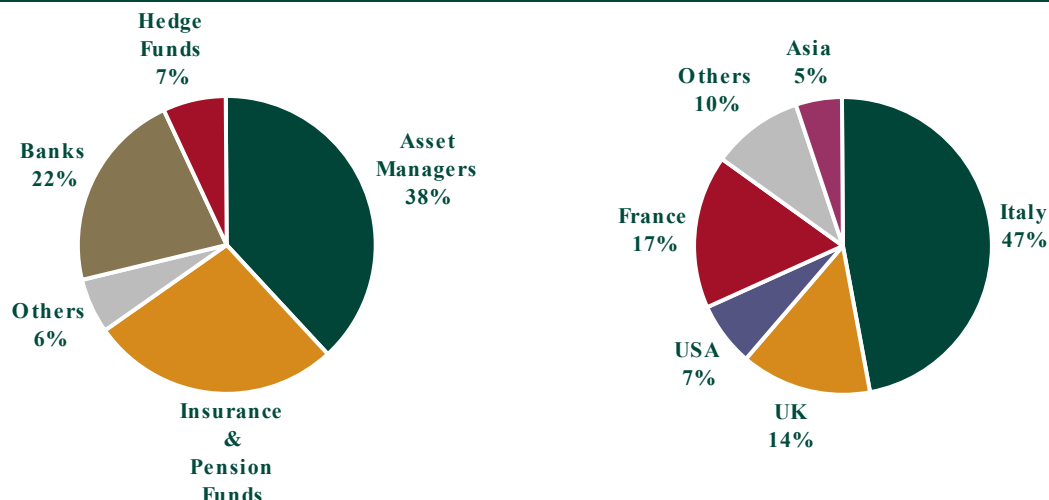
2.15% Sep-2014 BTPei

Syndications of BTPei

Transaction Details

- ◆ Issue date: 18-Feb-2004
- ◆ Issue size of € billion
- ◆ High demand as orderbook reached €1.5 billion from 170 accounts
- ◆ Re-offer price of €9.051 equivalent to 2.264% gross real yield

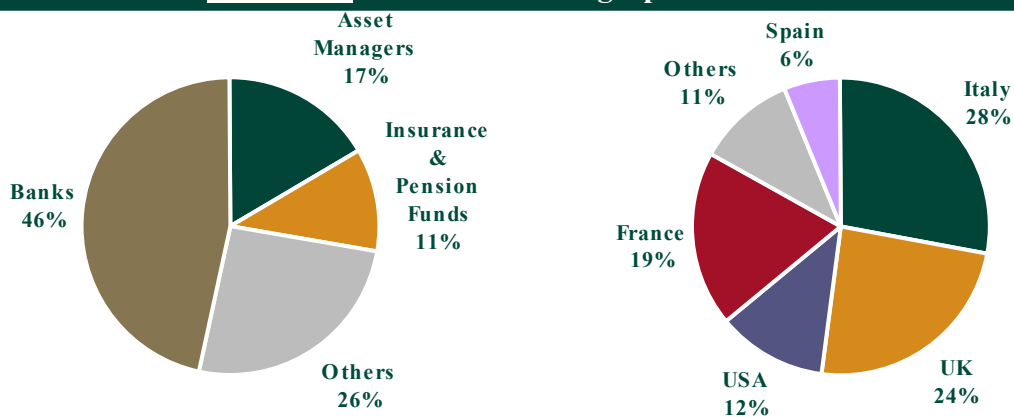
New Issue Investor and Geographic Distribution



Transaction Details

- ◆ Re-opening date: 16-Apr-2004
- ◆ Amount issued was €3.5 billion
- ◆ Initial size of €3 billion, upped to €3.5 billion
- ◆ Orderbook reached €6 billion from 90 accounts
- ◆ Re-offer price of €9.51 equivalent of 2.215% gross real yield

Reopening Investor and Geographic Distribution



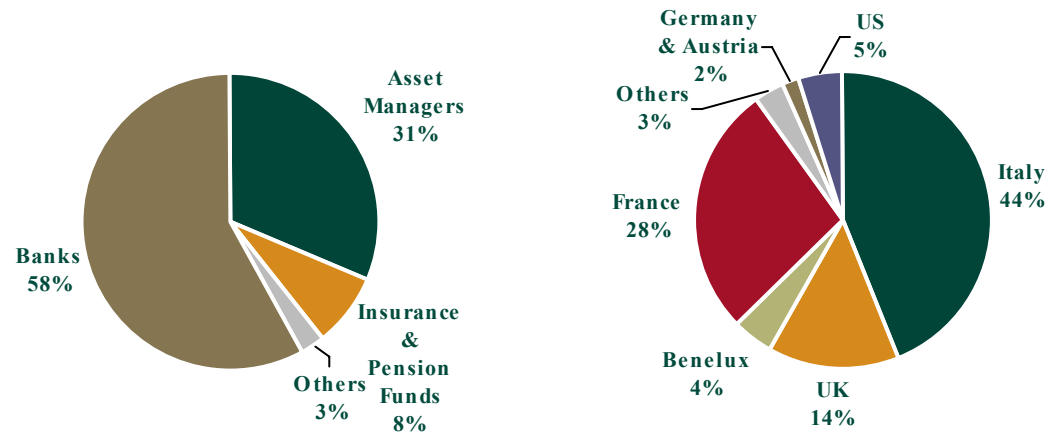
0.95% Sep-2010 BTPei

Syndications of BTPei

Transaction Details

- ◆ Issue date: 31-Jan-2005
- ◆ Initial announced issue size of €3 billion
- ◆ High demand as orderbook reached €9.1 billion from 167 accounts
- ◆ Issue size is upped to €5 billion
- ◆ Re-offer price of €99.903 equivalent to 0.97% gross real yield

New Issue Investor and Geographic Distribution



1.65% Sep-2008 BTPei

Syndications of BTPei

Transaction Details

- ◆ Issue date: 17-Sep-2003
- ◆ Issue size of €7 billion
- ◆ High demand as orderbook reached €1 billion from 220 accounts
- ◆ Re-offer price of €99.79 equivalent to 1.694% gross real yield

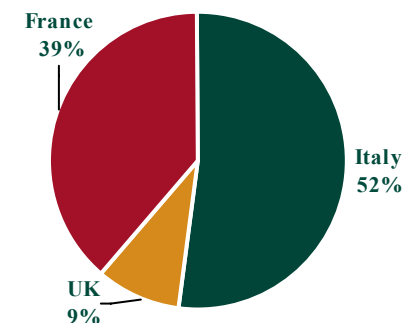
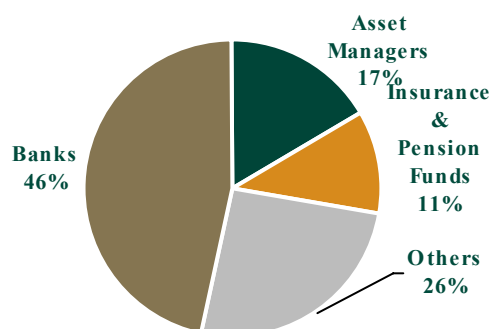
Transaction Details

- ◆ Re-opening date: 21-Oct-2003
- ◆ Amount issued was €3.15 billion
- ◆ Orderbook reached €5 billion
- ◆ Re-offer price of €99.938 equivalent of 1.670% gross real yield

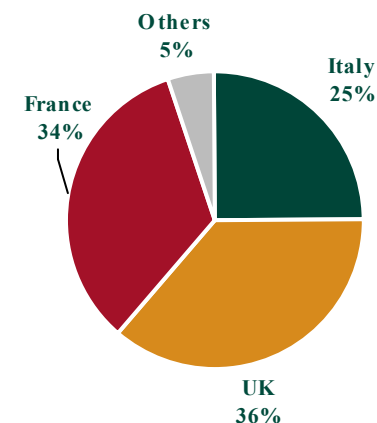
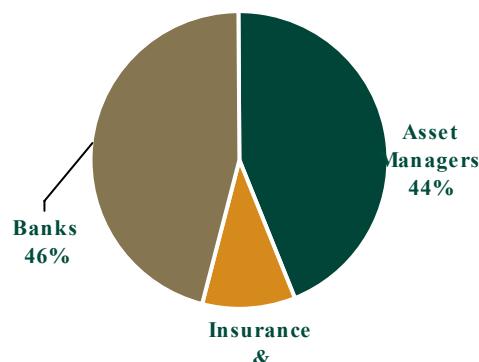
Transaction Details

- ◆ Re-opening date: 26-Mar-2004
- ◆ Amount issued was €3.25 billion
- ◆ Orderbook reached €4.5 billion
- ◆ Re-offer price of €102.522 equivalent of 1.071% gross real yield

New Issue and Reopening Investor and Geographic Distribution



Reopening Investor and Geographic Distribution



Lehman Brothers' presence in the inflation market

Inflation Transactions Placed by Lehman Brothers

Lehman Brothers' presence in the inflation market

Issuer	Maturity	Notional	Structure
LEHMAN BROTHERS	28 February 2010	Indexed to Italian Inflation €80m	Year 1: 5% Then: 2% + Italian Inflation With Minimum of 2%
LEHMAN BROTHERS	14 March 2011	Indexed to Italian Inflation €65m	Year 1: 6% Then: 1,5% + Italian Inflation With Minimum of 2%
LEHMAN BROTHERS	10 October 2013	Indexed to Italian Inflation €300m	Year 1: 7%; Year 2: 5% Then 1.5% + Italian Inflation With Minimum of 2%
 European Investment Bank	01 October 2010	Indexed to European Inflation €75m	Year 1: 5% Then: 1.25%+ European Inflation With Minimum of 1.25%
 kfw BANKENGRUPPE	24 November 2015	Indexed to Italian Inflation €100m	Year 1: 6%; Year 2: 4% Then: 1.25%+ Italian Inflation With Minimum of 2%
LEHMAN BROTHERS	26 November 2013	Indexed to European Inflation €50m	Year 1: 7%; Year 2: 5% Then: 1.75%+ European Inflation With Minimum of 2%
LEHMAN BROTHERS	14 January 2014	Indexed to Italian Inflation €140m	Year 1: 7%; Year 2: 5% Then 1.25% + Italian Inflation With Minimum of 1.75%

Italian Inflation Innovation Award

Lehman Brothers' presence in the inflation market

Product Innovation - Italian Inflation-Linked MTNs Lehman Brothers

MEETING LINKER APPETITE WITH LOCAL PRODUCT

The first dealer to sell Italian inflation-linked notes and the only one to sell a TIPS-style product linked to the domestic index, Lehman Brothers achieved a dominant position in the structure this year with 85% market share, and EUR700m of sales. Its efforts to meet Italian appetite for linkers with a local product even drove the development of a swaps market and gave the firm a stand-out product in a year when it reorganised its MTN business under the continuously-offered products umbrella and more than doubled its total structured MTN sales.

Italian retail demand attracted at least EUR10bn of inflation-linked government bond and MTN issuance during 2003, but the challenges of an illiquid - almost non-existent - swap market forced most sellers into printing tickets linked to the wider Eurozone measure. But as Eurozone inflation lags the Italian measure, retail investors lacked a product mirroring their everyday perception of price increases.

"The vast majority of investors are Italian. They might feel that even the measure we use (FOI) is too low, compared to the price increases they see," explained Harsh Shah, Lehman Brothers Head of Derivatives Structuring. Italian inflation measured by the year-on-year FOI index has averaged 40bp to 50bp more than the corresponding ex-tobacco Eurozone HICP index.

Spotting the opportunity

Lehman spotted the opportunity to tailor a product specifically for the Italian market in January, after seeing the success of the early European Investment Bank (EIB) deals sold at the end of 2002 and the beginning of 2003 (see EIB's Innovation & Achievement Award above). In those deals international houses teamed up with domestic distribution partners to sell inflation bonds to Italian retail.

Lehman also used this strategy for its first issue, which it made in its own name. However, the firm departed immediately from the established Eurozone formula, differentiating its offering by offering the first Italian CPI-linked issue instead. With a group of four co-managers - Abaxbank, Banca Profilo, Banca Idea and MPS Finance - it sold EUR80m of 7-year notes. Like most standard inflation MTNs, the trade was structured to pay a fixed first-year coupon, then a margin over the FOI index.

Despite on-going sales of larger Eurozone deals, this first issue was not an overwhelming success. Shah describes it as "a slow start". But it was enough for the firm to start planning its next foray.

A second tranche, this time a EUR50m 8-year, followed in March. Abaxbank and Promos SIM served as co-managers.

With no previous issues in the market and few natural buyers of the inflation swap - payers of Italian inflation - Lehman hedged the issue using Eurozone HICP swaps instead. This meant taking the risk of divergence between the two indices onto its books, something few other houses were willing to do.

The breakthrough issue

It was not until September and the launch of its most ambitious issue to date that Lehman could start shedding the risk, as players in the fast-developing European inflation swaps market began offering prices for the Italian measure on an HICP margin basis. Launching a larger transaction with Abaxbank as joint-lead and Banca Akros and Promos as co-managers, it only closed the books at EUR300m on the 10-year deal because its treasury operation did not require more funding.

"It was the breakthrough deal," Shah recalls.

Shortly afterwards, Banca Intesa - one of Italy's largest issuers and retailers of inflation MTNs - launched a 5-year FOI-linked deal under its domestic programme. That issue, originally sized at a maximum of EUR500m, was re-opened several times and now stands at EUR854m. Intesa is currently selling a new issue that will settle in December.

Further Euro-MTN issues followed in the last quarter of 2003, notably a EUR100m trade for Kreditanstalt fuer Wiederaufbau (KfW), as well as more paper in Lehman's own name. These took total FOI-linked outstandings under Euro-MTN

documentation to EUR805m, including trades from Barclays Capital for France Telecom and Morgan Stanley for the World Bank.

Lehman also found institutional demand for Italian inflation paper during the quarter. It sold a US TIPS or UK Gilt-style issue that pays a real fixed-rate coupon based on a nominal amount that increases by the rate of inflation. Only a handful of such MTNs have sold in any currency. The note was sold to a single institutional investor looking at Italy's Eurozone inflation-linked BTP-i government bond but wanting the domestic index.

Praying for payers

Even after a bumper year for Eurozone structures, dealers and brokers still complain about liquidity in the inflation swap market. Many look to potential sovereign issuers, hoping that Italy will supply more than another EUR10bn, that Germany will follow suit and that rumours of the Netherlands joining the linker market turn out to be more than wishful thinking.

"It's still a one-way market, but if there is more issuance on the bond side, we hope to have a tighter swap market," comments one inflation derivatives professional.

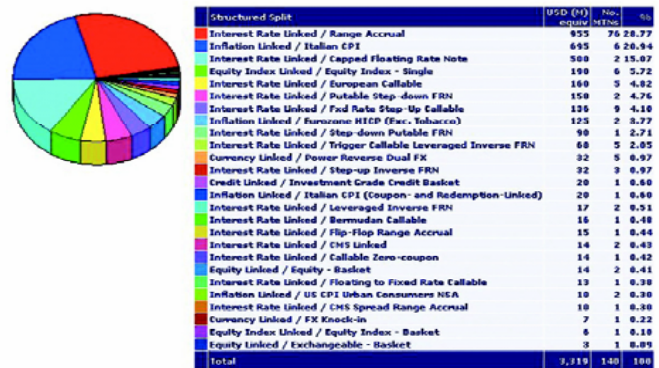
Almost from nowhere

Besides its Italian inflation innovation, Lehman achieved a higher profile across the structured MTN market this year. It reorganised its MTN business, bringing it under the continuously-offered products umbrella and putting Jon Ford in London in charge of the product. Structured volumes doubled over 2002, according to mtn-i data, as the firm sold more than USD3.5bn-equivalent via nearly 150 trades. Over the year it became a top 10 dealer for range accruals.

"They've come almost from nowhere last year to be one of our most important dealers in 2003," said a senior funding executive at one of the market's leading borrowers.

Nick Jacob

Structured MTNs by Structure Type - Lehman Brothers - 2003



Source: mtn-i

Italian Inflation Innovation Award

Lehman Brothers' presence in the inflation market



Inflation Linked Notes (Euro zone Inflation Indices)							
2004	Rank	2003	Lead Manager	Amount EUR m 2004	Market Share % 2004	Amount EUR m 2003	Market Share% 2003
1	1		Lehman Brothers	515.50	33.3	890.0	13.8
2	5		Barclays Capital	162.50	10.5	293.0	4.5
3	3		UBM	138.00	8.9	2157.7	33.4
4	4		Morgan Stanley	125.00	8.1	980.0	15.2
5	6		CDC IXIS	123.00	7.9	65.0	1.0
6	2		Calyon	112.00	7.2	490.0	8.0

2014 BTPei Reopening: Lehman Joint Bookrunner

Lehman Brothers' presence in the inflation market

16 April 2004



Republic of Italy

€ 500 000 000

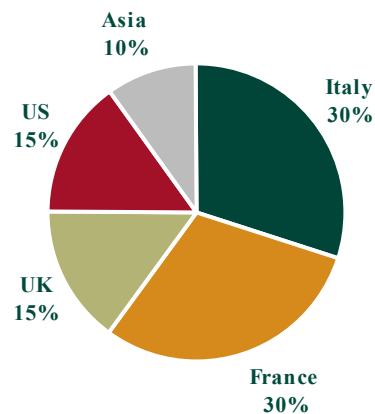
2.15% Inflation Linked Bond due Sep-2014

Joint Bookrunner

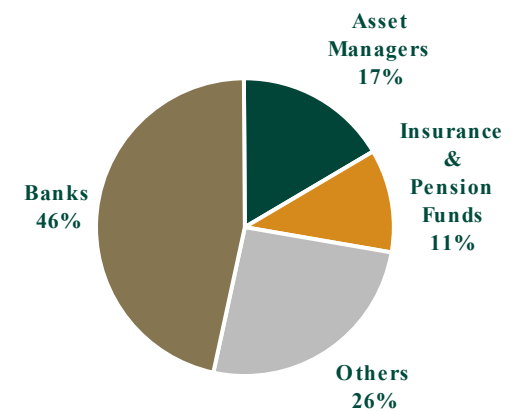
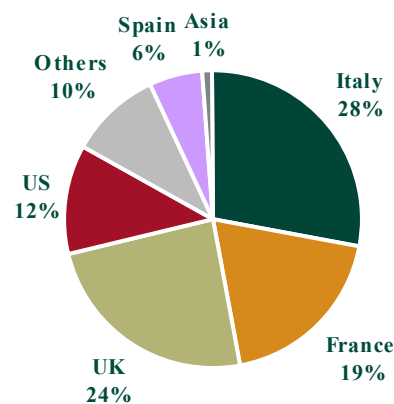
LEHMAN BROTHERS

- ◆ On 16 April 2004, Lehman Brothers acted as Joint Bookrunner for the Republic of Italy's reopening of its 10-year BTPei.
- ◆ Over the course of nearly two days, a €6bn order book was built and, in consequence, the borrower agreed to raise the size of the increase by €500m to €3.5bn
- ◆ A significantly higher proportion, 72%, was placed with international investors than the 53% of the inaugural deal.
- ◆ Price guidance had been set at 2.17% to 2.21% below the cash 2014 BTP and eventually settled at 2.20%, that being towards the tighter or more expensive side of the range for investors. However, versus the outstanding, which at the time of pricing was trading at 2.205%/2.21%, the increase was marginally cheaper for investors.
- ◆ The original deal, launched at the start of February, was priced on a breakeven of 2.13%. As the market has since become 7bp more expensive, the pricing further reflected the underlying bid for euro denominated inflation-linked bonds.

Expected Distribution (LB Forecast)



Final Distribution



References and resources

Useful Resources / References

A list of useful references

US Treasury Department

<http://www.publicdebt.treas.gov/of/ofinfin.htm>

US Federal Reserve Bank of New York

<http://www.ny.frb.org/pihome/statistics/soma.shtml>

Agence France Tresor

http://www.aft.gouv.fr/aft_en_21/debt_management_51/products_248/oatis_256/index.html

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Albert Brondolo and Ciaran O'Hagan, *Inflation-linked Bonds: Opportunities & Risks*, 2004

Inflation products website:

https://live.lehman.com/go/LL/lehmanlive?url=%2FLL%2Fcomposite%2FLFA_INFLATION_PRODUCTS&menuCode=MENU_INF_PROD

Other resources

Mark Deacon et al., *Inflation-indexed Securities*, 2004, John Wiley & Sons Ltd.

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