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Global Rates Viewpoint

Welcome to the real world: Global inflation-linked primer

Primer

24 July 2023

Rates Research
Global

The inflation-linked cash and derivative markets

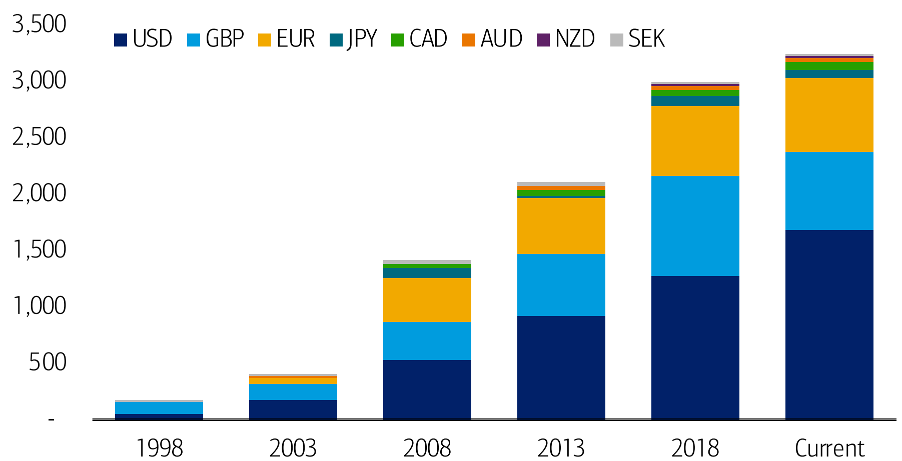
This primer is intended as a reference guide for those learning about the inflation market for the first time and those seeking a refresher on market conventions. In it we present an introduction to the asset class and delve more deeply into topics like carry, seasonality, inflation derivatives, and the basis. This note is largely based on our two recent inflation market teach-ins (part of a BofA summer series).

Get real – it's a $4 trillion bond market

The inflation-linked market allows investors to trade inflation and real interest rates. The cash flows of a "linker" security are tied to a specific inflation index such that an investor in the security will be protected against an increase in the price level over the life of the bond. As shown in Exhibit 1, the size of the global linker market has grown exponentially since the US entered it in the late 90s. The US market now comprises 52% of the market share with GBP and EUR linkers representing 21% and 20% of the market, respectively. In this primer, we focus on the three major developed inflation markets – the US, the Eurozone and the UK – that our team covers most frequently in a variety of publications, including the Inflation Strategist (see report: Curve ball published 3rd July).

Exhibit 1: Size of the global inflation market ($bn)

Global inflation market has grown exponentially since the late 90s, with the US leading the way



Source: BofA Global Research, Bloomberg. Chart shows the members of the BofA Global Inflation index in USD market value

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Table of Contents

Introduction – the real risk-free asset	2
Inflation-linked bonds – a quick outline	3
The case for linkers, and recent challenges	7
The Fisher Equation	10
Indexation mechanics	11
Linker carry	13
Seasonality	17
Expanding Fisher, introducing premia	22
Inflation derivatives	25
Linker asset swaps and the inflation basis	27
Positioning across economic cycle	31
Research Analysts	35

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TIPS : Treasury Inflation Protected Securities

PCE: Personal Consumption Expenditures

HICP: Harmonized Index of Consumer Prices

SOFR: Secured Overnight Financing Rate

CPI: Consumer Price Index

Introduction – the real risk-free asset

Mutual benefits for investor and borrower

The purpose of saving is to defer consumption. Investors should primarily be interested in what they or their dependents will be able to buy with their savings in the future. And government bond issuers have assets and tax revenues that are real – or at least more real than nominal.

So although there are several other reasons for the inflation-linked asset class to exist (and arguments that some make against) as we will discuss later, the essence is that a bond with cash flows that are adjusted for changes in a consumer price index should reduce risk for both parties – the lender and the borrower. That, in the end, is the very nature of trade itself – trade occurs between two parties because it suits both.

Corn, beef, wool, and sole leather

Many trace the origin of the inflation-linked market to 1780, when the Commonwealth of Massachusetts issued bonds, called ‘depreciation notes’, linked to a price index based on a small basket of basic commodities (those in our subtitle). For a full discussion, see Robert Shiller’s 2003 paper: ‘The invention of inflation-indexed bonds in early America’.

Irving Fisher, famous for his innovations in many areas of economics, is perhaps most renowned for giving economics the MV=PT money identity and for describing the debt-deflation process. For inflation-linked investors, he is famed for telling us that a nominal bond yield was made up of real yield and inflationary expectations components (long before there were such things as inflation-linked bonds). We will expand upon this ‘Fisher equation’ later. He also wrote the book on price indices, (the weighty 1922 tome ‘The Making of Index Numbers’), furnishing rules on how to distinguish between good and bad index calculation methods.

This work alone might be sufficient to confer Fisher with the title of father of the inflation-linked market, but his contribution went beyond the theoretical. He built an inflation index, using wholesale prices, and published its values, insisting that his secretary sign an inflation-indexed contract linked to the index. In 1925, his company Rand Kardex issued an inflation-indexed bond on the day it opened for business. (see: ‘The ideal inflation indexed bond and Irving Fisher’s impatience theory of interest in an overlapping generations world’, J. Geanakoplos, July 2003).

The modern market

Various bond and contract structures and linking indices have been experimented with through time, but the goal of adjusting cash flow values for changes in a linking index has been common to all. The modern inflation-linked bond market has largely settled on a form whereby a bond’s coupons and principal are adjusted for changes in a consumer price index between the bond’s launch and its cash flow payment dates, with most adopting the linking methodology created by Canada for its market launch in 1991 (sometimes with slight variations in its implementation).

Although there were earlier precedents, where very high inflation meant that indexing debt was a way for governments to access long-term finance (notably Latin American countries, Israel and Iceland), the major developed markets began entering the market in 1981 with the UK. Australia joined in 1983, Canada in 1991, Sweden in 1994 and the US in 1997. France led the vanguard for the Euro Area in 1998 (a year before European Monetary Union), with Italy, Greece, Germany and Spain following since. This is far from a comprehensive list, and the charts that follow in the next section show the participants in what is now a $4 trillion global market ($3.3tn developed, $0.7tn emerging markets).

In an uncertain world, if you know your savings horizon, an asset that offers real value certainty to that horizon is something to be prized.

Inflation-linked bonds – a quick outline

Modern "linker" markets have converged on a settled form, known as the Canadian Model because the linking methodology was devised by Canada for its inaugural Real Return Bond in 1991.

Coupon, redemption, transaction and valuation amounts are adjusted for changes in the "reference index" since issue. Documentation will often specify that it is the principal that is adjusted for inflation, but since coupons are set as a fixed percentage of the principal, they are also indexed as a result.

All settlement/payment dates have a "Reference Value". The Reference Value for a bond issue's launch is its "Base Value". The Reference Value for a given settlement date divided by the Base Value gives us an "Index Ratio" for that settlement date. An index ratio of, say, 1.1000 would mean that the linking index has risen 10% between a bond's launch and the settlement date (i.e., 10% cumulative inflation), and amounts due or valued on that settlement date would be uplifted accordingly.

This allows market to think and trade in "real space". Trading is done in terms of real prices (before adjusting for inflation), and real yields are calculated from these real prices using the same yield formulas and market conventions as nominal bonds. Real quantities – prices, accrued interest, coupons, redemption values – are converted to cash amounts by multiplying them by their Index Ratios.

Inflation indexation is not quite contemporaneous. There is a small "indexation lag" – usually three months – because of the time it takes for a statistical authority to compute and publish the inflation index. For instance, for most markets the Reference Value for 1 August would be the CPI for the preceding May, so although this is described as a "three month lag", that is not an exact description of the situation. We go through a more detailed explanation of the calculation methodology later.

The difference between a linker's real yield and a matched-maturity nominal "comparator" is known as its breakeven inflation rate, or just its "breakeven".

What you want from a linking index. An index should be…

- Representative in coverage. The basket should reflect expenditure patterns.
- Transparent. The calculation should be clearly understood (ideally replicable).
- Timely. Published promptly after the period it refers to.
- Not subject to revision. Cash amounts paid cannot be changed after the event.
- Trusted. The overarching need, covering familiarity, sampling methodology, data collection, and calculation.

Only Consumer Price Indices are generally regarded as meeting all the above needs. Other indices have been tried (e.g., GDP, wholesale prices, wages) and yet more might seem desirable (e.g., health costs, Konüs – constant utility – indices). However, these others all have practical shortcomings when tested against the above checklist.

Not all inflation measures are created equal

Widely followed measures of inflation for the same economy can often produce different results (even if they do satisfy our list above), because basket compositions or calculation methods differ. For instance, the US CPI used for TIPS indexation has tended to rise at a faster rate than the PCE measure targeted by the Fed, while the Retail Price Index (RPI) used for UK linkers has persistently outstripped UK CPI by a large margin. Within the Euro Area, France's CPI measure (indexing those of its bonds linked to domestic inflation) has grown at a slightly slower rate over the long term than the French HICP measure used for the French component of the Eurozone linking index. An awareness of these differences is important in assessing value.

Summary table of inflation indices and market convention

Exhibit 2 shows a summary table of inflation indices, their relative indexation lags, and other market conventions. The standard indexation lag follows the method discussed further below (between 2-3 months). The principal floor refers to whether the inflation indexed principal at maturity can be fixed below 100; the UK and Canadian markets stand out as exceptions. Additionally, in most inflation markets the quoted price is in real terms.

Exhibit 2: Summary of key tickers and features

Salient tickers and features, but not a comprehensive list of differences in market conventions.

Market	Bloomberg Bond Ticker	Bloomberg Bond Series	Linking Index	Bloomberg Index ticker	Indexation Lag	Principal Floor	Quoted Price	Notes
US	TII		CPI-U nsa	CPURNSA	Standard	Yes	Real	
UK	UKTI		RPI	UKRPI	Standard	No	Real	
UK	UKTI		RPI	UKRPI	8-month	No	Adjusted	The original UK model. 3 issues remain.
France	FRTR	OATE	Euro HICP excl. tobacco	CPTFEMU	Standard	Yes	Real	
France	FRTR	OATI	French CPI excl. tobacco	FRCPXTOB	Standard	Yes	Real	
Italy	BTPS	CPI	Euro HICP excl. tobacco	CPTFEMU	Standard	Yes	Real	
Germany	DBRI, OBLI (discontinued)		Euro HICP excl. tobacco	CPTFEMU	Standard	Yes	Real	
Spain	SPGBEI		Euro HICP excl. tobacco	CPTFEMU	Standard	Yes	Real	
Japan	JGBI		CPI excl. fresh food	JCPNJGBI	Mod. Standard	Yes	Real	10th of month takes 3mth prior index, not 1st
Canada	CANRRB		CPI All Items	CACPI	Standard	No	Real	
Australia	ACGB	##CI	CPI All	AUCPI	6 months	Yes	Adjusted	Coupons also "floored"
Sweden	SGBI		SWCPI	SWCPI	Standard	Yes	Adjusted	

Source: BofA Global Research

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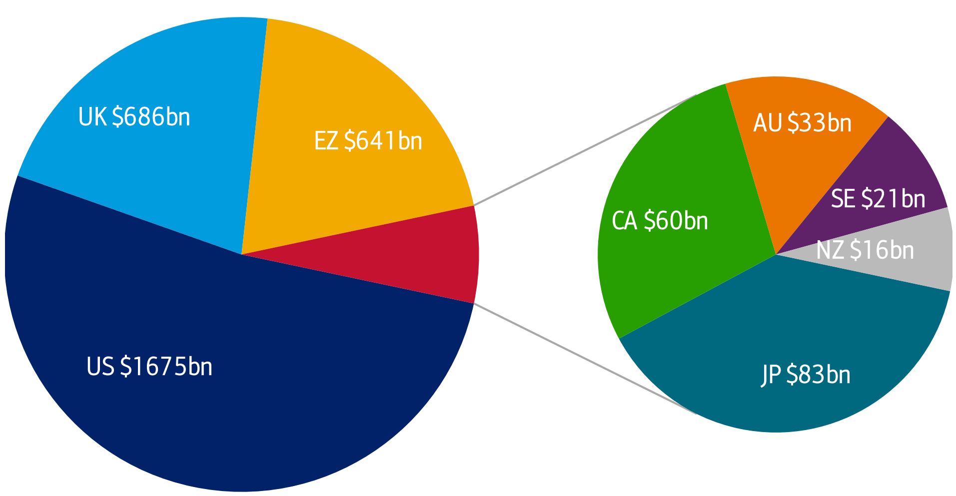
The $4 trillion market (developed and EM combined)

Exhibit 3: ICE BofA Global Inflation-Linked Government Index, market value, 30 June 2023

Developed markets by country composition, with a total of $3.2 trillion.



Source: ICE BofA Bond Indices

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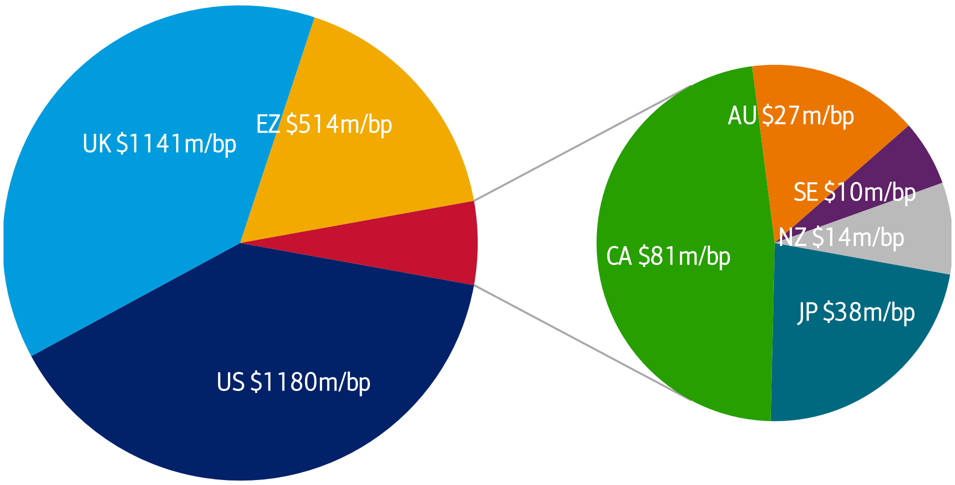
Exhibit 4: ICE BofA Global Inflation-Linked Government Index, duration risk, 30 June 2023
The long durations of the UK and Canada inflation-linked markets boost their DV01 shares dramatically.



Source: ICE BofA Bond Indices

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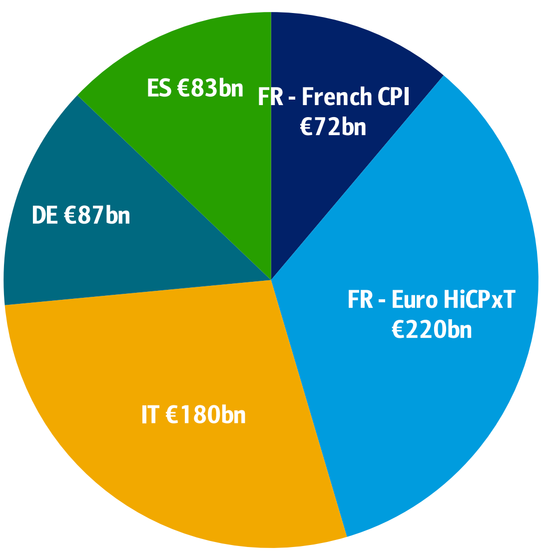
Exhibit 5: ICE BofA Euro Inflation-Linked Government Index, market value, 30 June 2023
France issues bonds linked to both domestic French CPI excluding tobacco and to Euro HICP excluding tobacco. All other countries' issues link to the latter index.



Source: ICE BofA Bond Indices

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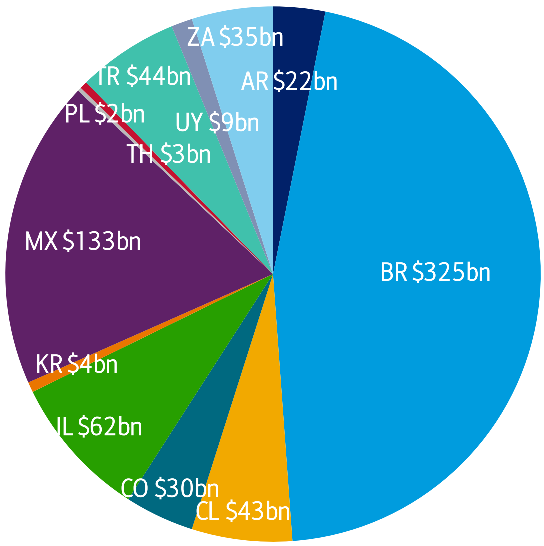
Exhibit 6: ICE BofA All Maturity Emerging Markets Inflation-Linked Sovereign Bond Index, market value, 30 June 2023
A $711bn market, dominated by Latin American issuers.



Source: ICE BofA Bond Indices

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The case for linkers, and recent challenges

A meeting of needs

You save to defer consumption, for yourself and for your dependents. Your prime concern should be what you'll be able to buy with your savings in the future. An inflation-linked government bond (a bond with cash flows tied to a price index), maturing at your expected future consumption date, is therefore your risk-free asset. A 3mth Treasury Bill is not, no matter what your textbook might say.

There are qualifiers and complications, of course: you might have nominal obligations to meet (e.g., a mortgage), you don't know precisely when you'll want to consume your savings, and there is 'personal basis risk' – your own consumption basket will differ from the composition of the linking index. But these do not undermine the broad premise.

Important secondary benefits of "linkers" for the investor include their unique behavioural characteristics (making them a diversifying asset, improving the efficient frontier of a mixed asset portfolio), and the opportunity to express views about future inflation and real policy rates explicitly, rather than approximately with other instruments.

That's all great for the investor, but what about the borrower? The main argument for a government issuing inflation-linked debt is the fiscal hedge: a government's assets – its land and buildings – are real, while its tax revenues – income, consumption and corporate tax – are real (not precisely, but more real than nominal). So, its liabilities should be real.

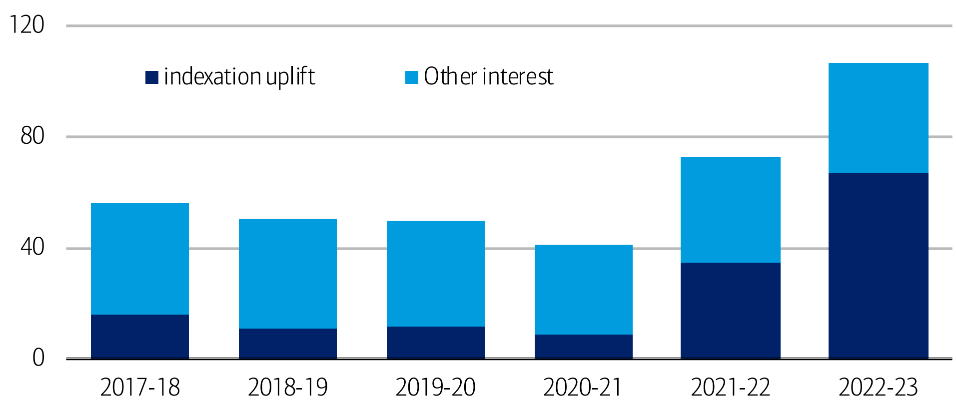
There are potential secondary benefits for the borrower. If you issue different instruments to suit different buyers, this should lower overall debt servicing costs. And you might be able to save a so-called "risk premium"; if investors are willing to pay extra for real value certainty, then inflation-linked debt will be a liability with a lower expected cost than nominal debt. There might also be a "credibility feedback" benefit – by reducing governments' ability to inflate away their liabilities, this gives them skin in the game to keep inflation low.

The live reading of inflation expectations that inflation-linked instruments give central banks and market participants is regarded as a positive externality. But it might be more than that. If it illuminates why nominal bond yields are where they are, this understanding might enhance market stability, thereby lowering (nominal) bond yields.

So, we have an ideal asset class; something that appears to extinguish risk for both borrower and investor…

But then this happened…

Exhibit 7: UK government debt interest bill per fiscal year, separating out indexation costs, £bn
Under ESA 2010, linker indexation uplift is charged to interest as it occurs in the national accounts.



Source: ONS, BofA Global Research

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Inflation shock prompts issuers to question the benefit of inflation-linking

Exhibit 7 Shows the contribution to the UK's debt interest costs from the indexation uplift of its inflation-linked bond liabilities. We've used the UK as an example because it is the most dramatic: the UK has the largest inflation-linked share of the national debt among the major developed issuers (with the longest duration) and has had perhaps the most uncomfortable mix of very high inflation and weak growth recently.

The picture is disturbing. In the 2022-23 fiscal year that finished in March, the indexation uplift charge to interest was £67 billion, and this doesn't even include the actual coupons paid on the linkers (which are part of the "other interest" component in the chart). The debt servicing costs of the UK's linker liability, which represents about a quarter of the national debt, made up about two thirds of the total interest bill, equivalent to about 3% of GDP.

This brings us onto the case against inflation-linked liabilities. As with the arguments in favour of inflation linking, there are arguments against that have long been understood, with the main one being that there might be times when inflation-linked liabilities are a poor fiscal hedge. The example that has been commonly used over the years is that of an oil price shock because it simultaneously lifts inflation but hurts growth. Governments will now be considering whether the experiences of a pandemic and war in Ukraine fall into the same category.

Other objections expressed about inflation-linked liabilities include: the fact that governments have a lot of other real liabilities already (e.g., state pension provision); the possibility that the indexation of debts, contracts, wages, etc., might normalise inflation; and the risk that fragmentation of issuance might cannibalize the debt market, reducing issue sizes and thereby the liquidity in the nominal bond market.

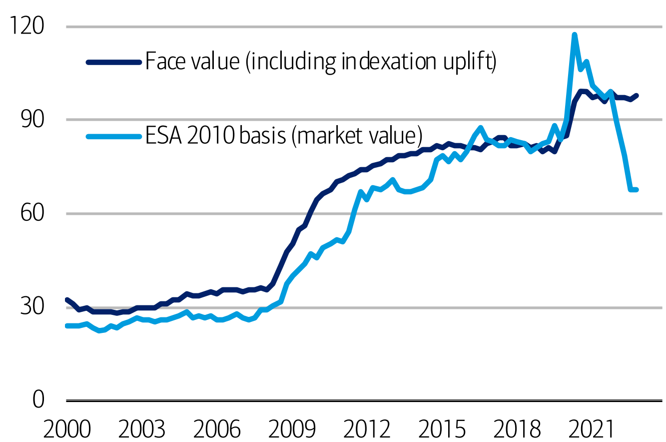
Perhaps the most practical concern is that issuers might not get value for money due to lack of demand, illiquidity, or perceived product complexity.

For the sake of completeness, we should add the possibility that governments might actually want to retain the option to erode the value of their debts with inflation, an option that only nominal debt confers.

Thinking differently about debt/GDP ratios

The accruals accounting impact of the recent high inflation indexation on budget deficits, although ugly, doesn't undermine the fiscal hedge argument for issuers.

Exhibit 8: UK debt/GDP ratio shown two ways, %
Moving sideways in notional terms, collapsing in market value terms.



Source: BofA Global Research, ONS, Refinitiv

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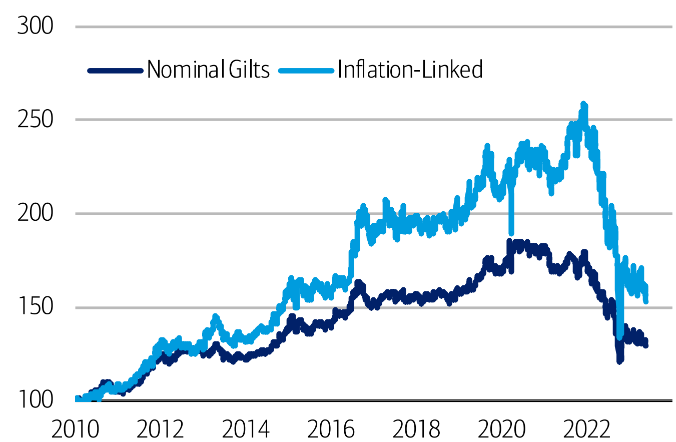
Exhibit 9: Nominal and index-linked Gilt total return indices, rebased
Despite high inflation, UK linkers have done badly for the investor.



Source: BofA Global Research, Refinitiv

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Inflation linked liabilities of governments have been uplifted a lot, but so have nominal GDP levels. While it is true that GDP deflators have lagged linking indices a little, differences haven't been material. Looking at the debt/GDP ratios of governments issuing linkers, the numerators have gone up because of inflation but so have the denominators. This is the fiscal hedge in action.

And there is a bigger issue in play here. Despite the fact that the financial world has come to accept that assets and liabilities should be marked-to-market, when it comes to government indebtedness and debt/GDP ratios, the reporting convention and the way we all think about them is in terms of notional amounts, or original "face" values (uplifted by index ratios in the case of linkers).

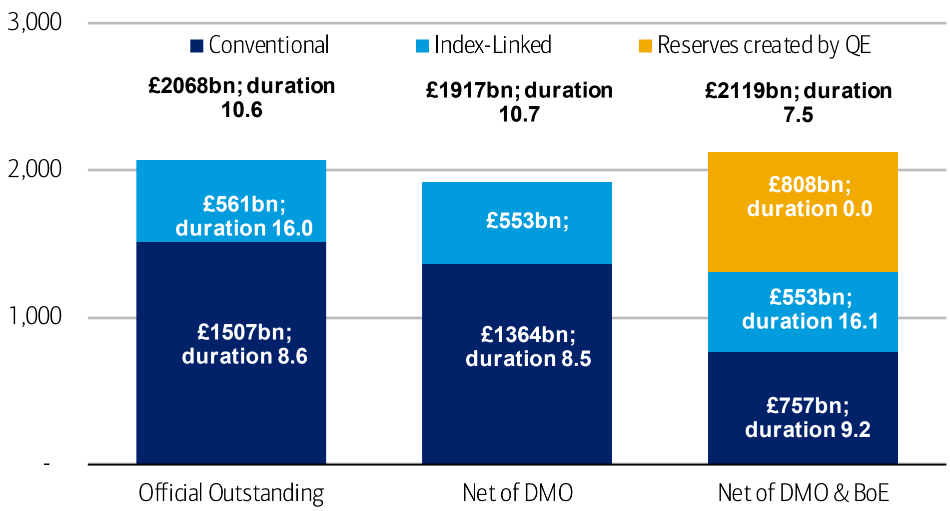
There are simple ways to demonstrate that a government's debts should be valued at market. For instance, consider two (nominal) French 2y issues. France has a 1% OAT maturing in November 2025 (an old 10y) and a 6% OAT maturing a month earlier (an old 30y). They have very different prices because the latter is far more valuable to the investor. It is also, therefore, a more onerous obligation for the borrower. The way to account for this is to mark-to-market debt obligations. Indeed, that is what public accounting standards such as the European System of Accounts (ESA) standard say.

This changes the perspective dramatically, as Exhibit 8 shows for the case of the UK (but it is true generally). "Haven't our inflation-linked liabilities been costly?" is an important question, but so is: "Didn't we do well to issue so many linkers at very negative real yields over such a long period, given that real yields are now positive?". As ever, the situation for the UK is even more extreme than for others. Exhibit 9 shows how the UK linker market has underperformed nominals dramatically through this high inflation episode, because of the former's much higher average duration. In terms of returns, duration has eclipsed indexation for investors (and also for borrowers, if a mark-to-market premise is accepted).

Should governments regard TBills (and CB reserves) as inflation-linked?

Exhibit 10: UK national debt shown three ways (market values, TBills and NS&I excluded, £bn)

Quarter of debt explicitly inflation-linked. But a bigger share, reserves, arguably also inflation-linked, indirectly.



Source: BofA Global Research, DMO, BoE, Bloomberg

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We need to remember that floating rate government liabilities like Treasury Bills, are also loosely inflation-linked, something forgotten during the years at the lower bound. Policy rates go up and down with inflation. And if we treat the balance sheets of central banks as consolidated parts of the state, then quantitative easing converted fixed rate obligations of the state into reserves paying the policy rate (or something close to it).

The Fisher Equation

Irving Fisher saw nominal bond yields as a combination of real yield and inflation components. This is normally expressed as a geometric sum:

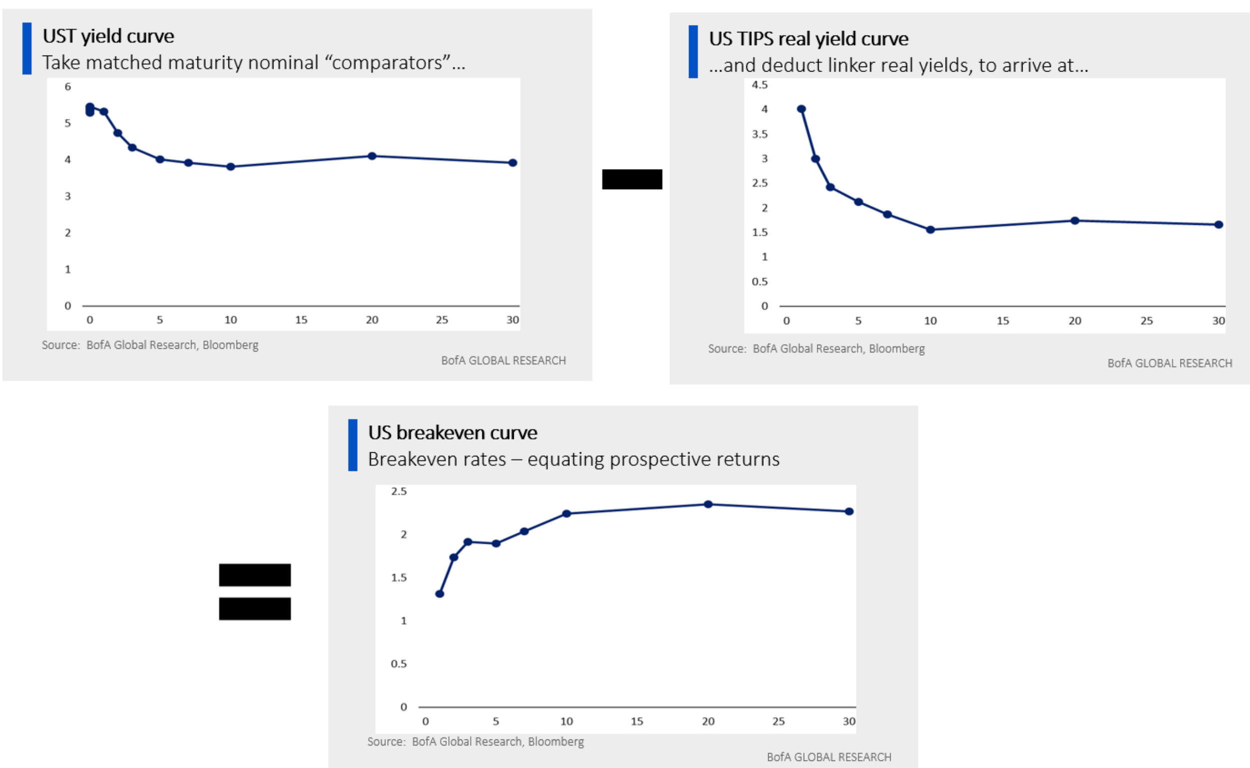
$(1 + n) = (1 + r)(1 + f)$, ...

...where n is the nominal yield, r the real yield, and f inflation. This is typically now elaborated, making explicit that the inflation component is inflation expectations and augmenting the equation with other components. We discuss this later.

For practical purposes, the most basic use of the Fisher equation by the market is as shown in Exhibit 11, with nominal rates decomposed into real rates and "breakeven" inflation rates, with the latter calculated by taking the simple difference between a linker real yield and a matched maturity nominal bond.

Exhibit 11: Fisher equation decomposition in the US bond market

The breakeven inflation rate is the difference between two tradeable asset yields: nominal bond and matched-maturity linker



Source: BofA Global Research

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Indexation mechanics

As we have said, with the Canadian Model, widely used by most inflation-linked bond markets, each day has a unique Reference Value for indexation purposes. However, because inflation indices are usually published monthly, in arrears, the index value for a given month is typically applied to the first day of the month three months later. Days in between are calculated by linear interpolation:

Exhibit 12: Standard indexation calculation

Linear interpolation formula used to calculate reference index for a linker.

$$Reference\ Value = CPI_{m-3} + \frac{(d-1)}{ND_m}\left(CPI_{m-2} - CPI_{m-3}\right)$$

Where:

CPI_{m-2}	is the inflation index print two months prior (E.g. for a settlement date in July, this will be the May CPI print).
CPI_{m-3}	is the inflation index print for three months prior (E.g. for a settlement date in July, this will be the April CPI print).
d	is the day of the month.
ND_m	is the number of days in the month.

Source: BofA Global Research

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Taking the US TIPS market, the May 2023 CPURNSA Index becomes the Reference Value for 1st August 2023, and the June CPURNSA Index becomes that for 1st September. The formula above gives reference values for days in between. Exhibit 13 illustrates how the earlier index print is phased out and the later one phased in through the month.

Exhibit 13: Reference value calculation

For the month of August, the reference value that the US TIPS will trade with is an interpolation of the May and June CPI

	May CPI NSA	June CPI NSA	Reference value
	303.294	303.841	
1-Aug	100%	0%	303.294
2-Aug	97%	3%	303.312
3-Aug	94%	6%	303.329
4-Aug	90%	10%	303.347
5-Aug	87%	13%	303.365
6-Aug	84%	16%	303.382
7-Aug	81%	19%	303.400
8-Aug	77%	23%	303.418
9-Aug	74%	26%	303.435
10-Aug	71%	29%	303.453
11-Aug	68%	32%	303.470
12-Aug	65%	35%	303.488
13-Aug	61%	39%	303.506
14-Aug	58%	42%	303.523
15-Aug	55%	45%	303.541
16-Aug	52%	48%	303.559
17-Aug	48%	52%	303.576
18-Aug	45%	55%	303.594
19-Aug	42%	58%	303.612
20-Aug	39%	61%	303.629
21-Aug	35%	65%	303.647
22-Aug	32%	68%	303.665
23-Aug	29%	71%	303.682
24-Aug	26%	74%	303.700
25-Aug	23%	77%	303.717
26-Aug	19%	81%	303.735
27-Aug	16%	84%	303.753
28-Aug	13%	87%	303.770
29-Aug	10%	90%	303.788
30-Aug	6%	94%	303.806
31-Aug	3%	97%	303.823
1-Sep	0%	100%	303.841

Source: BofA Global Research

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The index ratio allows the market to think and trade in "real space" – i.e., in terms of real prices and real yields – using standard market conventions to convert real prices to real yields. Real quantities (price, accrued interest, coupons, redemption values) are converted to cash amounts by multiplying them by their Index Ratios.

Exhibit 14 gives an illustration of the Reference Value and Index Ratio calculations, then Exhibit 15 uses this to calculate cash values for a trade settlement, as presented in the 'Invoice' area of the Bloomberg YA screen.

Exhibit 14: Annotated example of Reference Value and Index Ratio calculations
Using OATei 1.85% 2027 bond (issued by France, linked to Euro HICPxT), for value 21 July 2023.

Reference Value:

21st of month, so 20 (21-1) days since 1 July

May HICPxT is Ref for 1 August

122.79 + ((21-1)/31) x (122.81 – 122.79) = **122.80290**

April HICPxT is Ref for 1 July

31 days in July

Reference Values and Index Ratios truncated to 6d.p. then rounded to 5d.p.

Reference Value for Base Date (25 Jul 2010) = 93.72591 (calculated in same way).

So, **Index Ratio** for Value Date = 122.80290/93.72591 = **1.31023**

Source: BofA Global Research

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Exhibit 15: Using the Index Ratio result from Exhibit 14 to calculate settlement proceeds
Again, we are using OATei 1.85% 2027, for value 21 July 2023. These are the same calculations represented in the 'Invoice' area, at the bottom right of the Bloomberg YA screen.

Real price	=		104.646
Cash value of €1m principal	=		(104.646/100) x 1.31023 [the Index Ratio] x €1m
		=	€ 1,371,103.29
Days accrued	=		361
Days in coupon run	=		365
Real accrued interest	=		1.85% x (361/365)
Cash accrued interest on €1m	=		0.0185 x (361/365) x 1.31023 [the Index Ratio] x €1m
		=	€ 23,973.62
Total settlement value	=		€ 1,395,076.91

Source: BofA Global Research

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Linker carry

In fixed income, carry is thought of as the forward yield less the spot yield. For inflation-linked bonds, this calculation needs to take account of prospective indexation, so the calculations need to be done in cash or nominal terms then converted back into real terms. We start by working out the current total (or "dirty") price in cash terms, including accrued interest and indexation adjustment. If the example in Exhibit 15 was reworked using a face amount of 100, the final total settlement value for the OATei issue would be the dirty cash price.

We project a forward cash value at a given horizon date using an appropriate financing rate, then convert this figure into forward real price and real accrued interest values using a forward Index Ratio for the horizon date (after allowing for any interim coupons between settlement and horizon dates). These forward Index Ratios might be known with certainty if the horizon is close or will need to be based on estimates of future monthly inflation index prints.

Because Reference Values are lagged between 2-3 months, you know the forward Index Ratio for short holding periods. For instance, ahead of the July CPI released on 10 August, we knew all Reference Values through 1 September. Once the July CPI prints, we then know Reference Values through 1 October (Exhibit 16).

Exhibit 16: Linker reference index guide for August

Ahead of July CPI index print, reference index known through Sept 1; after July CPI print reference index known through Oct 1

	Reference blend	Last known CPI	Reference index known through
1-Aug	May	June	1-Sep
2-Aug	May/ June	June	1-Sep
3-Aug	May/ June	June	1-Sep
4-Aug	May/ June	June	1-Sep
5-Aug	May/ June	June	1-Sep
6-Aug	May/ June	June	1-Sep
7-Aug	May/ June	June	1-Sep
8-Aug	May/ June	June	1-Sep
9-Aug	May/ June	June	1-Sep
10-Aug	May/ June	July	1-Oct
11-Aug	May/ June	July	1-Oct
12-Aug	May/ June	July	1-Oct
13-Aug	May/ June	July	1-Oct
14-Aug	May/ June	July	1-Oct
15-Aug	May/ June	July	1-Oct
16-Aug	May/ June	July	1-Oct
17-Aug	May/ June	July	1-Oct
18-Aug	May/ June	July	1-Oct
19-Aug	May/ June	July	1-Oct
20-Aug	May/ June	July	1-Oct
21-Aug	May/ June	July	1-Oct
22-Aug	May/ June	July	1-Oct
23-Aug	May/ June	July	1-Oct
24-Aug	May/ June	July	1-Oct
25-Aug	May/ June	July	1-Oct
26-Aug	May/ June	July	1-Oct
27-Aug	May/ June	July	1-Oct
28-Aug	May/ June	July	1-Oct
29-Aug	May/ June	July	1-Oct
30-Aug	May/ June	July	1-Oct
31-Aug	May/ June	July	1-Oct
1-Sep	June	July	1-Oct

Source: BofA Global Research

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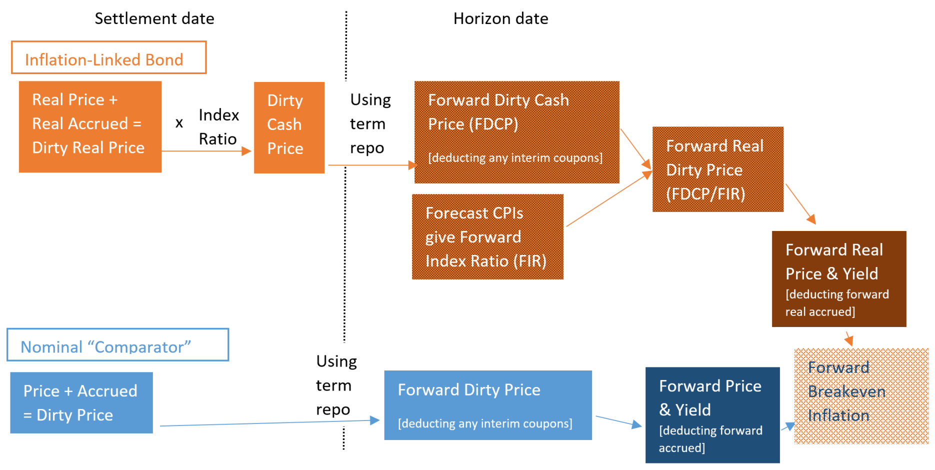
For time horizons beyond the period of known Reference Values, you need to make assumptions about how inflation will print to generate a carry profile. In our analysis we tend to compare and use two different sets of assumptions: firstly, the prospective index values from the inflation swap/linker market, and secondly, the forecast profiles of our economists. Our economists' expectations for the monthly linking indices in the US, Euro and UK are regularly published in our monthly Inflation Strategist report.

The above process gives us real yield carry estimates. These are combined with yield carry estimates for matched-maturity nominal bond comparators (as done with the Bloomberg FPA screen) to give breakeven carry projections.

Exhibit 17 shows a schematic layout of real yield and breakeven carry calculation process. We then go on to step through a specific example for calculating TIPS carry.

Exhibit 17: Schematic of real yield and breakeven carry calculations for an inflation-linked bond
Forward CPI Reference Values and Index Ratios use known values to 1st of next month (or 1st of following month, if prior month's CPI is known), economist forecasts or readings from inflation market thereafter.



Source: BofA Global Research

BofA GLOBAL RESEARCH

Worked carry example using an April 25 TIPS issue

Assume an investor bought a TIPS maturing April 25 on July 19, 2023 for 95.20313 at a spot yield of 2.981% that has a 0.125% coupon what is carry over the next month?

Steps to calculate TIPS carry:

- **Dirty price**: includes what I owe to the seller for inflation accrued since TIPS inception= (Price + settle accrued interest)* settlement index ratio = (95.20313 + 0.125% *(95/365))* 1.17627 = 112.02261
    - Settle accrued interest = coupon rate * time from last coupon payment
    - Settlement index ratio = settle interpolated CPI / base CPI
- **Forward cash value** = how much do I earn on this by investing at repo rate = dirty price * (1+ repo rate) ^(1/12) = 112.02261* (1.053) ^ (1/12) = 112.52675
- **Forward dirty price** = forward cash value - forward cash value of any coupons received = there are no cash payments received over the holding period so = forward cash value, 112.52675
    - forward cash value of any coupons received = coupon de-annualized multiplied by interpolated CPI on date of coupon payment / base CPI held at repo rate from time received through end of holding period
- **Horizon index ratio** = CPI index as of Aug 19 (end of holding period) / base CPI = 304.69719/ 258.30093 = 1.17962
- **Inflation adjusted forward dirty price** = forward dirty price/ horizon index ratio = 112.52675/ 1.17962= 95.39229

- **Real forward accrued interest**: this will be how much will be owed to the owner if they were to sell the security on August 19= (0.125%)*(126/365) = 0.04303
- **Forward real clean price** = inflation adjusted forward dirty price – forward interest = 95.39229– 0.04303= 95.34926
- **Forward real yield**: implied from forward real clean price, coupon, forward date and maturity= 3.026%
- **Real yield carry** = forward yield – spot yield = 3.026%- 2.981%= 4.6bps

The importance of carry – a much more critical issue for linkers than nominals

Carry is a consideration when dealing in any fixed income product, but its importance for inflation and breakeven trading – both in assessing future prospects and in understanding past behavior – is far greater.

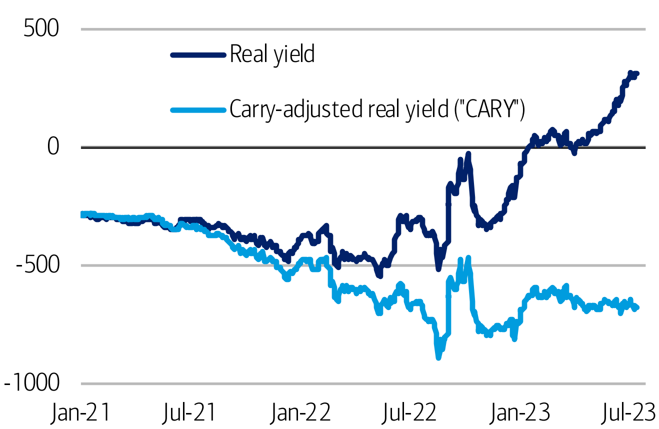
Though not entirely predictable, the carry for a nominal bond position will tend to evolve smoothly and will typically not dominate our understanding of how the position has performed. A simple yield chart of, say, a 5y nominal German government bond will generally give a reasonable indication of the return delivered.

That is much less likely to be the case for linkers, either with real yield or breakeven trades. Linking indices are volatile month-to-month, with predictable (e.g., seasonal) and unpredictable elements to the volatility. This means that linker carry, in turn, is likely to be much more volatile and uncertain than nominal bond carry, and this can cause large divergences between observed moves in quoted yields and the true realized yield performance of a trade after allowing for carry. This is especially the case for shorter-dated linkers, where the basis point value of changes in the Index Ratio is greater.

What you see is not always what you get. Carry rewrites history

The past few years of high and volatile inflation have produced some dramatic illustrations of this issue. Using a short-dated linker from the UK, where the inflation experience has been particularly troubling, consider these charts comparing quoted real yield and breakeven behaviour (what you see if you chart them in Bloomberg) with carry-adjusted behaviour (what your position would have realized, allowing for carry). Note that the carry for a long breakeven inflation trade is the carry for the linker less that of the nominal comparator.

Exhibit 18: UKTI 2024 – observed and carry-adjusted real yield, bp
Real yield has risen by 6% since Jan 2021, from -2.87% to 3.11%, but a long position would still have done well, thanks to nearly 1,000bp positive carry.



Source: BofA Global Research, Bloomberg

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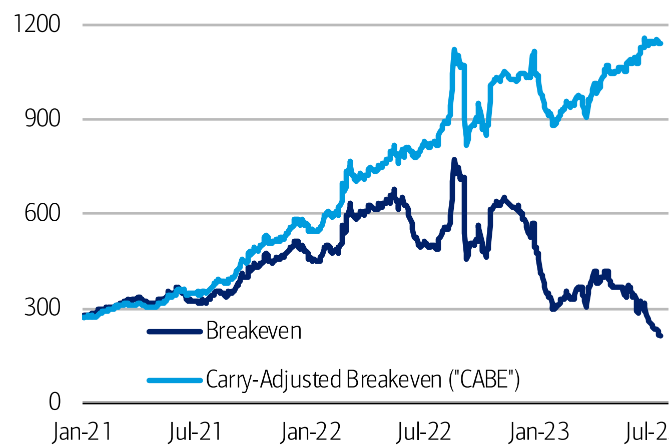
Exhibit 19: UKTI 2024 – observed and carry-adjusted breakeven, bp
As a result of the carry shown left, a long breakeven trade would have made nearly 900bp, despite the observed breakeven rate falling over the period.



Source: BofA Global Research, Bloomberg

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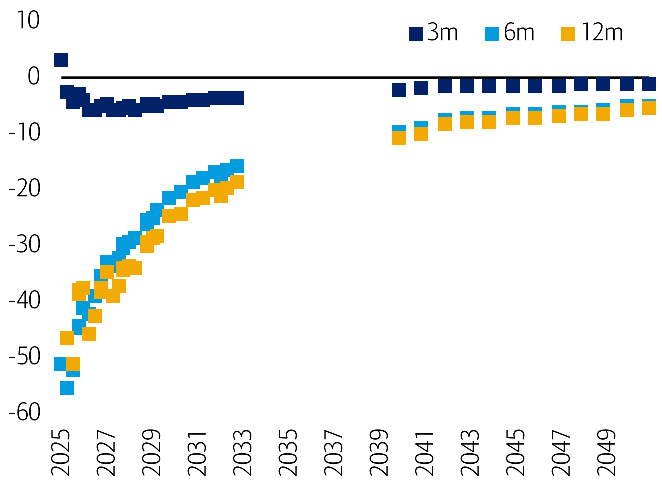
Carry is therefore a complication in understanding the historic performance of real yield and breakeven trades, not just in forming judgements about prospects. Similarly, steepening or flattening in the 'observed' or 'quoted' real yield or breakeven curve (by charting, for example, the 2s10s breakeven difference) might provide a misleading impression of how a steepener or flattener trade would actually have done in the past.

In Exhibit 20 and Exhibit 21 we show estimated prospective carry to different horizons for the whole US TIPS curve, on both a real yield and a breakeven basis, using the inflation market's projections for future CPI prints. Shorter dated linkers usually offer greater absolute carry (either positive or negative), because changes in the Index Ratio have a larger impact on the implied forward yield at shorter maturities, as we have said.

As with carry for nominal bonds, positive carry should not be equated with positive prospective returns; far better to compare how the market prices the future evolution of real yields or breakeven rates with your own expectations. In our judgement, the market is good at pricing the predictable elements of carry (e.g., very near-term index print prospects and seasonal variations in the index).

Exhibit 20: TIPS carry implied by CPI fixings across maturity dates and investment time horizon (BPS)

TIPS carry unattractive over next 6 and 12 months



Source: BofA Global Research

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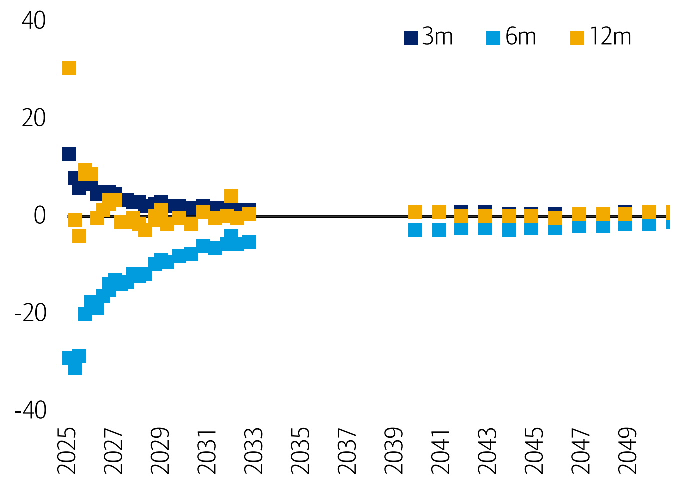
Exhibit 21: Breakeven carry implied by CPI fixings across maturity dates and investment time horizon (BPS)

Breakeven carry attractive over 3mo holding period, unattractive over next 12 months



Source: BofA Global Research

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Seasonality

There is a fairly predictable seasonal pattern to most price indices used for indexing inflation-linked bonds; times of the year when indices are seasonally strong and seasonally soft. As we mentioned earlier, this seasonality is an important consideration for carry purposes.

However, seasonality deserves its own section because it will influence a linker's cash flows over its entire life. Indeed, the most important issue with seasonality for valuation purposes is not the seasonal pattern in the immediate future, to a carry horizon date; it is the seasonal conditions that are likely to prevail when a bond matures (or, more precisely, in the months determining the final Reference Value for the maturity date). Seasonality is also a critical issue when valuing aged inflation swap contracts, as we will come on to discuss.

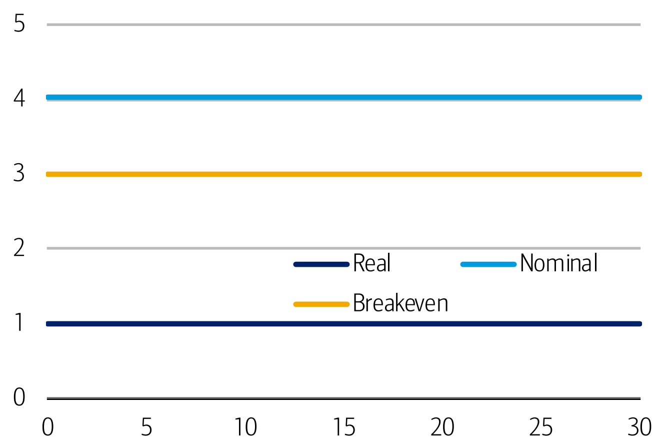
We will start by illustrating the impact of seasonality on linkers with two extremely stylized "toy" models.

Model 1. Two perfect foresight worlds

Imagine first a world with perfectly liquid nominal and inflation-linked bonds maturing every day for the next thirty years, where there are no influences on market pricing other than policy rate and inflation expectations. This is a perfect foresight world, where future interest rates will always be 4%, with certainty, and the nominal bond curve is therefore horizontal at 4%. Future annual inflation is also known with certainty – it will be 3% and will run smoothly at a constant monthly rate. Therefore, the breakeven curve is horizontal at 3%, and the real yield curve is horizontal at 1%. Exhibit 22 shows us the three curves in this world.

Now, imagine a second world exactly like the first but where instead of arriving smoothly through the year, the 3% annual inflation all happens in one month each year, April, with monthly changes in the price index in other months always zero. Under the Canadian model, linker indexation would all accrete over the course of June, and the curves for 1 July 2023 would look like Exhibit 23.

Exhibit 22: Yield and breakeven curve in 1st 'perfect foresight' world
See text for explanation.



Source: BofA Global Research

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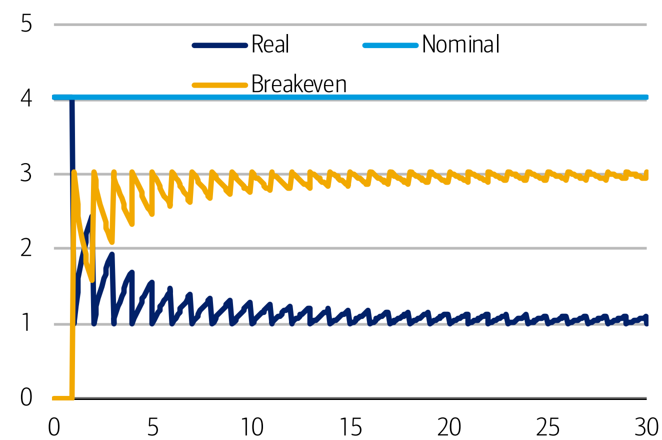
Exhibit 23: Yield and breakeven curves in 2nd 'perfect foresight' world
See text for explanation.



Source: BofA Global Research

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In this second scenario, the next monthly index accretion would occur over the course of June 2024, so inflation-linked bonds maturing before then would experience no inflation uplift; their real yields would therefore have to be the same as nominal bond yields (4%). Bonds with a 1y horizon would enjoy a full years' indexation, and would have a real yield of 1%, but bonds maturing between 1y and 1y11m would experience no further indexation, and so on, along the curve, creating “saw tooth” no-arbitrage real yield and (by subtraction) breakeven curve.

Model 2. Perfect foresight with sine wave seasonals

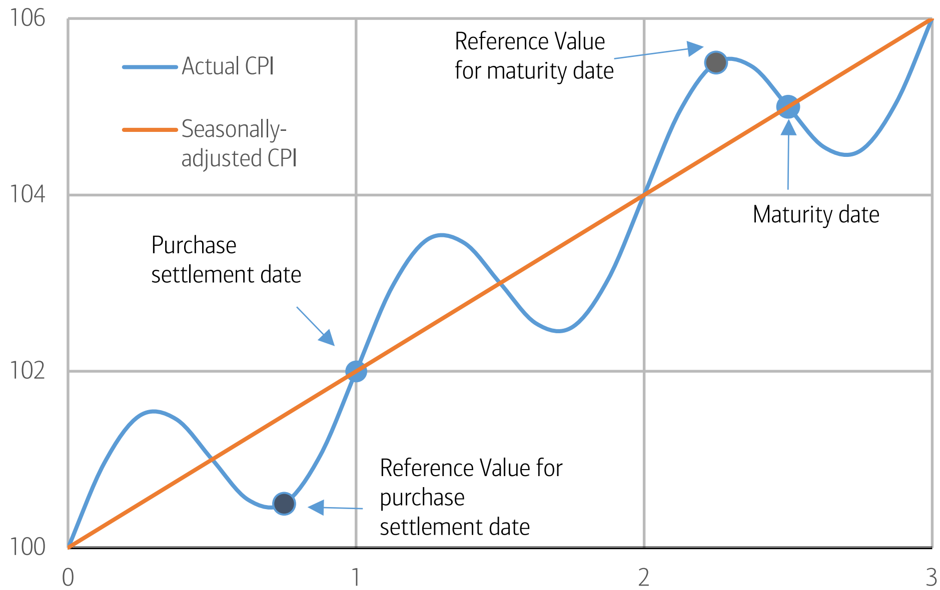
In another perfect foresight world, underlying inflation runs at a constant 2%, but the linking index is seasonally strong in the first half of the year then seasonally weak in the second half. The seasonal peak is at three months and the seasonal trough is at nine months.

Exhibit 24 shows the evolution of actual and underlying inflation in this world for three years. We have also marked the date where a linker is bought, at the end of year 1. The linker matures in the middle of the third year, so has only 18 months remaining life at the time of purchase.

The purchase and maturity dates are at points where the actual CPI and seasonally-adjusted CPIs are equal, so the inflation rate experienced over the holding period is 2%. However, with the indexation lag, the Reference Value for the purchase date is three months earlier, when the index is seasonally weak, while that for the maturity date is when the index is seasonally strong. As a result, in this diagram the holder experiences a total inflation uplift of 5% (the Reference Value for the maturity date divided by that for the purchase date) having only held the bond for 18 months – an annualized inflation accretion rate of 3.3%.

If traded at fair value, the bond would have been purchased with a breakeven of 3.3%, and because it is “seasonally advantaged” (its maturity Reference Value sits at a season high), it will have a significantly lower real yield than a bond maturing six months earlier or later, with a seasonally disadvantaged maturity Reference Value, other things being equal.

Exhibit 24: Stylised linking index behaviour, with sine wave seasonality around the trend rate
Covering a three year period, with a linker purchase and its maturity 18 months later marked.



Source: BofA Global Research

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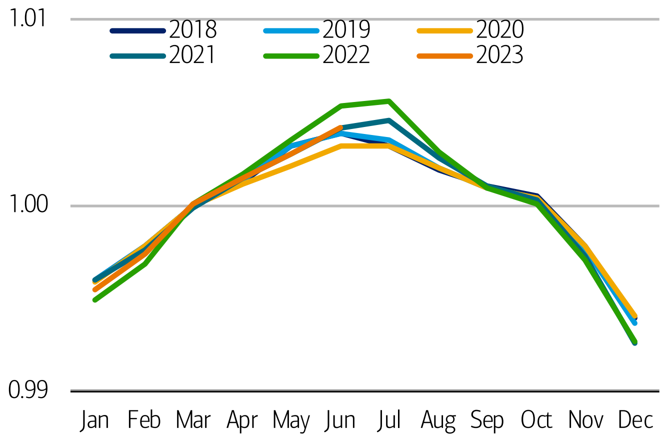
Valuing seasonality in linkers

The above theoretical example of “sine wave seasonals”, is not completely divorced from reality when we consider seasonal patterns of CPI linking indices. Exhibit 25 shows how the seasonality of the US CPI has evolved since 2018 as a ratio of the unadjusted series over the adjusted one. Exhibit 26 shows the seasonal contribution to monthly changes in the index, using the same data.

As we learnt from our second "toy" model, it is an advantage for a linker to have its final index fixing when the price index is seasonally strong. In the case of TIPS, issues with a 15 July maturity date are favored in this way. And those with maturities referencing seasonally weak months, like 15 April maturity TIPS (with final Reference Values being a blend of January and February prints), are disadvantaged.

The market strives to price seasonal advantages and disadvantages. July TIPS issues appear rich against a simple fitted real yield curve – lower real yields are the quid pro quo for a stronger expected cumulative indexation over their remaining lives. Conversely, April issues appear cheap, requiring yield compensation for their seasonal disadvantage.

Exhibit 25: Multiplicative US CPI seasonal factors, ratio of indices
CPI nsa/CPI sa. A number above 1 indicates seasonal strength relative to the average for the year.



Source: BLS, BofA Global Research

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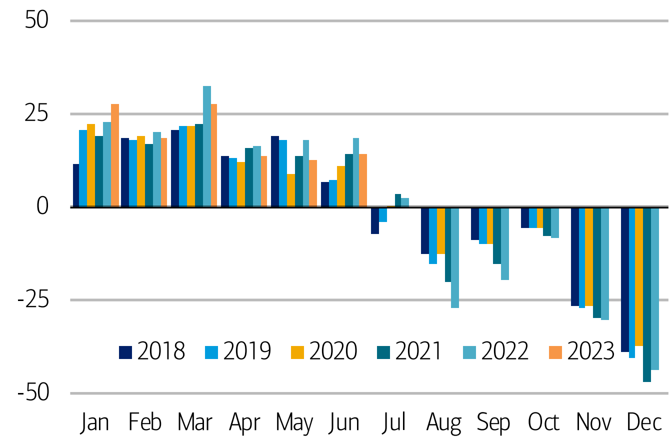
Exhibit 26: Additive US CPI seasonal factors, bp
Seasonal contribution to monthly change in CPI nsa.



Source: BLS, BofA Global Research

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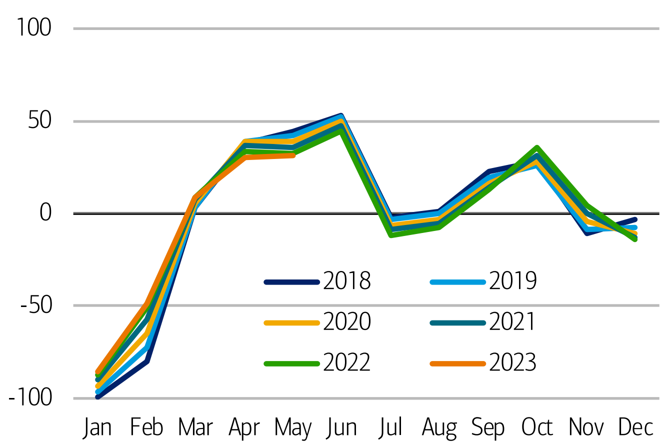
Exhibit 27 shows how the seasonality of the Eurozone linking index has evolved over time. Exhibit 28 applies the indexation lag to the 2022 seasonal pattern to show the seasonality of Reference Values rather than the underlying index. This allows us to mark the maturity dates for the different Euro government issues to see how they compare.

Exhibit 27: Multiplicative Euro HICPxT seasonal factors, ratio of indices
HICPxT nsa/HICPxT sa. A number above 1 indicates seasonal strength relative to the average for the year.



Source: Eurostat, ECB, BofA Global Research

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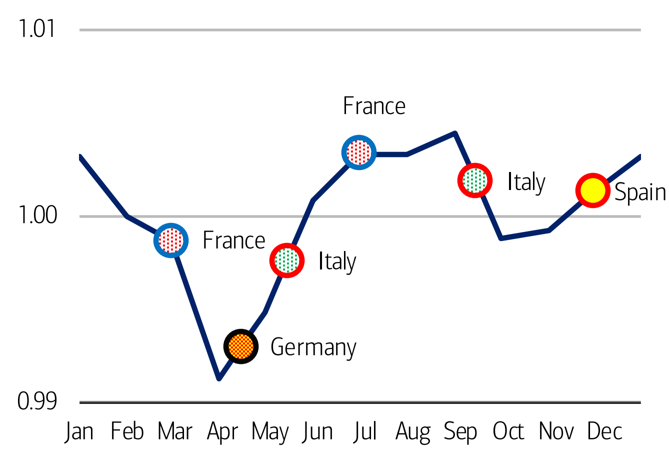
Exhibit 28: As left, after applying indexation lag to give seasonal pattern for Reference Values, with issuer maturity days marked
Using only last year's seasonality values. France's July issue are most seasonally advantaged, Germany's issues most disadvantaged.



Source: Eurostat, ECB, BofA Global Research

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Formalizing valuation - seasonally adjusted real yields and breakevens

Knowing some bonds are seasonally-advantaged or disadvantaged, we can seasonally-adjust real yields (SARYs) and, thereby, breakevens.

We do this by creating a seasonals index, centered on a convenient number (1 or 100), lagged and interpolated in the same way as CPI reference indices. We then project this seasonals “vector” for every future year.

We then seasonally-adjust the (real) clean price (P), using:

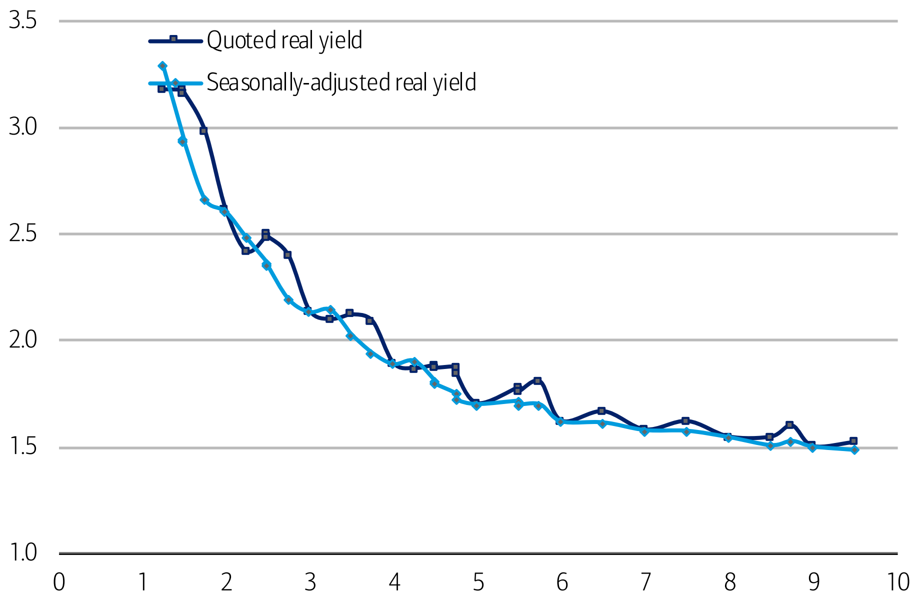
Seasonally-Adjusted Price (SAP) = P x Sv/Sm, …

… where Sv is the seasonal index at value date and Sm is the seasonal index at maturity.

The seasonally-adjusted price can now be used to calculate a seasonally-adjusted yield in the usual way.

Note. Strictly speaking, we should seasonally adjust the real dirty price, but the basis point value of a seasonal adjustment applied to accrued interest is very small, especially in the context of uncertainty over the accuracy of seasonal adjustments and their future persistence through time. For semi-annual paying bonds, an even greater degree of precision would require dealing with the fact that interim coupons will have different seasonal factors to cashflows on the anniversary of the maturity date.

Exhibit 29: US TIPS – observed and seasonally-adjusted real yields out to ten years, %
Using Bureau of Labor Statistics seasonal factors for 2021 (providing better fit than 2022 factors).



Source: BofA Global Research, BLS

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In the chart above, we exclude sub-1y issues, where the market has far more granular information and expectations about likely price index developments (and the basis point value of this information can be large).

We have chosen 2021 Bureau of Labor Statistics seasonals, rather than more up-to-date ones, because those for 2022 seem to overcorrect, producing a less smooth curve. The seasonal pattern for US CPI has become more pronounced in recent years, and it seems that the market assumes a future moderation. Exhibit 25 does suggest that 2023 seasonals seem to be tracking the 2021 pattern thus far, rather than the more aggressive 2022 pattern.

Important considerations

These calculations assume that the current seasonal pattern will persist indefinitely. It obviously won't. Seasonality evolves for a host of reasons, e.g., because consumption baskets change, or because price discounting behavior changes.

The question is whether the current pattern is an unbiased estimate of the future pattern. Can the future evolution of the seasonal vector be modelled (for instance, is the magnitude of seasonal variations correlated with the level of inflation, or some other macro variable)?

Market participants will use different seasonality assumptions. Even after seasonal adjustment, apparent cheapness/richness of bonds might mean our assumptions are different to those of the market in aggregate.

Thankfully, although confidence in the future seasonal pattern decays as the horizon becomes more distant, the critical issue is the seasonality applicable when a bond matures. The basis point yield value of seasonal factors also decays as duration lengthens.

Watch Easter! Easter is a source of seasonal strength in prices (travel, holidays, etc.), but Easter moves around, complicating matters.

Expanding Fisher, introducing premia

Using the linkers market, nominal interest rates can be decomposed into component parts (Exhibit 30). The "breakeven" is the inflation rate that equates nominal and linker returns and is typically closely proxied as the nominal yield less the real yield of the matched-maturity linker.

Just as the nominal yield is thought to have a short rate expectation and a term premium component, so too do real yields and breakevens. While the simple breakeven inflation versus real yield decomposition is taken from market pricing, term premium and expectations need to be estimated from models, such as the Fed's DKW (D'Amico, Kim, and Wei) model.

Real yield expectations can be interpreted as how the market views the expected policy rate to evolve relative to the inflation level. Inflation expectations represent how the market estimates inflation to evolve over time. Term premium is associated with upside uncertainty around inflation levels and Fed policy stance. This higher level of uncertainty generally means that investors should be compensated with a higher yield. Term premium is lower when Fed policy and inflation risks skew to the downside.

The fifth component in the nominal yield decomposition is liquidity premium. Linkers tend to be less liquid than nominal securities and so they trade with a liquidity premium. When this increases, real yields widen and breakevens are compressed.

Exhibit 30: Decomposition of nominal UST yield

Nominal yield can be decomposed into short rate/ term premium and real yield/ inflation compensation

nominal	=	real yield	+	inflation compensation
=		=		=
nominal short rate expectation	=	real ***short rate expectation***	+	***inflation expectation***
+		+		+
nominal term premium	=	real ***term premium***	+	inflation ***term premium***
		+		-
		liquidity premium		liquidity premium

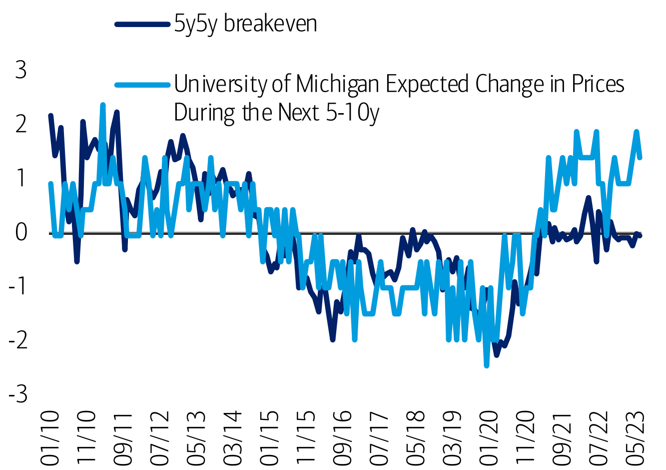
Source: BofA Global Research

BofA GLOBAL RESEARCH

Inflation expectations: Because the inflation market is influenced by supply/ demand and liquidity, it is not an explicit read on inflation expectations. Models give us a sense for how much changes in inflation compensation can be explained by inflation expectations vs. term premium and liquidity dynamics, but still they are not a perfect representation.

Exhibit 31 shows the z-score of 5y5y breakevens vs the University of Michigan survey of 5-10y inflation expectations. Historically, these two components tend to move loosely together, but there are periods of divergence. Since the start of 2022, longer term inflation expectations measured from this survey have been elevated, while the comparable forward inflation measured by the market has remained in-line with longer run averages.

Exhibit 31: 5y5y breakeven vs survey inflation expectations (Z-score)
Inflation compensation and inflation expectations tend to move together, but showed some dislocation in late 2020-2022



Source: BofA Global Research, Bloomberg

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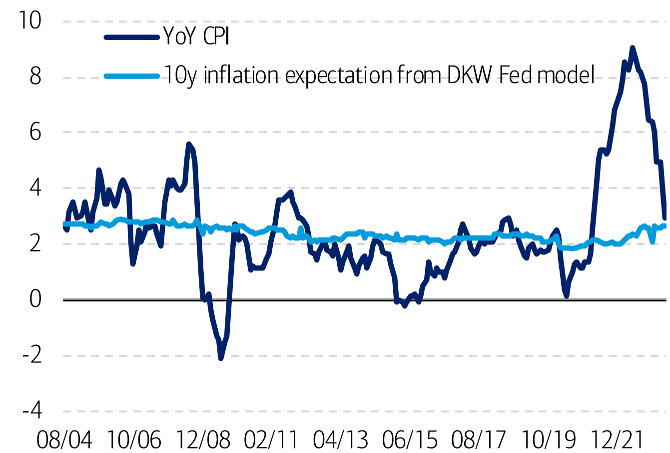
Exhibit 32: Market based inflation expectations and realized inflation
Market inflation expectations tend to be very stable despite volatility in realized inflation



Source: BofA Global Research, Bloomberg, Federal Reserve

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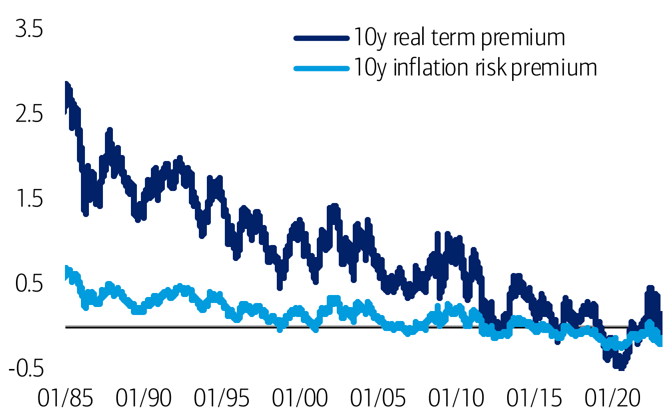
As shown in Exhibit 32, the DKW model suggests that this is because inflation expectations extracted from market pricing are notably stable despite fluctuations in realized inflation. The bond market tends to show greater conviction in the Fed being able to achieve 2% inflation over the longer run vs surveys which show greater sensitivity to realized inflation.

Term premium: Term premium, which can be decomposed into real and inflation components, is the extra compensation that bond investors demand for bearing interest rate risk. Inflation term premium specifically is the extra compensation bond investors demand for bearing inflation risk. According to the DKW Fed model (D'Amico, Kim, and Wei, 2010), inflation term premium depends on the relationship between inflation and real economic activity.

As shown in Exhibit 33, inflation term premium was positive and higher in the 80s through the mid-90s when investors were more worried about stagflation scenarios (higher inflation accompanying lower growth). More recently, inflation term premium has been close to zero, or negative, suggesting investors do not view stagflation as a high risk in the current regime.

Exhibit 33: Components of term premium
Both real and inflation term premium have declined over recent decades



Source: BofA Global Research, Federal Reserve

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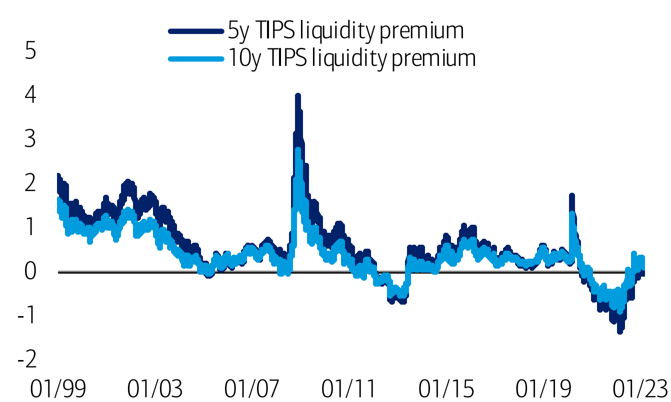
Exhibit 34: Liquidity premium implied from Fed DKW model
Liquidity premium spikes during stress events



Source: BofA Global Research, Federal Reserve

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Liquidity premium: TIPS liquidity premium reflects the difference in liquidity between real and nominal yields. As shown in Exhibit 34, this premium was high when TIPS were first issued as it took some time for investor demand to develop. TIPS liquidity premium was highest though during the Global Financial Crisis (GFC), as investors fled from less liquid/ more risky instruments to safer/ more liquid assets like nominal Treasury securities.

More recently, we saw a sharp repricing of liquidity premium during the covid crisis and subsequent Fed QT purchases. Like the GFC, the covid crisis in 2020 was an event where investors moved into more liquid assets, and so TIPS cheapened vs nominals. However, in mid-2021, TIPS liquidity premium fell sharply to some of the lowest levels since the TIPS market was launched. This occurred as the Fed was buying a larger share of TIPS relative to the TIPS proportion of Treasury issuance, with strong demand from inflation protected funds emerging. Since then, liquidity premium has repriced back towards longer run levels as the Fed reduces the size of its balance sheet and the inflation market in the US has observed more balanced supply/ demand backdrop.

We should stress that these premia are not directly observable. We have tried to present the above in a straightforward, easily understandable way, but there are many complexities in interpreting this nominal yield decomposition, and different mathematical models can produce quite different estimates for the unobservable components.

Inflation derivatives

The Zero Coupon (ZC) inflation swap

The main form of inflation derivative is the Zero Coupon Inflation Swap. The good news is that it is an extremely simple structure – more simple than a standard nominal rate swap – making it a versatile building block with many applications. There is only one exchange of payments, at maturity, where one party pays a compounded fixed rate for the whole contract period – the quoted inflation swap rate at entry – and receives from the counterparty the cumulative change in the inflation index over the same period.

The inflation "receiver" is the party that receives the uncertain floating leg linked to the inflation index, in contrast to nominal swaps, where the receiver receives the fixed rate leg. Given the scope for confusion, it is common for these trades to be expressed as being "long inflation" or "short inflation", for clarity.

Stating the obvious perhaps, it is important to stress that this is an explicit trade in prospective inflation, not in real rates (although real rate derivatives can be constructed), whereas a trade in an inflation-linked bond is a trade in a real rate, which must be paired with a nominal bond to create a close-to-equivalent trade in prospective inflation.

Unlike most developed inflation-linked bond markets, ZC inflation swaps generally do not have a deflation "floor". A year-on-year inflation swap (an inflation derivative structure which is also popular, and where the inflation accreted over the contract period is paid out each year) does incorporate a floor.

Differences in market conventions

The US ZC inflation swap market uses the same 3-month indexation lag and linear interpolation as the TIPS market. For example, a 5-year ZC inflation swap with a starting settlement date of 25 July 2023 would have an initial Reference Value of 303.95448, interpolating between the April print of 303.363 and May print of 304.127 – the same value used to calculate the Index Ratio of a TIPS issue traded for value on that day.

Euro HICPxT and French CPI swaps also have a 3-month indexation lag; however, (unlike Euro linkers) they do not interpolate through the month. For example, for settlement dates through the whole of July 2023, contracts will reference the April index print. They have a "month-end roll".

Exhibit 35: Stylized term sheet for 5y US CPI swap quoted at 2.500%
Entry terms and final payment in the event of 3% inflation over 5-years.

Notional:	100,000,000
Index:	Consumer Price Index, NSA
Source:	First publication by Bureau of Labor Statistics, as shown on Bloomberg CPURNSA
Start date:	25-Jul-23
End date:	25-Jul-28
First CPI fixing:	303.95448 (Reference Value for 25 Jul 2023)
Fixed leg:	(1+2.500/100)^5 -1
Inflation leg:	$CPI_{ReferenceValue25Jul28}/CPI_{ReferenceValue25Jul23}$ -1
Payment at maturity in the event of 3% average inflation:	
Final HICP fixing:	352.36655 (Reference Value for 25 Jul 2028)
To pay on fixed leg:	13,140,821
To receive on inflation leg:	15,927,408
Net payment to Inflation long	2,786,587

Source: BofA Global Research

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Exhibit 36: Stylized terms for 5y Euro HICPxT swap quoted at 2.435%
Entry terms and final payment in the event of 3% inflation over 5-years.

Notional:	100,000,000
Index:	Eurozone Harmonized Index of Consumer Prices, excluding tobacco, unrevised (HICPxT)
Source:	First publication by Eurostat, as shown on Bloomberg CPTFEMU
Start date:	25-Jul-23
End date:	25-Jul-28
First HICPxT fixing:	122.79 (April 2023)
Fixed leg:	(1+2.435/100)^5 -1
Inflation leg:	$HICPxT_{April2028}/HICPxT_{April2023}$ -1
Payment at maturity in the event of 3% average inflation:	
Final HICP fixing:	142.35 (April 2028)
To pay on fixed leg:	12,782,537
To receive on inflation leg:	15,929,636
Net payment to Inflation long	3,147,099

Source: BofA Global Research

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UK RPI swaps (and the more modest UK CPI swap market) also do not interpolate, rolling the indexation reference print at month-end. And, unlike the others above, the UK has a shorter 2-month indexation lag.

Rethinking carry and seasonality

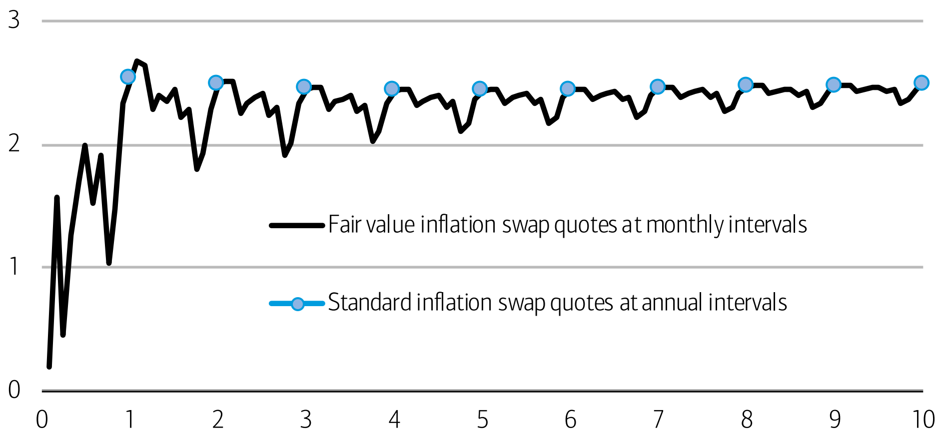
Imagine the 1-year inflation swap rate is 4% and the 5-year rate is 3%. If you go long 5-year inflation at 3%, and the 1-year rate is in line with your own estimate, then your estimated carry is indeed positive for the next year. However, this is not the best way to think about it. The value of your position after a year will depend upon the actual path of the linking index over the year and how the then prevailing 4-year rate compares to the 1y4y rate at outset.

Seasonality is a complicating issue for inflation swaps, as it is for linkers. When you enter a fresh inflation swap, it is typically for a tenor set in whole years – for example a 5-year inflation long at 3%. With the day of the year the same for entry and maturity, seasonality should not be an issue (insofar as seasonal patterns are expected to persist through time, as we discussed earlier).

As time passes and an inflation swap ages, seasonality becomes an important valuation consideration. If the first six months of a 5-year period is seasonally strong, then the residual "stub" period to the first anniversary of the swap will be seasonally weak. A 4.5y inflation swap rate will therefore be lower than the original 5-year rate if the curve is unchanged. Seasonality needs to be reflected in quotes for non-integer periods.

Exhibit 37: The Euro inflation swap curve you see, and the one you don't, 21 July 2023, %

You can't simply interpolate between market quotes based on whole years to get rates in between.



Source: BofA Global Research

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Linker asset swaps and the inflation basis

"Proceeds" and "par/par" ASW conventions for nominals apply to linkers too

As with a nominal bond asset swap, an inflation-linked bond asset swap exchanges all cash flows received by the bond holder for a (nominal) floating rate plus an agreed spread and a final principal payment from a counterparty. The floating rate will be the same used for standard nominal asset swaps, such as SOFR, Sonia, Euribor, €str, etc.

For example, when an investor enters into a TIPS asset swap, they buy a TIPS security (from a dealer) and agree to pay the dealer all the TIPS cash flows. In return, the investor receives (SOFR + spread) through the life of the bond and a principal payment, with the principal payment dependent on the type of asset swap transaction.

The buyer will do so to take advantage of the relative cheapness of linker asset swaps versus nominal bonds. These investors are effectively getting compensated for providing liquidity to the market and make money by earning the spread, roll down (if the spread curve is upward sloping) and if spreads tighten (linkers richen vs swaps).

The convention for inflation asset swaps is different across inflation markets: in the US and UK asset swaps are "proceeds" based, in the Euro area asset swaps are more commonly done on a "par/par" basis. These types of asset swaps have equivalents in the nominal market.

With a par/par asset swap, the floating interest rate leg is calculated on the original (non-indexed) par amount (i.e., 100). A Euro linker investor would buy the bond at par, "pay away" all inflation-linked cash flows (income and principal) and receive Euribor/€str plus a spread through the life of the bond, then the same non-indexed par at maturity.

When an asset swap is done on a proceeds basis, this means that the swap notional amount is based on the dirty cash price of the linker, including accrued interest and adjusted (normally uplifted) for inflation indexation.

A TIPS asset swapper would buy the bond at its market price, with the settlement amount calculated in the normal way. She then pays away all inflation-linked cash flows (income and principal), receiving SOFR plus a spread through the life of the bond and the original settlement amount (the purchase cost) of the TIPS issue at maturity.

The preference for the proceeds method in the US and UK reflects the fact that the value of a position can be very different from par for a linker – particularly older issues with a lot of accreted indexation. For instance, $100 original par of the TII 3 7/8 Apr 2029 has a current full cash price of $207.33, which would make the spread-to-SOFR calculated as if the exposure were only par very misleading.

Assuming positive future inflation, even the proceeds measure doesn't capture the fact that the position will likely rise in value over its remaining life. One type of asset swap that tries to deal with this issue is the "accreting" asset swap, although it is not widely used (perhaps because of its extra complexity) and we will not discuss it here.

Z-spreads most useful for assessing value

As with nominal bonds, the z-spread is a very popular measure for judging relative value between issues (and between linkers and nominals). Although it is not a tradeable construct, it gives a truer/fairer perspective of asset swap spreads because of the complications discussed above.

For linker z-spreads, the future cash flows of a linker are projected in nominal terms, taking readings for future reference values from the inflation swap curve. The cash flows are discounted with the appropriate floating rate reference curve (SOFR, Sonia, Euribor, €str, etc).

This will give a total present value that differs from the current dirty cash price, so the floating curve is "bumped" by a basis point amount sufficient to equate the present value to the price. This is the z-spread, and Exhibit 38 shows a worked TIPS example using TII 2.5% Jan-2029. We've chosen an old high coupon issue in order to have a full dirty cash price well away from par.

Exhibit 38: Calculating linker z-spreads – example using old TIPS issue with high cash price
The methodology is similar to nominal bond z-spreads, but requires market-based projections of CPURNSA.

Value	24 July 2023
CUSIP	912810PZ5
Coupon	2.500%
Maturity	15 January 2029
Base Ref' CPI Value	214.69971
Index Ratio	1.4156
Real Price	103.6015625
Real Accrued	0.061
Real Dirty Price	103.663
Cash Dirty Price	146.745

			Using SOFR			Using SOFR + 38.9bp		
	Index Ratio	Cash flow	Rate	Discount Factor	Present Value	Rate	Discount Factor	Present Value
15 January 2024	1.42630	1.783	5.407%	0.975	1.739	5.796%	0.974	1.736
15 July 2024	1.44695	1.809	5.345%	0.950	1.719	5.734%	0.947	1.713
15 January 2025	1.45876	1.823	5.030%	0.930	1.696	5.419%	0.925	1.687
15 July 2025	1.48243	1.853	4.752%	0.912	1.691	5.141%	0.906	1.678
15 January 2026	1.49458	1.868	4.494%	0.897	1.676	4.883%	0.889	1.660
15 July 2026	1.51890	1.899	4.321%	0.882	1.674	4.710%	0.872	1.656
15 January 2027	1.53155	1.914	4.162%	0.868	1.661	4.551%	0.857	1.640
15 July 2027	1.55669	1.946	4.051%	0.854	1.662	4.440%	0.841	1.637
15 January 2028	1.57005	1.963	3.950%	0.841	1.650	4.339%	0.827	1.623
15 July 2028	1.59632	1.995	3.884%	0.827	1.651	4.273%	0.812	1.620
15 January 2029	1.61033	163.046	3.820%	0.814	132.786	4.209%	0.798	130.095
					149.605			146.745

Source: BofA Global Research estimates

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The inflation basis

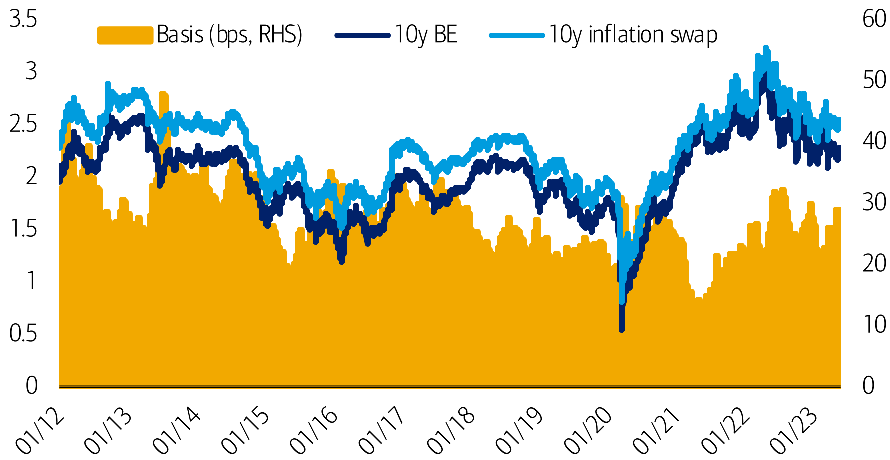
Market readings for future inflation given by breakeven rates and inflation swaps to a given horizon are not the same. The difference between the two is known as the inflation basis. For instance, in the UK, the 4-year inflation swap rate is 4.05%, while the 4-year breakeven for UKTi 2027s is 3.64%. There are mathematical reasons for these differences, but the bigger drivers are behavioral.

The mathematical reasons are straightforward. An inflation swap rate is based on a contract with a single exchange of cashflows at the tenor horizon, so it is a precise reading of average inflation to that horizon. A bond breakeven is a yield spread between instruments that normally have slightly different maturities, quite different interim cash flows and often very different durations. And a quoted inflation swap rate will typically represent a period in whole years, removing/minimizing the seasonality issue, but this is only true for bond breakevens on the linker's maturity anniversary.

The behavioral difference is essentially a bias to receive inflation in swap form. There are more long-term, or "natural", inflation receivers, such as pension funds (sometimes with an explicit inflation-linked hedging need, as in the UK) than there are natural long-term payers of inflation. Additional demand to receive, or be long, inflation via inflation swaps comes from structured products desiring some form of inflation protection or compensation.

The market mechanism to fill a shortage of inflation payers works in two ways: either the inflation swap rate pushes high enough for speculative investors to position against inflation pricing that is above their own expectations by paying it; or by linkers becoming sufficiently cheap on asset swap – either in absolute terms or relative to the asset swap spreads for nominal government bonds – for speculative investors to buy the bond and pay away the inflation.

Exhibit 39: 10y BE inflation and inflation swap
Inflation swap trades above BE in part due to demand imbalance between inflation pays and receivers



Source: BofA Global Research, Bloomberg

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Exhibit 39 shows the history of the inflation basis for 10y TIPS. A higher basis means that the cash breakeven is cheap versus the inflation swap.

We have recently observed notable swings in the US inflation basis:

- **2021 basis compression**: was driven from demand in the cash market for TIPS. This demand largely stemmed from strong inflows into inflation protected funds as well as Fed purchases: over the length of QE Fed purchased over 80% of gross issuance of TIPS.
- **2022 basis widening**: with the Fed out of the inflation market and reducing overall market liquidity, this eliminated a source of demand for TIPS and increased the liquidity premium. This drove a cheapening of breakevens versus inflation swaps.

Investors can take views on the inflation basis by putting on opposing positions in the cash bonds and inflation swap markets. When you are "long the basis", you are positioning for a relative cheapening of the cash breakeven to the inflation swap. Conversely, a short basis position is a view that the cash breakeven will richen versus the swap.

The second way of thinking about the basis

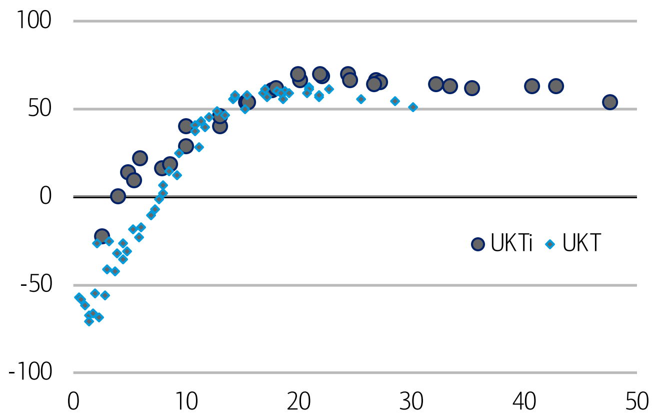
As we have said, the bias to be long inflation in inflation swaps tends to mean that linkers trade cheap to their nominal comparators on an asset swap basis. This spread of asset swap spreads is known colloquially in the market as the "iota".

This iota should, in principle, fill the gap between a bond breakeven and an inflation swap rate for a given term, and is therefore an alternative measure of the inflation basis. In practice, the two basis measures are not the same, again because the cash flows of the bonds in a breakeven trade are not perfectly aligned with each other or with the swap contract.

The next two charts show that although linkers tend to trade cheap to nominal government comparators on a z-spread basis, that is not always the case.

Exhibit 40: Nominal and inflation-linked UK Gilts, z-spreads, bp

Plotted vs duration. Linkers mostly cheap to nominals, but mainly in wings.



Source: BofA Global Research, Bloomberg

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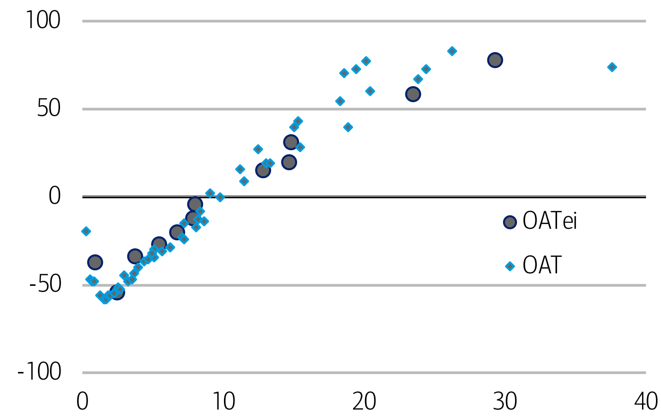
Exhibit 41: Nominal and inflation-linked OATs, z-spreads, bp

Plotted vs duration, OATei, linked to Euro inflation, now slightly expensive.



Source: BofA Global Research, Bloomberg

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Positioning across economic cycle

In addition to expressing views on the inflation outlook vs what the market is pricing, linkers also allow investors to express views on the broader macro environment. In Exhibit 42 we illustrate how real yields vs the breakeven inflation rate would be expected to move in different economic phases. In a stagflation scenario, investors want to be long linkers. During periods of hawkish Fed policy action, investors want to be short linkers.

Linkers will outperform nominals in a stagflation environment when inflation remains elevated, but growth is slowing. In this environment a weaker growth picture keeps real yields compressed, while higher inflation supports inflation compensation.

Linkers tend to underperform nominals when the central bank is taking on an aggressive stance. In this scenario breakevens compress due to a worsening economic outlook and hawkish Fed policies combating inflation pressure. Real yields will therefore often increase more than nominals and are supported by realized and expected central bank tightening.

Exhibit 42: Rate composition in different macro environments
TIPS outperform nominals in stagflation environment and underperform in hawkish central bank (CB) scenario

		Breakeven inflation	
		Increase	Decrease
Real yields	Increase	**High growth scenario**: nominal yields are supported by BEs and real yields-- negative nominal returns, but linkers will outperform	**Hawkish CB stance:** real yields rise from CB policy expectations, inflation compensation falls. Nominal will outperform linker.
	Decrease	**Stagflation:** linkers outperform, inflation comp is elevated, real rates are compressed by growth concerns	**Recession**: nominals outperform linkers, rate decline across real rates and inflation comp

Source: BofA Global Research

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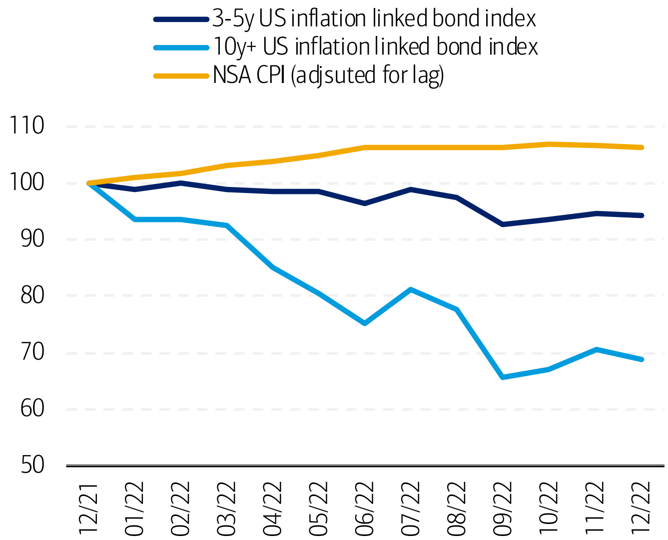
Owning a linker is not the same as owning inflation

A common question we received from new investors in the TIPS space when inflation continuously surprised to the upside during the post-covid period was: "why are TIPS underperforming?" (Exhibit 43).

Elevated inflation drove a much more aggressive policy stance which resulted in real yields increasing above and beyond nominal rates (Exhibit 44). Duration returns from owning a bond tied to the real yield more than offset the positive carry incurred from owning a bond that was indexed to NSA CPI. To offset the increase in real yields, an investor would have been better served to put on a long breakeven position: overlaying a short nominal rates position to in part offset the sharp rise in real yields that drove negative returns on the TIPS position.

Exhibit 43: BofA US inflation linked bond index returns in 2022
TIPS delivered negative returns particularly long duration bonds despite increase in indexed inflation



Source: BofA Global Research, Bloomberg

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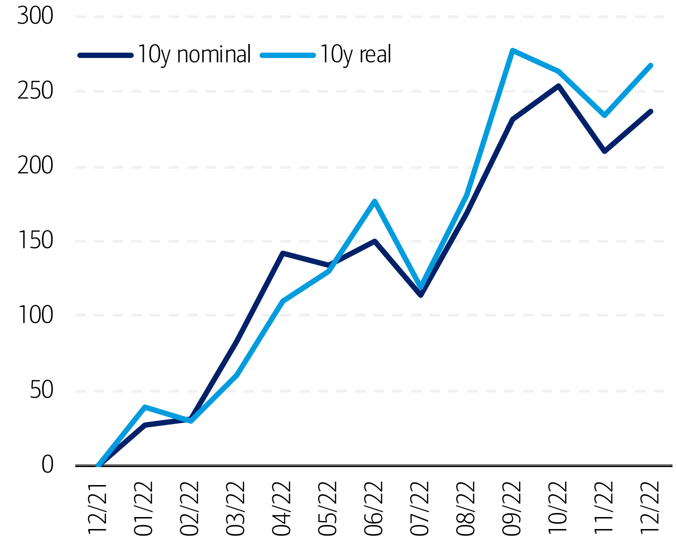
Exhibit 44: Change in 10y nominal and real interest rates in 2022 (bps)
Real yields increased more than nominals in 2022



Source: BofA Global Research, Bloomberg

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This was a prime example of Exhibit 42, which suggests that when central banks turn hawkish, investors want to be positioned short linkers to take advantage of a sharp increase in real rates. Despite inflation surprising to the upside and helping support carry, negative duration returns on TIPS would have more than offset the positive carry from owning a linker. Indeed, returns on the linker would diverge sharply from realized inflation over that holding period.

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