



Mastering Inflation Linkers and Derivatives

Overview of European and UK inflation markets

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European Rates Strategy

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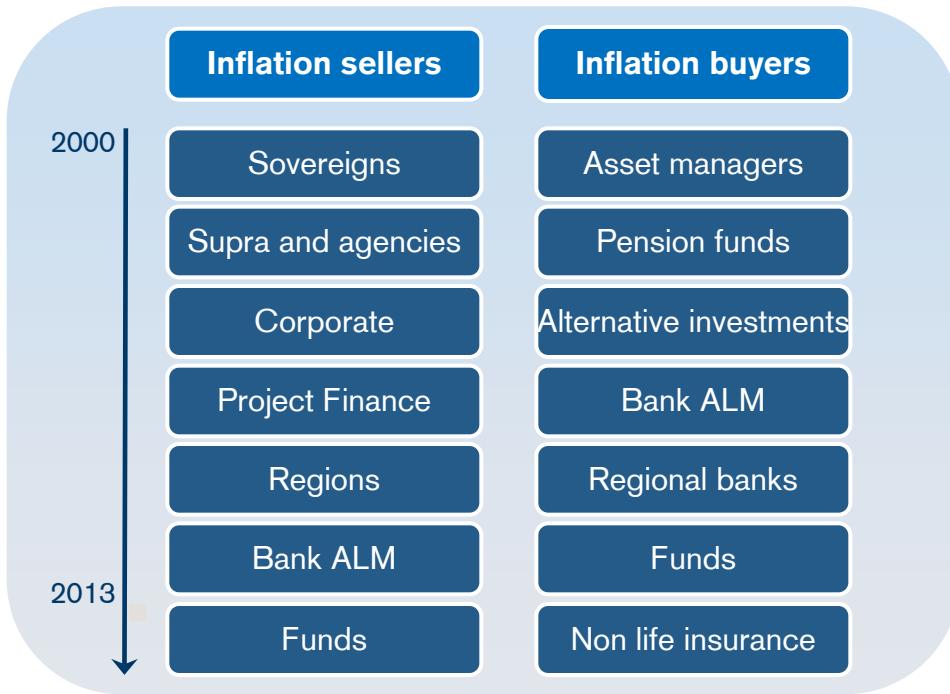
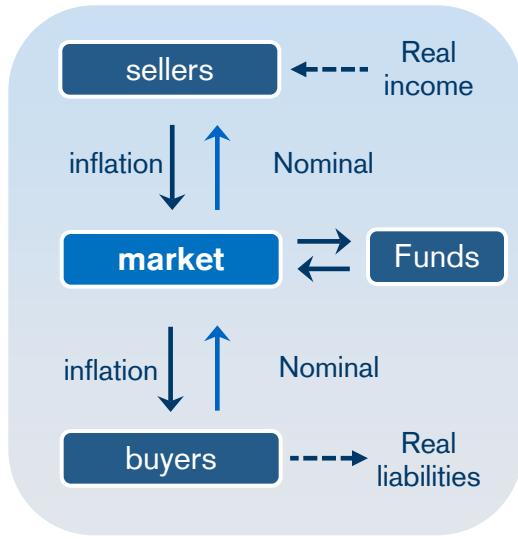
All sources throughout this report are Credit Suisse, unless indicated otherwise.

What is inflation?

Why trade inflation?

- **Asset/Liability Hedging**
 - Government/Corporations hedging inflation-linked revenue
 - Pension/Insurance, i.e., 'Real Money' hedging inflation-linked liabilities
- **Asset Return Focused Investing**
 - Inflation products being one of the key real assets in asset allocation mix to optimize risk/reward
 - Investors buy inflation-linked bonds on Asset Swap for yield/alpha enhancement
 - FX reserve managers, diversifying away from nominal to real assets during periods of high inflation
- **Tail-risk Hedging**
 - Inflation risk as one of the tail risks in current macro environment
 - Portfolio hedging using inflation options
- **Other reasons**
 - Inflation-linked issuance increases government credibility on price stability

Market participants



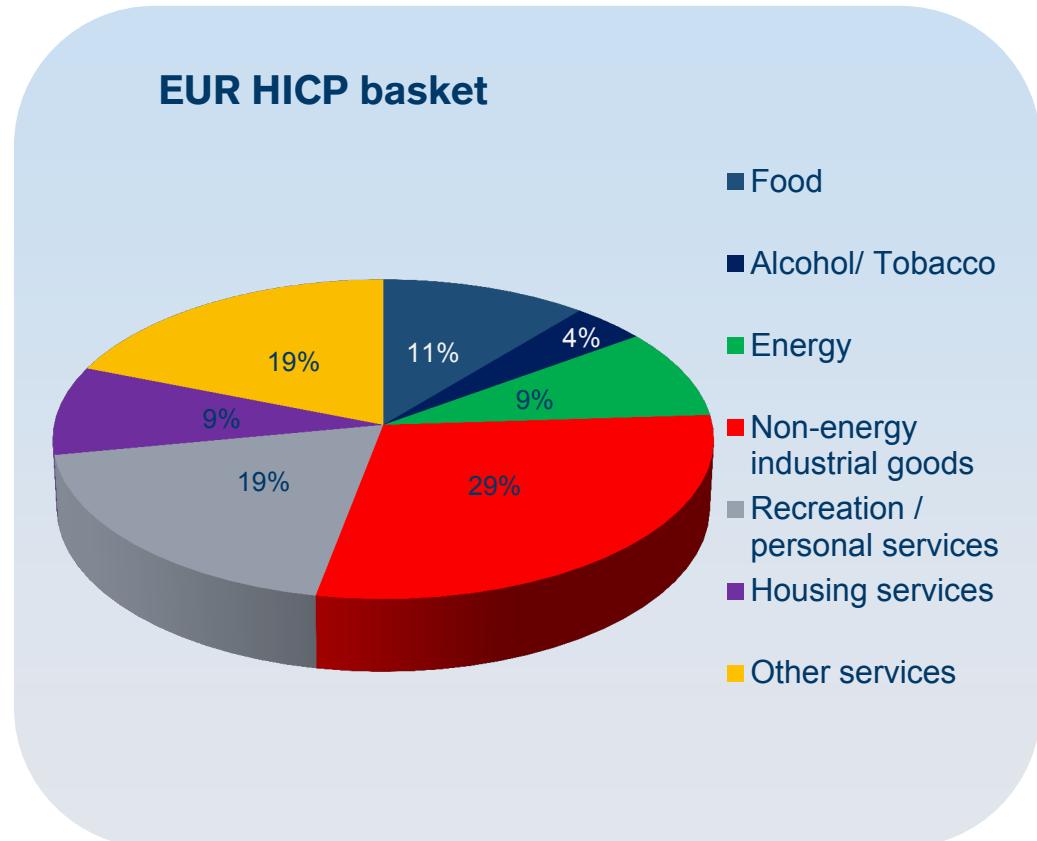
- Sovereign and regional agencies are among the biggest **inflation sellers**, as a hedge to their inflation linked incomes and as cheap financing (saves the inflation risk premium). Until 2000: UK, France, US, Canada, Sweden and Australia. Since then, also: Italy, Greece then Japan and Germany.
- Pension funds are the prime **buyers of inflation**, given their need for assets and liabilities to move in line. This has been emphasized by changing regulations in European countries as well as UK.
- All these flows have increased liquidity, attracting other players to seek opportunities.

What are the fundamental drivers of inflation?

A Deep Dive into a Typical CPI Basket....

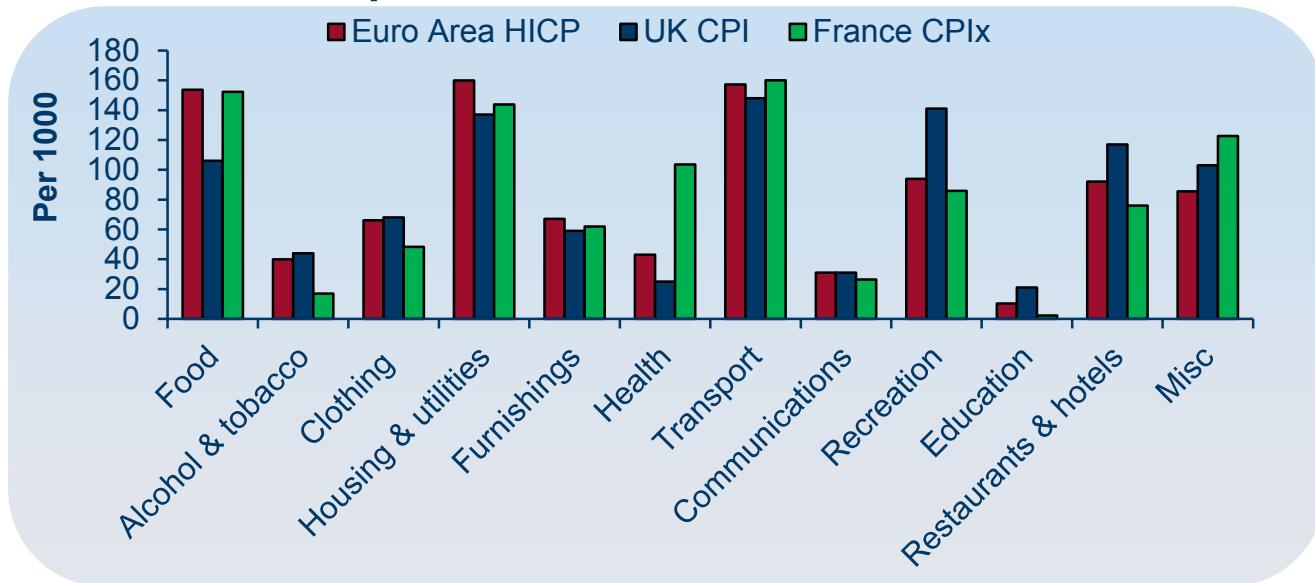
Key drivers:

- **FX** (particularly in core goods) – current account and trade balance
- **Oil prices** impact directly on petrol prices, and feed through with only limited lag
- **Tax changes** can impact alcohol/tobacco in particular (less so for HICPxT). VAT effects matter a lot in UK and EUR
- In some indices **house prices and interest rates** can have a direct impact on inflation (e.g., UK RPI)
- **Administered prices** are important (e.g., UK university tuition fees)



Source: Credit Suisse, ECB website: link [here](#)

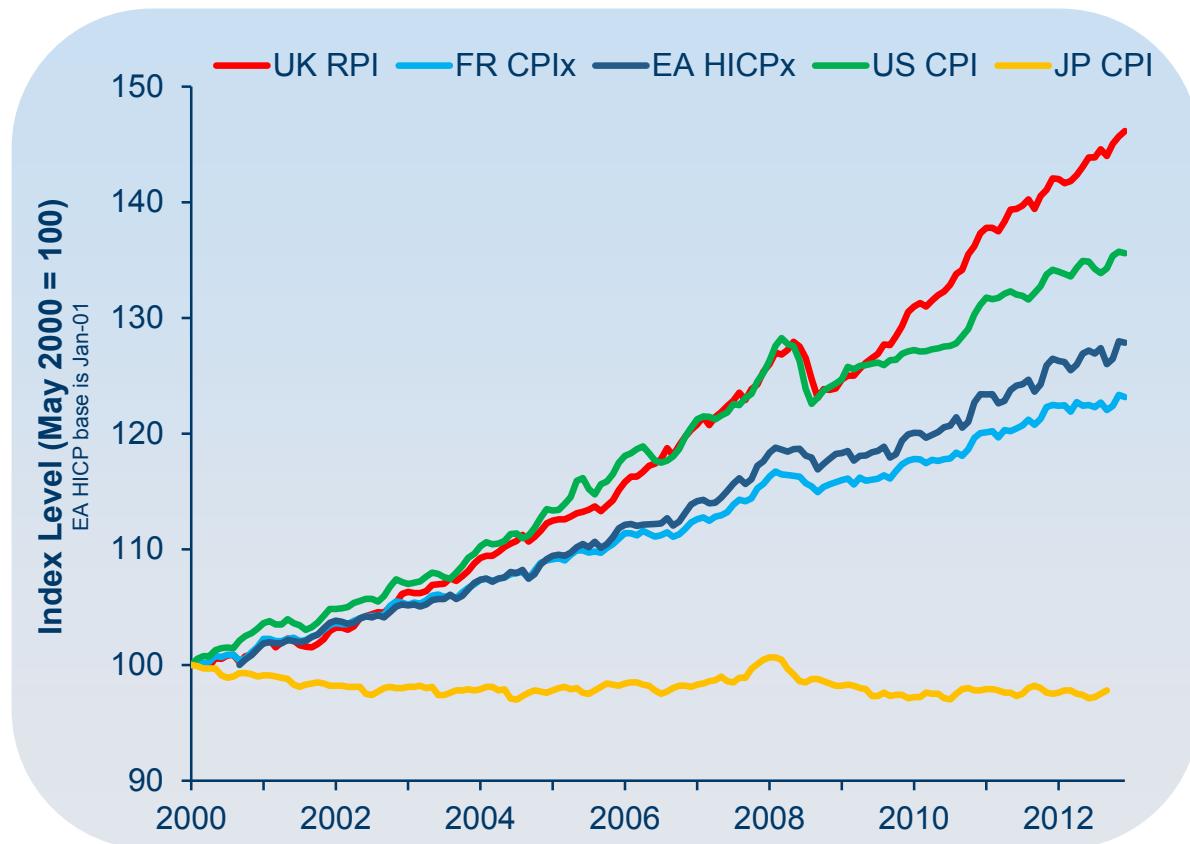
Inflation index components



- The weights assigned to each category (food, housing, clothing...) are generally revised annually.
- Different indices use different classification systems for their components (including UK RPI vs. CPI).
- Although the categories for EU HICPs are aligned, each country has different weights to reflect consumption differences.
- Differences between indices matter, for instance: weighting of energy between EUHICPx and FRCPIx or the CPINSA treatment of housing. This is important when evaluating cross-market trades.

Source: Credit Suisse, national statistical agencies

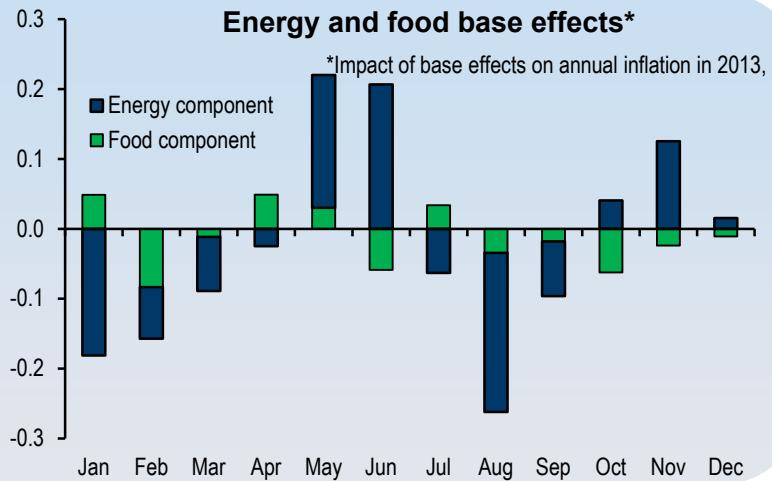
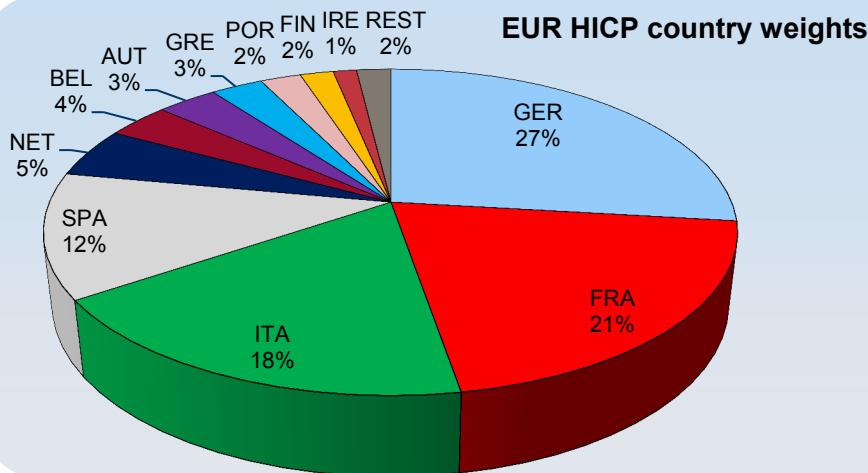
History of the main indices (rebased from 2000)



- Broadly similar evolution across developed markets, except Japan
- UK inflation has outstripped others since the 2008 crisis, despite historical similarity

Source: Credit Suisse, the BLOOMBERG PROFESSIONAL™ service

Seasonality matters (a lot)

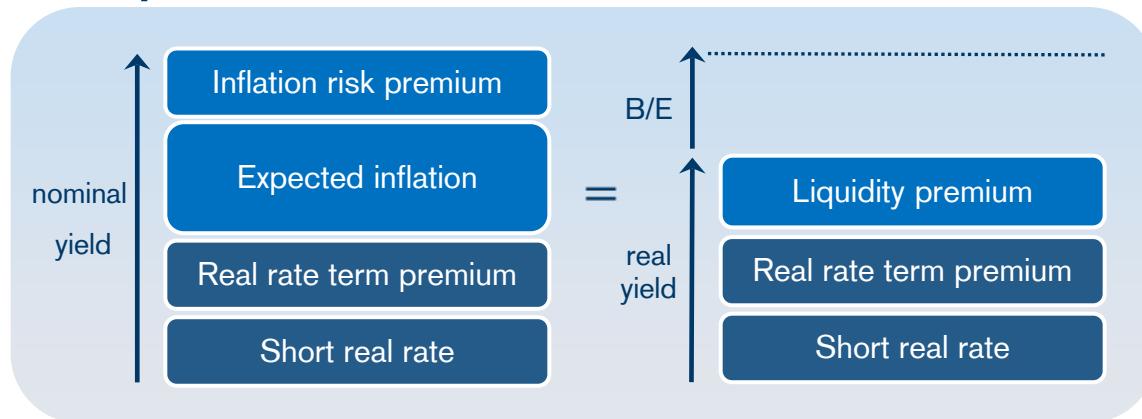


- Seasonality, i.e., persistent deviation from trend at specific times of the year, will be mainly dependent on commodity prices, natural factors, fiscal policy (e.g., VAT), as well as socio-cultural traditions.
- Bonds and swaps are almost always linked to non-seasonally adjusted inflation indices and so outside of a range of standardized maturity dates, interpolation must be used to build maturity curves using past estimates of seasonality.
- Measurement is usually done according to three methods: dummies, TRAMO/Seats or X-12 Arima. (See [Demetra](#)), with an annual revision of estimated seasonal adjustments (see [ECB paper](#).)

High seasonal inflation pay outs → High quoted real yield

Source: Credit Suisse, Eurostat

The Fisher equation: an introduction to “traded” inflation



- **Fisher:** $(1 + \text{nominal}) = (1 + \text{real}) \cdot (1 + \text{inflation}) \Rightarrow \text{nominal} \approx \text{real} + \text{inflation}$
- **Breakeven inflation** is defined as the level of future inflation that would equate the returns on a linker and the closest nominal bond. In practice: $BE = \text{yield}_{\text{nominal comparator}} - \text{yield}_{\text{real linker}} (\approx \text{inflation})$. This simplification doesn't capture differences in maturities between the two bonds, seasonality or repo.
- The **inflation risk premium** reflects the risk of increased inflation (particularly in the long end) while the **liquidity premium** reflects the relative lack of liquidity or demand (particularly in the front end) for a linker. All other things equal, if demand for linkers increases and/or nominal yield increases then BE widens.
- In swap format, BE is the inflation that must be realized for a ZC inflation swap to realize zero value: $(1 + BEI)^n = \frac{CPI^n}{CPI^0} \Rightarrow BEI = \left(\frac{CPI^n}{CPI^0}\right)^{1/n} - 1$ with n the tenor of the swap in years.

Inflation products: Find whatever suits you

Product	Inflation buyer receives	Inflation seller receives	Comments
Inflation-linked bond (“linker”)	[Semi-]Annually: $X\% * \frac{CPI(n)}{CPI(0)}$ At maturity: $\text{Max} \left[\frac{CPI(N)}{CPI(0)}, 100\% \right]$ for US/EUR or $\frac{CPI(N)}{CPI(0)}$ for UK	Upfront: Dirty Price (DP) = $(\text{Clean price} + \text{Accrued}) * \frac{CPI(N)}{CPI(0)}$	Less liquid than nominal equivalents
Zero Coupon Swap	At maturity: $\frac{CPI(N)}{CPI(0)}$	At maturity: $(1 + X\%)^N$	Liquid Hedging tool for pension funds, insurance, ALM, etc.
Zero Option (example: Zero cap)	At maturity: $\text{Max} \left[0\%, \frac{CPI(N)}{CPI(0)} - (1 + X\%)^N \right]$	Upfront or forward option premium	Often very liquid
Year-on-Year Swap	Annually: $\frac{CPI(n)}{CPI(n-1)} - 1$	Annually: X% or Libor + Spread	Liquid Capped/floored version used in structured notes
Year-on-Year Option (example: YoY cap)	Annually: $\text{Max} \left[0\%, \frac{CPI(n)}{CPI(n-1)} - 1 - X\% \right]$	Upfront or running option premium	Liquid
Real Rate Swap	Annually: $X\% * \frac{CPI(n)}{CPI(0)}$ At maturity: $\frac{CPI(N)}{CPI(0)}$	Annually: Y% or Libor + Spread At maturity: 1	Liquid Used to replicate cash flows of linkers
Limited Price Indexation Swap (example: LPI(0,5))	At maturity: $\frac{LPI(n)}{LPI(0)}$ With $LPI(n) = LPI(n-1) * (1 + \max(0\%, \min(5\%, YoY(n))))$ And $YoY(n) = CPI(n) / CPI(n-1) - 1$	At maturity: $(1 + X\%)^n$	Some liquidity in LPI(0, 5) and LPI(0,+oo) traded in the UK for regulatory requirements
Linker Asset Swap	Upfront: Par- DP in EUR; DP in US/UK [Semi-] Annually: linker's coupons At maturity: linker's redemption	[Semi-]Annually: (Libor + Spread) * (Par or DP) At maturity: Par or DP	Some liquidity. Generates pick-up compared to nominal ASW. Formats: Proceeds/ Par-Par

Introduction to the world of Linkers

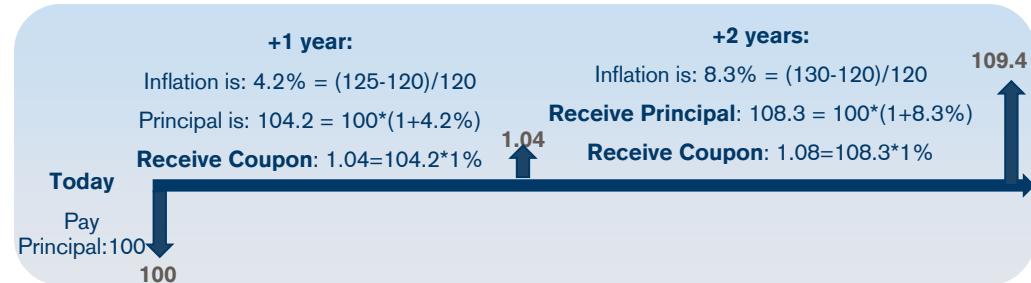
The first instrument: inflation-linked bond (“linkers”)

- A linker is similar to a nominal bond with a principal and coupon that grows with inflation. For each year n , it is defined as:

$$\text{Coupon}_n = \text{Fixed Rate} * \text{Principal}_n$$

$$\text{Principal}_n = \text{Principal}_0 * (1 + \text{Total Inflation between year 0 and year } n)$$

- Most linkers guarantee a redemption of at least 100% (except from UK, Canada and Japan) and therefore protect against a prolonged period of deflation.
- It protects a holder against realized inflation for a specific national reference index.
- The (clean) price of a linker is quoted in terms of its real yield and uses the same formula as for nominal bond: $\text{Price}_{\text{clean}} = \sum_{k=0}^n \frac{\text{Coupon}_k}{(1+\text{real yield})^k} + \frac{\text{Principal}_n}{(1+\text{real yield})^n}$
- However, the dirty price of a linker is a function of the total inflation recorded since issuance of the bond: $\text{Price}_{\text{dirty}} = (\text{Price}_{\text{clean}} + \text{Accrued Coupon}) * (\text{Inflation accretion})$
- Example: Buying a 2y Linker with a 1% coupon
 - Price index: 120 today; 125 in 1y; 130 in 2ys
 - Payment is 1.04 after 1y, 109.4 after 2ys



Government inflation-linked bond markets

Market	Amount outstanding (bn)	Number of bonds	Share of total issuance	Average maturity (years)	Longest maturity	First Issued	Last new issue	BB Index Ticker
UK	£ 223.21	22	22.26%	19.2				UKRPI
<i>3m lag</i>	180.36	16		25.2	2062	2005	2012	
<i>Old 8m lag</i>	42.84	6		9.0	2035	1981	2002	
France	€ 152.05	14	14.97%	9.0				
<i>Euro inflation</i>	85.54	8		11.0	2040	2001	2013	CPTFEMU
<i>Domestic inflation</i>	66.51	6		6.4	2029	1998	2012	FRCPXTOB
Italy	€ 160.22	14	11.41%	7.2				
<i>Euro inflation</i>	116.12	10		8.7	2041	2003	2013	CPTFEMU
<i>Retail</i>	44.10	4		3.4	2017	2012	2013	ITCPIUNR
Germany	€ 50.00	4	4.64%	5.9	2023	2006	2012	CPTFEMU
US	\$ 823.85	37	9.21%	8.8	2043	1997	2013	CPURNSA
Japan	¥ 3,447.27	16	0.44%	3.5	2018	2004	2008	JCPNJGBI

Source: Credit Suisse, the BLOOMBERG PROFESSIONAL™ service, as of 25 Jun 2013

- Linker issuance is an order of magnitude smaller than nominal government bonds.
- Several sovereigns have different threads to their inflation-linked issuance, such as different reference indices or fixing lags.
- Japan has not issued linkers since 2008, but JGBs issuance with floors will start again in Oct-13.
- As in conventional bonds, the UK issues particularly long-dated linkers; hence, benchmarked investors often use over-5y indices, so short-dated linkers (e.g., 2017s) will trade cheap.

Pricing linkers: 2-month lag and 3-month interpolation

- **Index publication lag:** reference index for month m is published during the 2nd half of month $m+1$. In order to have the daily quotations and address this lag, most markets use the “Canadian model”.
- **CPI fixing or Daily Inflation Reference (DIR)** is calculated using the interpolated value of the unrevised index 3-months and 2-months prior to the coupon payment data. The DIR for any day d in the month m is: $DIR_{d,m} = CPI_{m-3} + \frac{d-1}{NumberDays_m} (CPI_{m-2} - CPI_{m-3})$.
- The **Reference Price Index** is the $m-3$ price index. When a CPI number is released, the DIR can be assessed until the end of the following month. The Base Reference Index is the DIR calculated for the date where inflation accretes, usually the initial settlement date. The Index Ratio measures the accretion rate (e.g., total inflation since accretion) to apply to the nominal at current rate: $IR_{d,m} = \frac{DIR_{d,m}}{DIR_{base}}$.

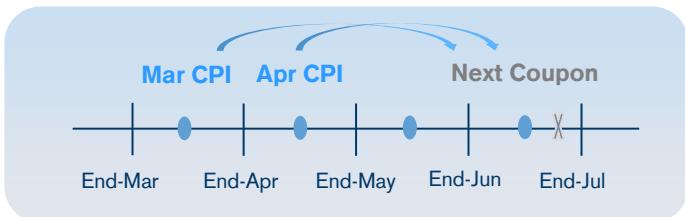
- **Coupon paid annually**= fixed coupon c . $IR_{d,m}$
- **(AC) Accrued Coupon**= fixed coupon c. $\frac{t_{settlement}-t_{last\ coupon}}{t_{next\ coupon}-t_{last\ coupon}}$
- **(UDP) Unadjusted dirty price**= clean price $P_{d,m}^{clean} + AC_{d,m}$
- **(ADP) Adjusted dirty price**= $P_{d,m}^{UDP} \cdot IR_{d,m} = (P_{d,m}^{clean} + AC_{d,m}) \cdot IR_{d,m}$
- **Yield to Maturity:** $P_{d,m}^{UDP} = \sum_{i=1}^2 \frac{c}{(1+Y_R)^i} + \frac{100}{(1+Y_R)^2}$



Getting through the cash flows in practice

- Over the life of a linker, the principal will be adjusted for inflation (growth rate of the price index of reference), with annual coupon payments calculated over this adjusted principal. But future inflation can't obviously be used to price linkers, we therefore use last two to three observations.
- Example:** Buying 1.6 OATEi Jul-15, settlement date 10 Apr 2013 where quoted price is €107.735
 - CPI Jan-13 = 116.83, CPI Feb-13 = 116.94; CPI April-04 = 97.86, CPI May-04 = 98.11
 - $$DIR_{settle} = CPI_{Jan-13} + (CPI_{Feb-13} - CPI_{Jan-13}) * \frac{10-1}{30}$$
 - $$DIR_{base} = CPI_{Apr-04} + (CPI_{May-04} - CPI_{Apr-04}) * \frac{25-1}{31}$$
 - July coupon amount can only be calculated when April-13 CPI is published
 - On 10/04/2013:
 - Accrued coupon = $1.6\% * \frac{10/04/2013 - 25/07/2012}{25/07/2013 - 25/07/2012} = 1.132$
 - Unadjusted dirty price = $107.73 + 1.13 = 108.868$
 - Adjusted dirty price = $108.868 * 1.17 = 127.824$
 - Yield to maturity: $108.868 = \sum_{i=1}^2 \frac{1.6}{(1+Y_R)^i} + \frac{100}{(1+Y_R)^2}$: $Y_R = -1.615\%$

$$IR_{settle} = \frac{DIR_{settle}}{DIR_{base}} = 1.17541$$



Carry

- Carry is defined as the income accrued while holding a security minus the cost of holding this position.

$$\text{carry} = \text{real coupon accrued} + \text{inflation accrual} - \text{repo rate}$$

$$= \text{current real yield} - \text{forward real yield}$$

- Seasonality can cause the **inflation accrual component** to vary considerably from month to month, and this can dominate carry and drive yields.
- **For instance**, negative inflation in January would accrete on a linker's principal during March. So for the total income from holding the bond to equal the repo cost, the quoted real yield (i.e., before inflation indexation is applied) will need to fall, and carry to be negative.

High seasonal in m → Increase quoted yield in m+2 → positive lagged carry

High seasonal in m → Decrease quoted yield in m+3 → negative lagged carry

- Consequently, **optionally rich or cheap linkers can be misleading** if carry is not accounted for – especially short-dated bonds (as carry is inversely related to duration).
- **Break-even carry** can also be calculated as the net carry on the linker (in real yield terms) minus carry on the comparator bond (in nominal terms).

Inflation accrued > BE → BE carry (usually) positive

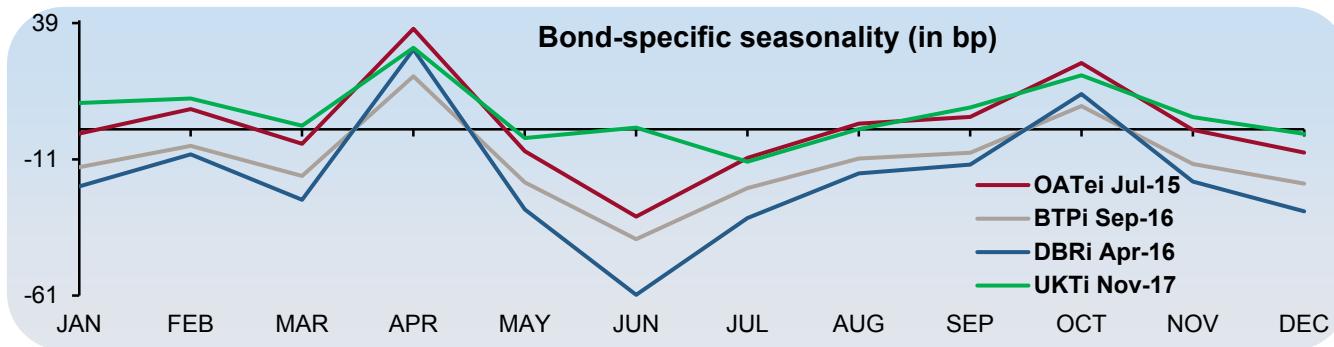
Carry in practice

- **For example**, European inflation was high in Mar-13 (2m/3m lag means this affects bonds from May).
- Taking the OATei 1.6% 2015 example from earlier, over a 1 month horizon from the trade on 10 April:
 - **Inflation-adjusted, dirty settlement price paid** = 127.824 (real yield = -1.615%)
 - Taking a repo rate over a month of 10bp gives a non-arbitrage **settlement price for 10 May** = 127.851 ($= 127.824 * (1 + \frac{30}{360} * 0.10\%)$)
 - Given CPI Mar-13 = 116.94: $DIR_{forward} = 115.954$, $IR_{forward} = \frac{115.954}{98.056} = 1.183$
 - Removing inflation gives an **unadjusted dirty price** = $\frac{127.851}{1.183} = 108.073$, equivalent to a **forward real yield** = -1.424%
 - This is a **real yield carry of +19.1bp** over the month (-1.615% \rightarrow -1.424%).
 - Note that short-dated linkers usually exhibit a higher carry in absolute terms.
- That is, the position will generate a profit if the real yield rises by less than 19.1bp.
- Easy money? NO! All else equal, the clean inflation-adjusted price of the bond will stay roughly constant, causing the yield to move mechanically higher as the bond's index ratio rises.

Spot real yield or breakeven provide a biased assessment of richness/cheapness

Seasonality in practice

- **To adjust linkers for seasonality**, we use the difference between the 3m lagged seasonal and the corresponding lagged seasonal corresponding to the maturity date of the bond in question and adjust by its modified duration:

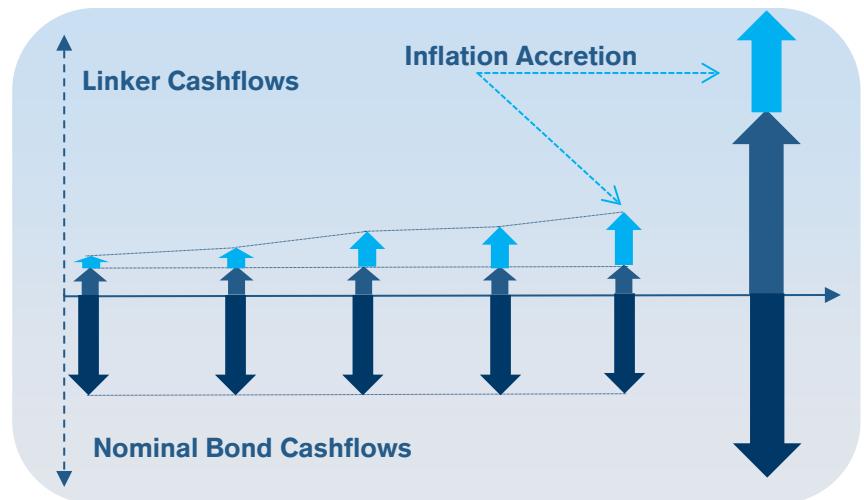


- When settlement equals maturity date, there is **no spot seasonal bias**.
- Seasonality in European inflation markets gives rise to **significant “optical” distortions** and explains why German breakevens can appear cheap to France, when they are not once seasonally adjusted.
- Seasonality has encouraged **investment** during positive carry periods. However, there is no clear positive return strategy given markets tend to be pretty efficient.

Source: Credit Suisse Locus

Linkers have a higher credit risk...

- A linker has a cash flow profile that is heavily skewed, with a greater proportion of the cash flow embedded in later payments and in the maturity payment. It is therefore **more sensitive to the sovereign credit than its nominal comparator** assuming a positive credit slope.



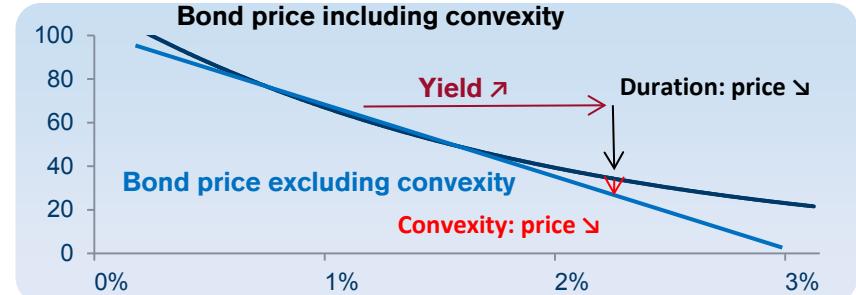
- A **long position** in the inflation breakeven (long linker/ short nominal) is therefore akin to a leveraged long credit position in the sovereign issuer.

Long position in breakeven → Long Sovereign credit

Source: Credit Suisse Locus

... and a higher duration

- **DV01** is usually defined as the sensitivity of the bond price to a small change in bond yield. Similarly to the nominal space, if the curve shifts up, a linker will lose in value. Linkers usually have higher real duration and real convexity than nominal bonds given their coupon and yield tend to be lower.
- **Convexity** is seen as the second derivative of a price with respect to its yield. A positive convexity implies that the price decreases less if its yield goes up than it increases if the yield goes down.
- But more importantly is how much real yield moves relative to a shift in the nominal curve. For any given move in nominal yields, usually part is a change in real yield and part is breakevens (note they can move in opposite directions). For instance, an upward shift in growth expectations incorporates rising inflation expectations, for which the linker holder will be partly compensated, it is the idea of beta:
- **Beta** is the sensitivity of real yields of a given maturity to nominal yields of the same maturity.
- The beta can be used to transform '**real duration**' to 'nominal' one and thus determine the desired allocation amongst linkers and nominal bonds within a portfolio containing both.



Beta

- Nominal yields depend on both **growth and inflation expectations** while real yield only depends on growth. So given that inflation and growth expectations are well correlated:
- $n_{nominal} = r_{real} + BE \Rightarrow var(n) = var(r) + var(BE) + 2 \cdot cov(r, BE)$. Provided the correlation between real yield and BE is not too punitive ($var(BE) + 2 \cdot cov(r, BE) > 0$) then **var(n) > var(r)**.
- Put differently, the yield sensitivity of a linker to a change in the equivalent nominal yield – **beta** – will usually be less than one (~0.5%), but not always so. This makes **breakevens directional**: when growth expectations increase nominal yields sell off more than real yields, widening breakevens.
- **QE** has caused BEs to remain wide even as nominal yields fell. The QE unwind has had the reverse impact, causing betas to be high (even >1 for periods of time).
- **Measures**: the estimate of beta is sensitive to the time period and maturity assessed. Beta for short-maturity can be volatile, especially when central banks look through near-term inflation.

$$\beta^{r,n} = cov(r, n) \cdot \frac{\sigma^r}{\sigma^n} \quad \text{or} \quad \beta^{BE,n} = cov(BE, n) \cdot \frac{\sigma^{BE}}{\sigma^n} \quad \text{with} \quad \beta^{BE,n} + \beta^{r,n} = 1$$

Inflation risk premium decreases → Higher beta

Unwind of QE policy → Higher beta

Inflation expectations: breakevens versus CPI swaps

- Inflation swaps and breakevens both measure the same economic variable – inflation expectations – but vary in technicalities.
 - **Inflation risk premium:** Primarily in the long end. Investors demand a premium for long-dated inflation products (e.g., breakevens and inflation swaps) due to the uncertain path of future inflation.
 - **Inflation liquidity premium:** Short end. Linkers are less liquid and more credit exposed than nominals. In particular, given the volatility of energy prices and their correlation to short-dated real yields, money managers with a nominal return mandate, will ask for a premium in linkers. The mismatch increases in times of stress, leading to lower breakevens.
 - Inflation swaps are also skewed higher due to the nature of the cash flows (Par versus Zero-Coupon), as well as a lack of natural sellers of inflation in swaps compared to bonds.
 - Note that the Iota spread (linker z-ASW – nominal z-ASW, see p.34) can be seen as an analytical measure of richness/cheapness of a BE versus inflation swap curve, given we have:
$$\text{CPI swap} \approx \text{BE} + \text{Linker Z-spread ASW} - \text{Nominal Z-spread ASW} \approx \text{BE} + \text{Iota Z-spread}$$
- But to understand this measure, first we must look in detail at derivatives...

Time to explore derivatives

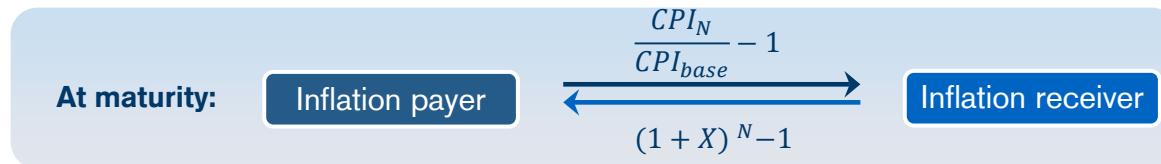
Inflation derivatives: real yield and swaps

- **Zero-coupon inflation swap:** exchange realized inflation for a compounded fixed rate
 - Purest inflation instrument
 - Straightforward to price and compare to inflation rates
 - Lagging principles may differ from the bond market
- **Real rate swap:** exchange realized inflation for a floating rate (+ spread), annually
 - Combines nominal duration and inflation
 - These “bond-style” swaps are standard in EUR while in the UK the ZC real rate swap remains more common
- **YoY swaps:** exchange realized inflation for a fixed nominal rate, annually
 - More cash flows complicate the relationship between swap rate and inflation
 - Requires estimating the path of inflation, not just the overall rate over the period
 - Need to adjust for inflation volatility and convexity, especially for longer-dated swaps

Zero-coupon derivatives

▪ Zero coupon (inflation) swaps

- Zero coupon (ZC) inflation swaps are the most liquid inflation derivatives but their pricing remains less transparent than linkers. However, they are not limited by issuance levels and are more flexible in terms of matching maturity.
- The fixed rate is calculated so that the expected net pay-off of the two legs is zero. It is usually called the **swap breakeven**.
- The payment received by the inflation buyer in a ZC derivative only depends on the final fixing of the index versus its fixing on start date; fluctuations in between have no impact.
- They involve only one exchange of cash flows at maturity:



▪ Zero coupon options (example of a zero coupon cap):

- The buyer of the cap pays a premium upfront and receives only one payment at maturity:

$$\text{Max} \left[\frac{CPI_N}{CPI_{base}} - (1 + X)^N; 0 \right] ; \text{ with } X\% \text{ the strike of the option}$$

Variation of zero-coupon derivatives

- **Other variations** are LPI swaps (e.g., for hedging UK pensions) where the annual rate of inflation to calculate the inflation leg is capped and/or floored, but still use a zero coupon format.
 - The inflation return is path- and volatility-dependent.
 - Only a few cap/floors are actively traded (LPI[0,5], LPI[0,3], LPI[3,5] and LPI[0,∞] in the UK) so there are little data from which to effectively value the optionality.
 - LPI swaps tend to trade rich to RPI swaps due to the structural demand for 0% floor. One of the reasons why LPI swaps exist in the UK is the absence of deflation floors in Gilt linkers.

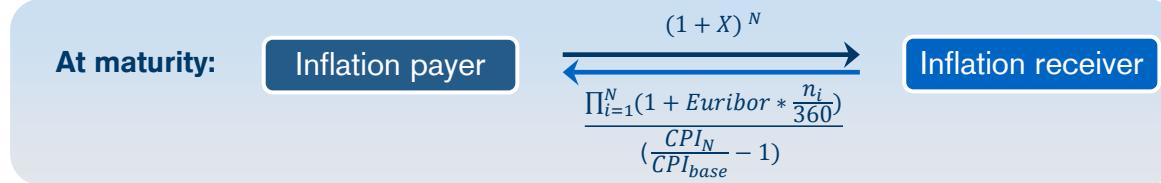
▪ Lag conventions

- Each market has its own conventions for deciding which index should be used in different contracts.

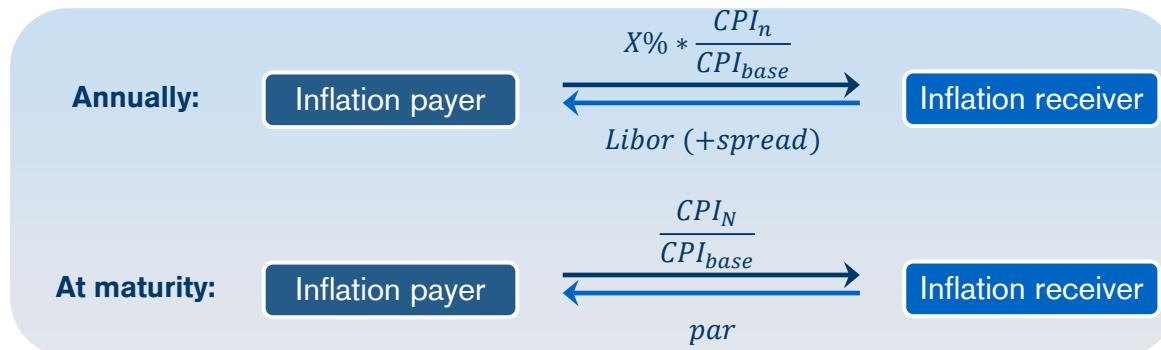
Market	Product	Convention	So for 12th June we use:
Euro	Swaps & Options	3m lag, no interpolation	Euro HICPxT value for March
UK	Swaps & Options	2m lag, no interpolation	UK RPI value for April
US	Swaps Options	Interpolation between 3m and 2m 3m lag, no interpolation	Average of US CPI value for March and April US CPI value for March
France	Swaps Options	Interpolation between 3m and 2m 3m lag, no interpolation	Average of French CPIxT for March and April French CPIxT value for March

Zero-coupon real swap versus Par real swaps

- **Zero-coupon real swap:** Combines nominal duration and inflation; more common in developing markets. Same principle as zero coupon swap but exchange realized inflation for a compounded floating rate (+ spread):

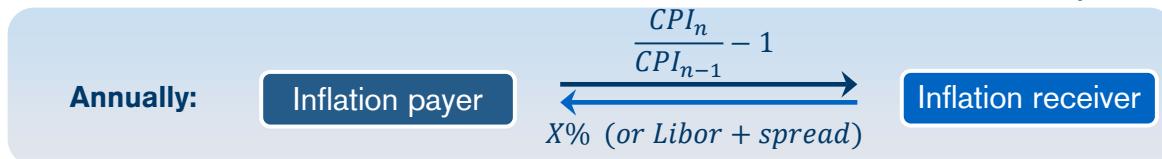


- **Real rate swap:** Designed to synthetically replicate the flows of linkers, these swaps are an established product. They can be used for asset and liability management for those who have exposure to real discount term structure. Combining it with a nominal swap allows an investor to change a fixed-rate bond into an inflation linked one (see p.35).



Year-on-year inflation derivatives

- **YoY swaps:** The payment received by the inflation buyer depends on the fluctuations of the index. It is quoted as X% and calculated so that the transaction is at zero-cost at inception:



- Once again, it comes back to the Fisher equation:

$$Nominal_{YoY} = Real_{YoY} + Inflation_{YoY} \Rightarrow Real_{YoY} = Libor - \left(\frac{CPI^n}{CPI^{n-1}} - 1 \right)$$

- YoY swaps can be replicated by a series of forward starting ZC swaps, but for longer maturities convexity distortions must be accounted for. The YoY structure is quite popular for non-linear products.

- **YoY options** (example of a YoY cap):

- YoY options are the most liquid inflation options. Floors/ Caps are used in structured notes.
- The buyer of the cap pays a premium (upfront or running) and might receive a payment on each payment date between Start and Maturity.
- YoY cap payment, with X% the strike:

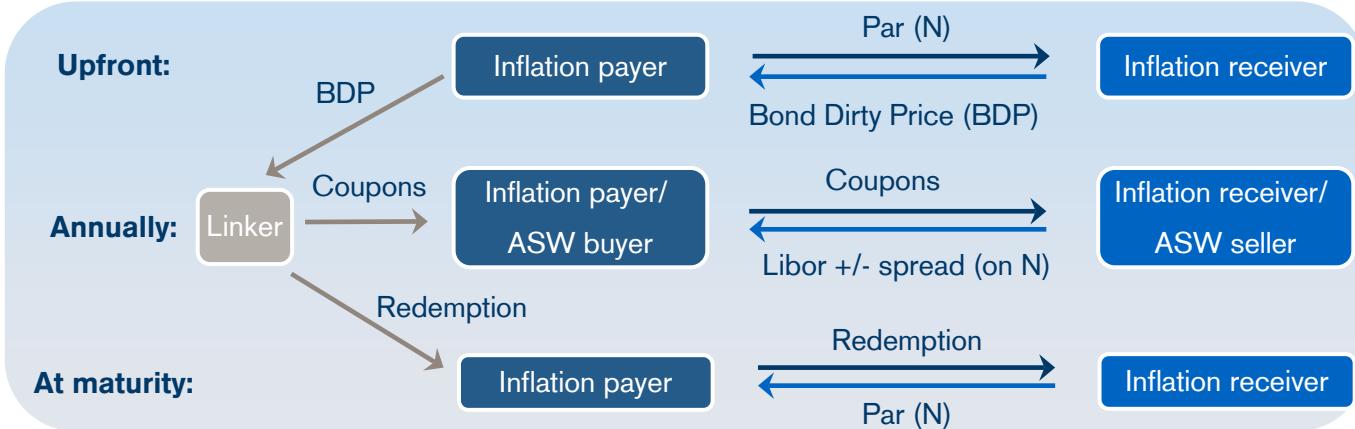
$$\text{Max} \left[\frac{CPI_n}{CPI_{n-1}} - (1 + X)^n; 0 \right] ; \text{ with X\% the strike of the option}$$

Forward swaps and convexity

- If forward rates in nominal space are rather intuitive, for inflation swaps it's another story.
- The expected future rate of inflation is correlated with the realized current rate of inflation and this can be defined as a convexity effect: **Higher inflation now → higher expected inflation**
- **Example:** Hedge a 5y5y ZC swap payer by paying 5y and receiving 10y spot ZC swaps.
 - Both spot notional (N_{5Y} , N_{10Y}) should be equal so the net exposure to inflation over [0y, 5y] is zero.
 - At that point, 10y inflation-adjusted notional should match the original 5y5y (N_{5Y5Y}) notional.
 - Therefore we find initially: $N_{5Y} = N_{10Y} = N_{5Y5Y} \cdot \frac{1}{\frac{\text{Expected}(CPI_5)}{CPI_0}}$
 - If inflation exceeds original expectations, the additional inflation accrual on the spot swaps means the (net long-inflation) hedge position must be reduced and will have made a profit.
 - In the opposite case, extra spot swap exposure must be acquired at cheaper levels than the initial trade, again yielding a profit from rebalancing. Hence the convexity effect.
- The convexity of the hedge biases forward rates lower than the simple forward calculation and are very rarely traded. Forming a forward swap synthetically by two spot swaps captures the efficiency of the curve while maintaining liquidity.

Linker asset swaps: Par-Par convention

- Just as with conventional bonds, asset swaps are common in inflation markets, both as traded instruments and for valuation purposes. But relative to nominal, the cash flow of the bond is not “fixed” anymore:

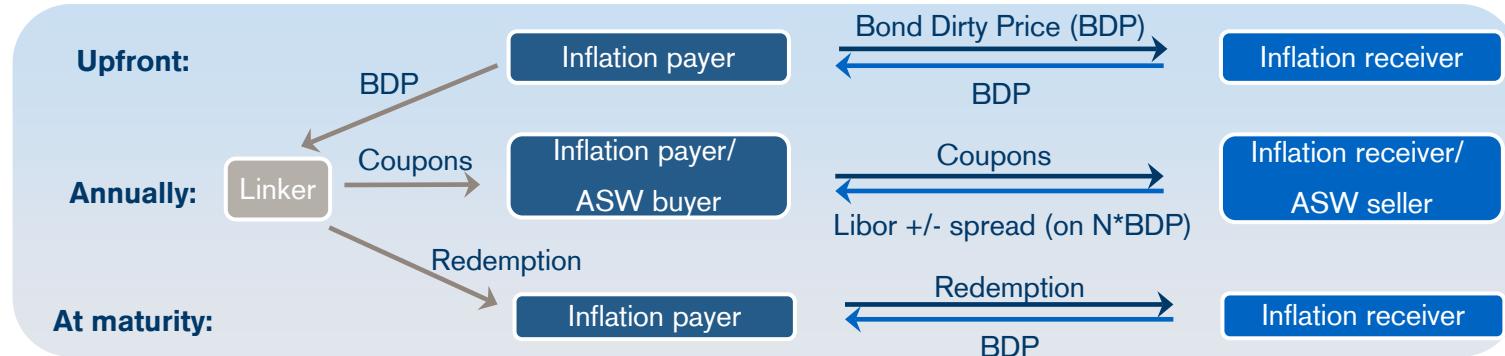


- Euro linkers are most often traded as par-par asset swaps:
 - The ASW buyer pays par (N) at initiation and then passes on the bond's coupons & redemption flow.
 - The ASW seller pays Euribor + a spread on the nominal amount (N) and pays back par at maturity.
- Simple product to calculate but given the long-dated nature of the cash-flow which the swap dealer is effectively lending to the ASW buyer, linkers can trade significantly away from par with a substantial upfront payment.

(Par) Price ↗→ Bond appears cheaper relative to its derivatives

Linker asset swaps: Proceeds convention

- UK & US linkers are generally traded as “proceeds asset swaps,” adjusting the notional for accrued inflation to date:



- By basing the swap on dirty price rather than nominal amount, the spread for bonds with different accrued inflation can be compared more fairly.
- The comparison with nominal ASW spreads is still not perfect as the accrual of inflation gives the linker a different credit risk profile.
- Albeit being primarily used in US and UK, it is increasingly being traded in Europe.
- Change in Proceed and Z-spread (see next page) asset-swaps will be similar over time.

Z-Spread and Iota Spreads - Overview

- **Z-spread**, as for a nominal bond, is the flat spread that must be applied to a discount curve to match the PV of the bond's cash flows and its dirty price.
- It is a better indicator of **true relative value** than ASW, as it includes term structure and removes distortion (seasonality, inflation accrual, etc.). It depends on the discount curve considered.
- **An Iota Spread** is the difference between a linker ASW or Z-spread and that of its nominal comparator:

$$\text{Iota} = \text{Linker ASW Z-Spread} - \text{Nominal ASW Z-Spread}$$

- Iota spread of Z-spreads indicates relative value between a breakeven against the swaps curve:

High iota → BE cheap versus swap

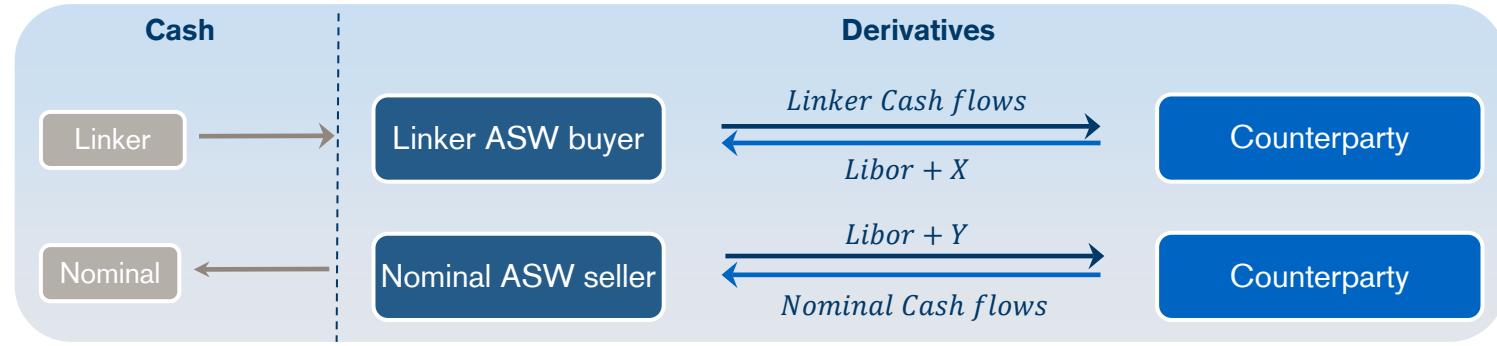
Low iota → BE rich versus swap

- Iota is normally positive due to the liquidity discount on the linker, the supply and demand dynamics as well as the back-end cash-flow on linkers, increasing the credit risk of the linker.
- In order to assess whether a linker is rich/cheap, investors will therefore often refer to a combination of real yield, breakeven, ASW and iota.

Z-Spread and Iota Spread – In more depth

- As seen, being long Iota is equivalent to be long Linker ASW and short Nominal ASW.

- 1:



- 2:



- 3: Given $\rightarrow (\text{Nominal} - \text{Linker}) \text{ Cash flows} \approx \text{ZC inflation Swap}$

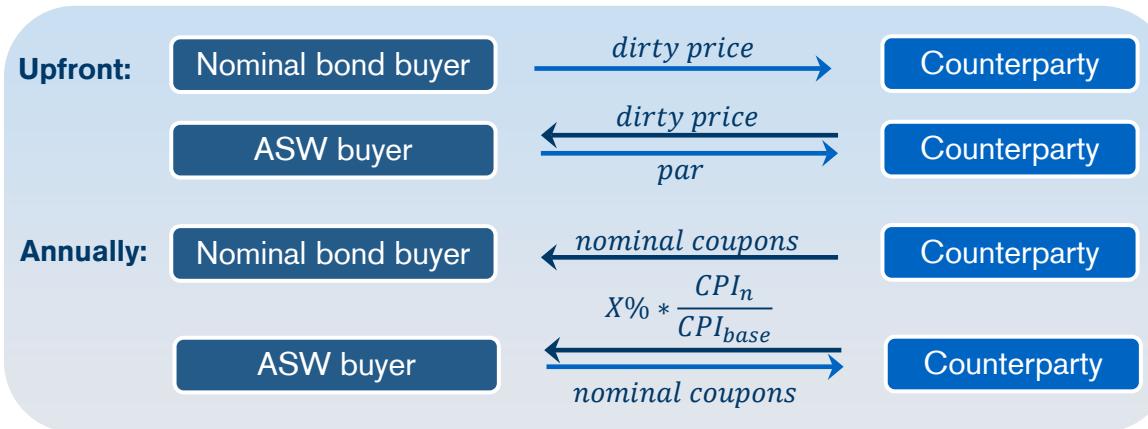
$\rightarrow X$ (proceeds ASW of Linker) and Y (proceeds ASW of Nominal) can be seen as the discount rates of their respective bonds, and thus their z-spread. So $(X - Y) \approx \text{Iota}$

- Hence, another way to express Iota is:

Iota \approx ZC swap – Breakeven corrected for seasonality

Linear trade idea: Create a synthetic linker

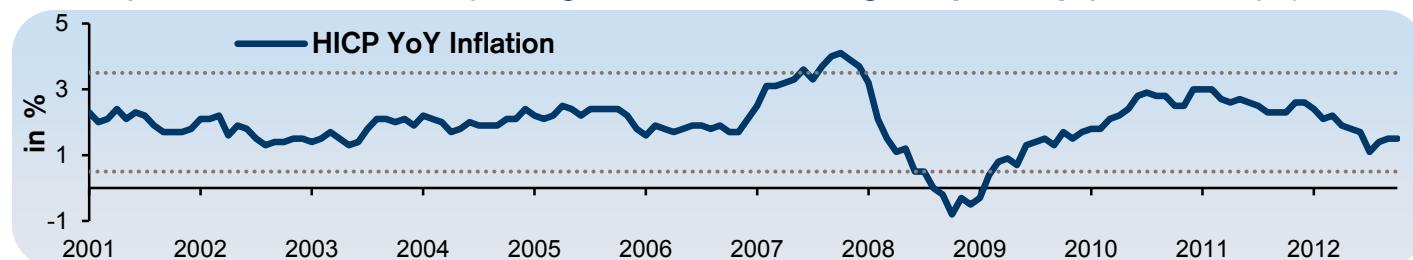
- Reproducing a synthetic linker can be useful when there is a lack of supply, when a specific linker is expensive, in order to stay neutral credit risk, etc.
- There are many ways to do so. For instance, buying a nominal bond and receiving the equivalent swap with a real floating leg (which can be seen as buying a nominal ASW and buying real swap):



- **Example:** Buying a synthetic OATe 30y.
 - On Trade Date, the synthetic OATe buyer buys the nominal comparator bond– that is FRTR 3.25% May 45 – and receives the difference of net proceeds and par.
 - Annually, the investor pays the FRTR 45 coupon and receives $X\% * \frac{CPI_n}{CPI_{base}}$.

Volatility trade idea: Trading ECB's inflation policy

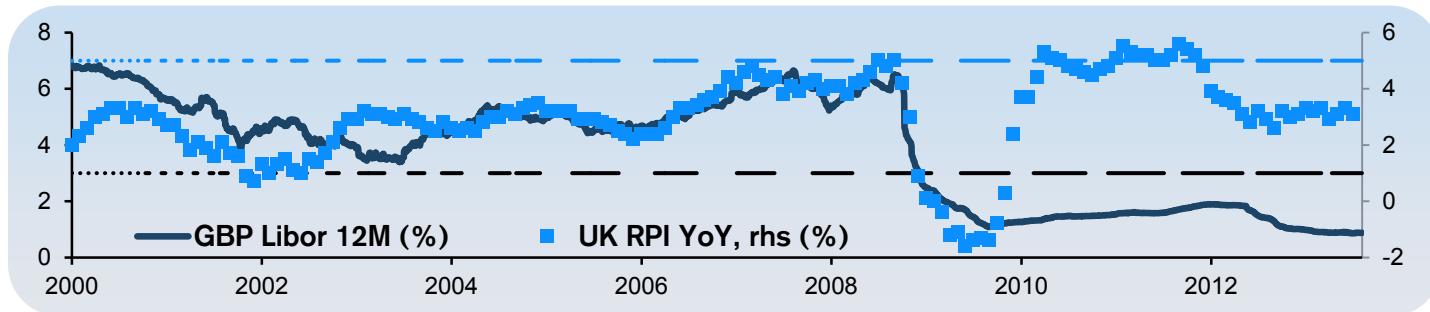
- As laid down in the Treaty on the Functioning of the European Union, the ECB is committed to its primary objective of maintaining price stability, with an inflation target of c.2% as measured by the HICP ([CPTFEMU <Index>](#) on Bloomberg): so far, it has been quite successful in achieving that objective.
- Selling YoY inflation volatility in a range accrual format is an attractive way to generate extra yield with a reasonable level of risk by taking the view that the ECB will continue to successfully maintain inflation stable.
- **Example:** Selling inflation implied volatility to generate extra yield:
- Looking at 15-year maturity note with a funding of (Euribor 3M +1.0%); the fixed rate range accrual coupon is $3.75\% * \frac{n}{N}$ with n the number of business days when HICP YoY is within [0.50%; 3.50%]. We find that compared to a vanilla coupon against same funding the **pick-up** p.a. is 95bp (fixed rate 2.80%).



Source: CS Locus

Exotic trade idea: Cheapen the cost of inflation hedges

- By taking advantage of the correlation between rates and inflation, clients can buy inflation hedges at a significantly lower price by adding a condition on rates, i.e., the hedge is activated only if the condition on rates is satisfied.
- **Example:** Adding a condition on rates can allow clients to substantially reduce the cost of their hedge against inflation:
 - 10Y YoY cap with a 5% strike on UK inflation; Underlying index: UKRPI; Maturity: 10 years; Payoff (annually): $\text{Max}[0 , \text{UKRPI YoY} - 5\%]$; Upfront premium: 3.12%.
 - Adding a condition on Libor (for example) allows to substantially reduce the cost of that protection: Payoff: if $\text{GBP Libor 12M} < 3\%$: $\text{Max}[0 , \text{UKRPI YoY} - 5\%]$ if $\text{GBP Libor 12M} > 3\%$: 0; Upfront premium: 2.37%, i.e., a 24% reduction.



Source: CS Locus

Trading inflation in practice

Market conventions (long vs. short)

Product	Long / Receiver	Short / Payer	Steepener	Flattener
Inflation-linked bond ("linker")	Buy the bond = long inflation	Sells the bond = short inflation	Buy short-dated, sell long-dated	Sell short-dated, buy long-dated
Breakeven	Sell nominal bond Buy linker Receive inflation	Buy nominal bond Sell linker Pay inflation	Steepener in nominals + flattener in linkers	Flattener in nominals + steepener in linkers
Inflation Swap	Receive inflation Pay nominal rate	Pay inflation Receive nominal rate	Receive short-dated Pay long-dated	Pay short-dated Receive long-dated

- Note the swap convention is different to IRS:
 - "Paying an inflation swap" means receiving the fixed rate!
 - "buying" (= "receiving") and "selling" (= "paying") an inflation ZC swap can also be used and removes confusion
- Breakeven and inflation swap steepeners are equivalent trades
 - But correspond to real yield (linker) FLATTENERS

Scenario performance of breakevens and real rates

If Realized inflation	Then Linker return
= BE inflation	= Nominal return
> BE inflation	> Nominal return
< BE inflation	< Nominal return

- Falling real yields raise the price of linkers, but the performance in nominal terms still depends on changes in breakeven spreads (a combination of inflation expectations, liquidity, etc.).
- For instance, in a low growth, disinflationary environment, nominal yields would fall faster than reals.

	Real yield FALLS	Real yield RISES
Breakeven inflation RISES	Stagflation Positive linker returns Nominal returns vary Linker outperforms nominal	Strong growth Negative linker returns Negative nominal returns Linker outperforms nominal
Breakeven inflation FALLS	Recession Positive linker returns Positive nominal returns Nominal outperforms linker	“Goldilocks” Negative linker returns Nominal returns vary Nominal outperforms linker

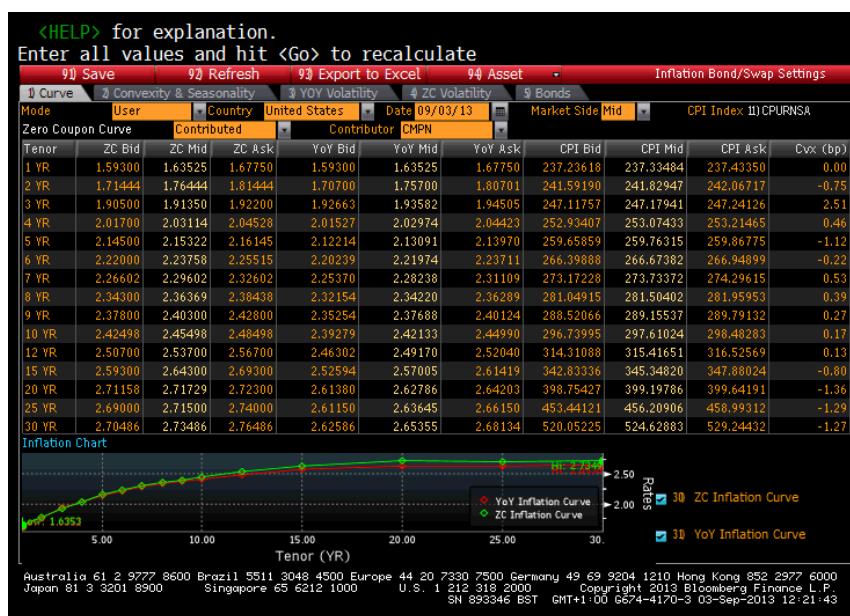
Credit Suisse inflation products on Bloomberg

- Live indicative prices of all of the (non-structured) products we offer are available in Bloomberg and in Credit Suisse PLUS.
- Our Bloomberg homepage is at [CIFL <Go>](#).
- Main markets:
 - US
 - UK
 - Eurozone
 - France
- Main products
 - Inflation-linked bonds
 - Swaps
 - Options
 - Asset-swapped bonds



Inflation pages on Bloomberg

- [SWIL](#) shows the term structure of swap-implied inflation and allows assessment of seasonality, volatility and convexity adjustment.
- [YAS](#) allows real yield and swap spread analysis of linkers – the Yields tab is particularly informative.
- [FPA](#) looks at forward yields and forward breakeven pricing tables.



Credit Suisse Plus Locus inflation tools

- Within the Credit Suisse PLUS system we have developed a toolkit for inflation investors.
- The homepage is found in the left column, within the Rates section: Global Inflation Analytics.

File Edit View Tools Help

Global Strategy & Economics

Rates

- Rates Research
- Money Markets
- US Cash Analytics
- US Swap & Vol Analytics
- Europe Cash Analytics
- Europe Swap & Vol Analytics
- APAC Analytics
- Covered Bonds**
- Tradable Indices**
- Archive
- Global Inflation Analytics
- Emerging Mkts**
- FX
- Credit
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- Equity
- Commodities
- Listed Derivatives
- Index Products
- Tools
- My Pages & Links
- Shared Pages & Links

Global Inflation Analytics

Global Inflation Analytics - Launch Page

Inflation Market Overview

Inflation-Linked Bond Tools

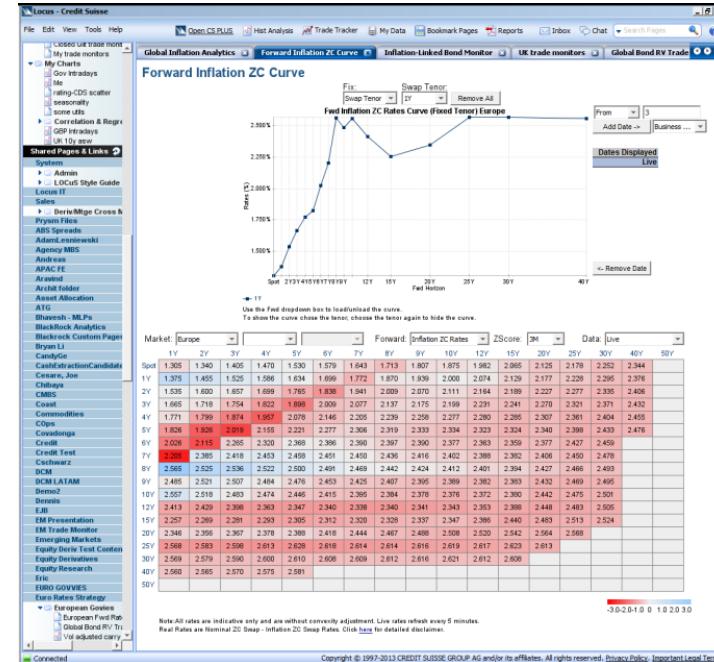
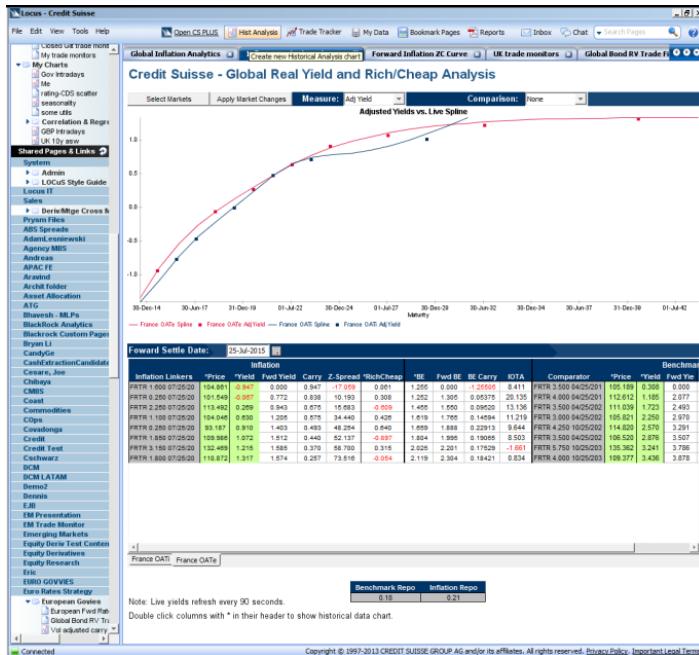
Inflation-Linked Derivative Tools

Charting and Trade Analysis

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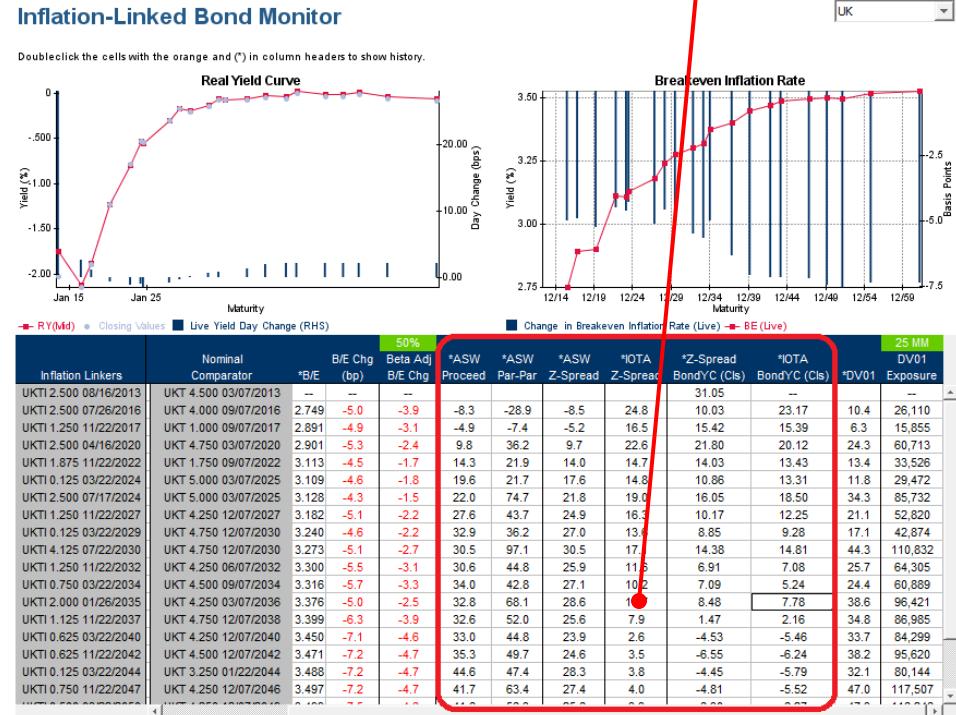
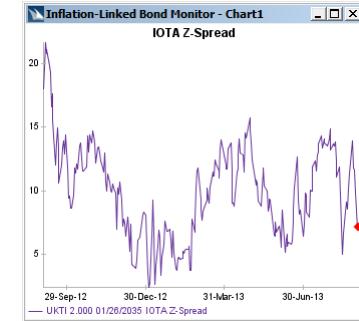
Finding value with Locus

- There are pages with yield curves for linkers and swaps, showing relative value measures, asset-swap levels, forward rates, etc.
- Z-scores and heat maps help identify relative value opportunities, and add another dimension to analysis.
- Full time series are only a double-click away.**



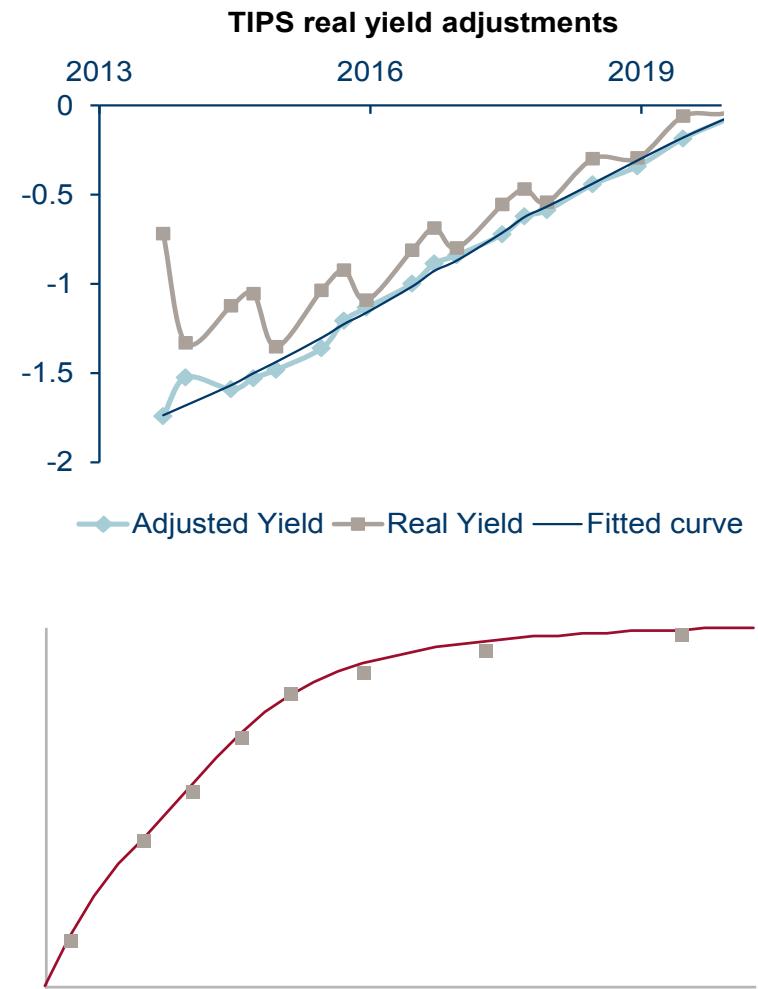
Locus Inflation-Linked Bond Monitor

- Chart the live term structure and intraday changes in the real and breakeven rates curves.
- The table contains par-par, proceeds and Z-spread ASW measures, plus iota.
- Locus also provides a Z-spread and iota calculated relative to the fitted (nominal) **bond yield curve** rather than swaps, better accounting for the contribution of the credit curve.
- Double-click any value to launch a historical analysis.



Real yields using Locus

- Locus provides a measure of real yield with corrections for certain distortions, for fairer comparisons:
 - **Seasonality**
 - **Value of floor premium**
 - **8m lag for old UK linkers**
- Locus also has real yield spline curves for the major markets with interpolated (constant maturity) yield histories.
- Locus can also show forward yields, carry and roll over various horizons, and carry-adjusted yield histories.



Source: Credit Suisse Locus

Analyzing carry and roll in Locus

- There are sheets that allow the user to run scenario analysis on trade ideas, look at roll down and carry or carry-adjusted yields for linker positions.
- Use inflation forecasts from the swaps curve, Credit Suisse economists' forecasts or enter your own.

Locus - Credit Suisse

File Edit View Tools More  Open CS PLUS  Hist Analysis  Trade Tracker  My Data  Bookmark Pages  Reports  Chat  Search Pages 

Global Inflation Analytics  Carry & Forward Analysis  Inflation-Linked Bond Curve  Forward Inflation 2C Curve  UK trade monitor 

Credit Suisse - Carry & Roll Analysis

Country: **UK**  View: **Carry**  Forward  Roll  Carry/Roll  Repo Assumptions  Forward Settle Date: **26/07/16**

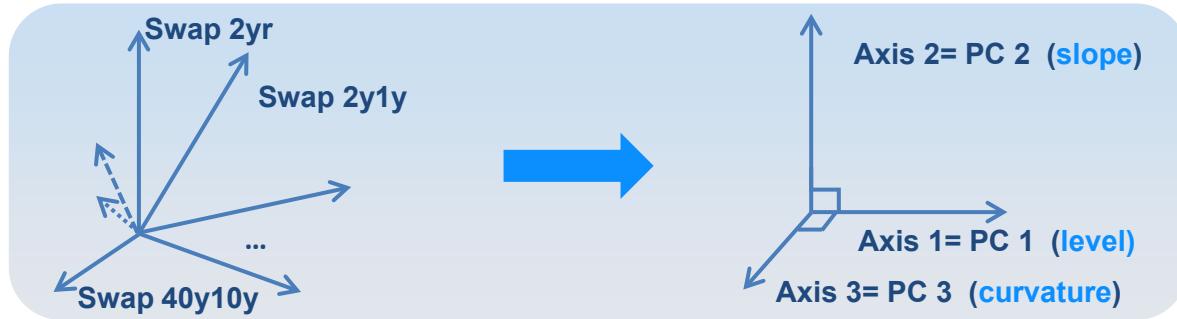
Yield  **Carry/Roll(b)**  **BE**  **BE**  **BE**  **BE**  **BE**  **BE**  **BE**  **BE**  **BE** 

Inflation Linkers  **Spot(b)**  **1M**  **10Nov13**  **3M**  **12Mar14**  **6M**  **Custom**  **Spot**  **1M**  **10/11/13**  **3M**  **10Mar14**  **6M**  **26Mar16**  **Custom**  **Spot**  **1M**  **10/11/13**  **3M**  **10Mar14**  **6M**  **26Mar16**  **Custom**  **Spot**  **1M**  **10/11/13**  **3M**  **10Mar14**  **6M**  **26Mar16**  **Custom**  **Spot**  **1M**  **10/11/13**  **3M**  **10Mar14**  **6M**  **26Mar16**  **Custom**  **Spot**  **1M**  **10/11/13**  **3M**  **10Mar14**  **6M**  **26Mar16**  **Custom**  **Spot**  **1M**  **10/11/13**  **3M**  **10Mar14**  **6M**  **26Mar16**  **Custom**  **Spot**  **1M**  **10/11/13**  **3M**  **10Mar14**  **6M**  **26Mar16**  **Custom**  **Spot**  **1M**  **10/11/13**  **3M** **10Mar14** **6M** **26Mar16** **Custom** **Spot** **1M** **10/11/13** **3M** **10Mar14** **6M** **26Mar16** **Custom** **Spot** **1M** <img alt="dropdown icon" data-bbox="7941 178 7954 1

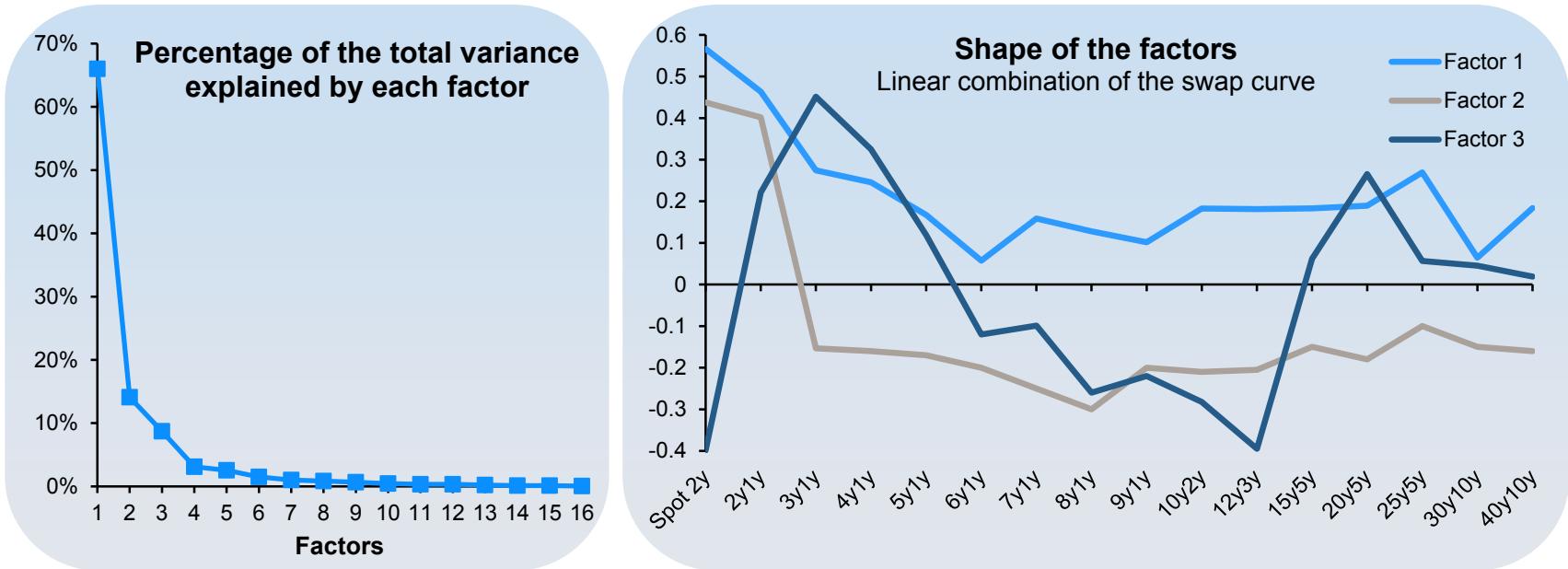


Principal component analysis (PCA)

- Principal Component Analysis (PCA) can be used to quantify movements in a specific market and represents them as a combination of 2 to 3 driving factors. More details in [PCA Unleashed](#).
- Often referred to for nominal swaps, PCA can also be used in the inflation market. We publish this analysis on a daily basis (available on request) for EUR, GBP, USD inflation and real swaps.
- The idea is to **make complex multivariate data easier to understand and analyze**. Given the data:
 - EUR inflation swap forwards term structure: [2y spot, 2y1y, 3y1y, ..., 40y10y]
 - On a rolling 1 year time-frame
- **We find 2 to 3 driving factors (PCs), built as a linear combination of the term structure.**
- The First PC will explain most of the variance of the term structure, and each succeeding PC accounts for as much of the remaining variance as possible.



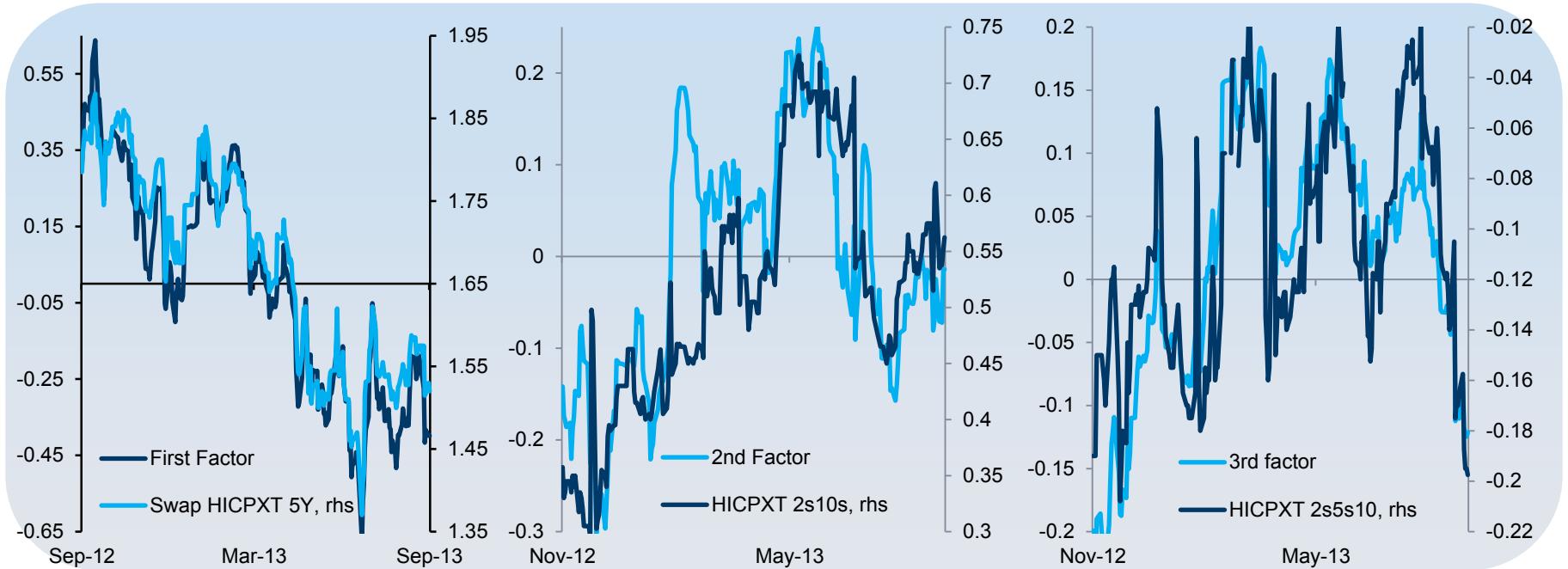
PCA: The case of EUR inflation swaps



- The three principal components (PCs) can be thought as representing:
 - **First factor (65%): Level.** All positive coefficients.
 - **Second factor (15%): Slope.** Positive coefficients on the very short-end and negative coefficients afterwards.
 - **Third factor (10%): Curvature.** Excluding the spot 2y, alternation of positive and negative coefficients, less straightforward though.

PCA: Correlation between PCs and change in yields, slope and curvature

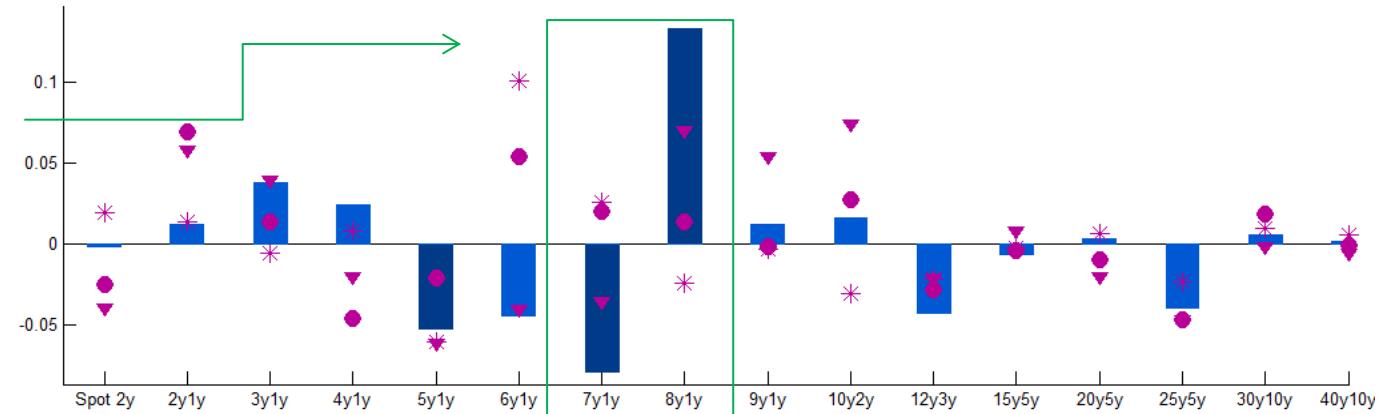
High correlation between each factor and a level shift, slope and curvature, respectively:



PCA: Residuals highlight dislocations, best place to express a view

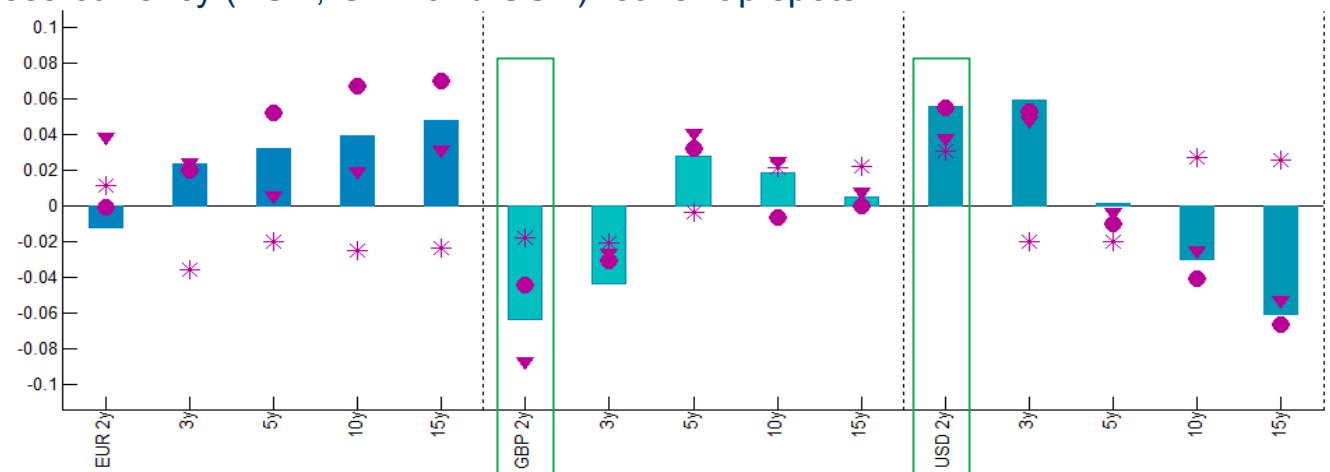
- PCA residuals on EUR inflation forwards, as of early September.

HCICPxT 7y1y is rich
relative to 8y1y
(following rebasing to
June).



- PCA residuals on cross-currency (EUR, GBP and USD) real swap spots

GBP real swaps are rich
relative to USD in the
front end.



Disclosure Appendix

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Buy: Indicates a recommended buy on our expectation that the issue will deliver a return higher than the risk-free rate.

Sell: Indicates a recommended sell on our expectation that the issue will deliver a return lower than the risk-free rate.

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Buy: Indicates a recommended buy on our expectation that the issue will be a top performer in its sector.

Outperform: Indicates an above-average total return performer within its sector. Bonds in this category have stable or improving credit profiles and are undervalued, or they may be weaker credits that, we believe, are cheap relative to the sector and are expected to outperform on a total-return basis. These bonds may possess price risk in a volatile environment.

Market Perform: Indicates a bond that is expected to return average performance in its sector.

Underperform: Indicates a below-average total-return performer within its sector. Bonds in this category have weak or worsening credit trends, or they may be stable credits that, we believe, are overvalued or rich relative to the sector.

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Disclosure Appendix cont'd

Corporate Bond Risk Category Definitions

In addition to the recommendation, each issue may have a risk category indicating that it is an appropriate holding for an "average" high yield investor, designated as **Market**, or that it has a higher or lower risk profile, designated as **Speculative** and **Conservative**, respectively.

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Sell	<1%	(of which 100% are banking clients)

*Data are as at the end of the previous calendar quarter.

**Percentages do not include securities on the firm's Restricted List and might not total 100% as a result of rounding.

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Disclosure Appendix cont'd

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