Inflation-linked bonds[1]

France was the first euro zone country to issue inflation-linked bonds with, in September 1998, the July 2009 3% OATi indexed to the French consumer price index excluding tobacco and, in October 2001, the OAT€i indexed to the euro zone's harmonised price index excluding tobacco, the HICP.

As a pioneer in euro-denominated indexed bonds, the AFT benefited from the experience already acquired in this field by the UK, Canada and the US, which began issuing such securities in 1981, 1993 and 1997 respectively. As might be expected, this example was followed by other sovereign issuers in the euro zone, namely Italy, Greece and Germany. Since 2007, all of the G7 sovereign issuers have been issuing inflation-linked bonds[2].

When indexed OATs were launched, the French Bond Association (FBA) or CNO[3] set up a working group to help harmonise the calculation methods applicable to this new class of bonds, drawing on existing bond markets and preparing for the introduction of new sovereign indexed issues.

This wish of market participants to harmonise the calculation methods applicable to sovereign indexed bonds was once again strongly demonstrated when, in 2005, the DMO, the British debt agency, decided to change the method for calculating indexed Gilt coupons, as we will see later.

This note mainly covers the calculation definitions and standards applicable to inflation-linked sovereign issues structured as OATis and OAT€is, with indexing of the principal and coupons.

Non sovereign issuers also issue on the indexed bond market, however, either with the same structure as those used by sovereign issuers, or with structures where only the bonds' coupons are indexed. This structure will be explained in the paragraph looking at private issuers' indexed issues.

Inflation-linked bonds are also known as inflation-indexed bonds[4] or I/L bonds and these terms are used interchangeably in this presentation.

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[1] This note is actually an extract from the more comprehensive document: ‘Bonds and related fixed income instruments: standards and practices’

[2] For a very comprehensive description of indexed bond markets worldwide, refer to "Inflation Indexed Securities, Bond swaps & other derivatives" ,Mark Deacon, Andrew Derry & Darius Mirfendereski, published by Prentice Hall Europe

[3] Comité de normalisation obligataire

[4] The term "indexed bonds" is sometimes confusing as, before the arrival of inflation-indexed bonds, other issues were and continue to be indexed to other references, for example stock market indices or commodity prices.

1 General remarks about inflation-linked bonds

1.1 Definition of inflation-linked bonds

A fixed rate bond is like a loan where the borrower must pay a fixed nominal yield in addition to repaying the principal at maturity.

According to the Fisher equation, the real yield and inflation are the two main components of the nominal yield:

- A fixed rate bond pays a nominal yield equal to the anticipated real yield and inflation up to its maturity;
- An inflation-linked bond pays the expected real yield corresponding to its maturity and realised inflation determined on each coupon payment date.

The Fisher equation breaks down the nominal yield of a nominal bond as follows:

$$(1+Nomy) = (1+Realy) * (1+EI) * (1+IRP) \qquad (A.2.1.1)$$

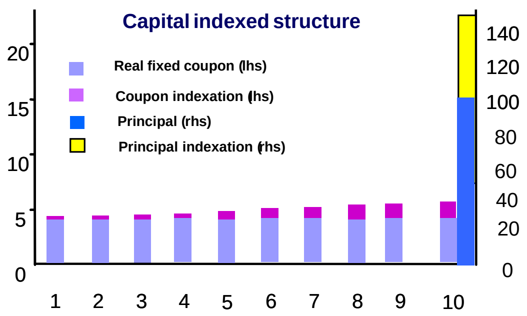
With :

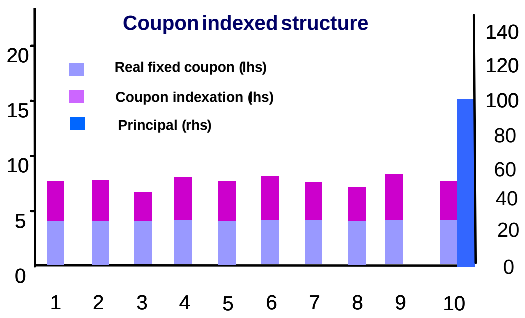
Nomy	*: Nominal yield*
Realy	*: Real yield*
EI	*: Expected inflation*
IRP	*: Inflation Risk Premium*

Two structures for indexing inflation-linked issues are used on the market:

- **Indexing of the principal and coupons, a structure known as "capital indexed", of sovereign bonds**: when they are paid, all of the cash flows (the real coupon and repayment of principal at maturity) are indexed to the change in inflation between the value of the price index on the issue's launch and the value of the index on the payment date of these cash flows[5].
- **Indexing of the coupon alone, a structure known as "coupon indexed":** non-sovereign issuers adopt either the same type of structure as governments, or another structure where only the coupons are indexed. In this last case, every year, in addition to the real yield fixed when the issue was launched applied to a non-indexed principal, the coupon pays the annual change in inflation, applied in percentage of the issue's nominal amount. The nominal amount of the issue repaid at maturity is not indexed, however.

Given the same real yield and the same annual change in the index, the future cash flows paid by each of these two structures differ, as shown by the two charts below:





[5] Another way of presenting the method for indexing indexed bonds with a "Capital Indexed" structure is to define these securities as bonds whose capital is indexed, the fixed rate coupons representing the real yield calculated on the value of their capital indexed when they are paid.

According to the Fisher equation, in a liquid, arbitrated market, and if the inflation risk premium[6] is excluded, the real yield should be the same as the nominal rate less the inflation expected over the bond's lifetime[7] for the same issuer and the same maturity.

As will be explained in paragraph 2 of this chapter, which looks at the reference index, there are several categories of price indices and several ways of calculating them, generating different price index levels. If the indexed issue uses an index which, for example, overestimates inflation on average, as is the case for the RPI paid by I/L Gilts, the overvaluation of the index is subtracted from the real yield for these bonds.

1.2 History of euro-denominated inflation-linked issues

By 2010, all of the G7 countries (the US, Japan, Germany, France, the UK, Italy and Canada) were issuing inflation-linked bonds. However, this type of issue remains relatively recent for developed countries. The UK was the first of these countries to issue indexed government bonds, in 1981[8]. Previously, these issues were the prerogative of countries with high inflation, particularly in Latin America (Brazil or Mexico), in Israel and in Iceland: for these countries, indexed bonds were practically the only way to raise funds over the long term, as investors wished to protect themselves against the erosion of the currency's value.

1.2.1 Reasons that led the British Treasury to issue I/L Gilts[9]

Although for emerging countries inflation indexing was a necessity, as investors required protection against inflation, the situation was different in developed countries, where there was a lively debate between economists about the merits of indexing. The issue was deciding whether or not introducing indexing of a proportion of savings left an economy more or less exposed to inflation risk. Proponents argued that by denying itself the possibility of "annuitant euthanasia" by inflation (reducing its debt in real term by benifiting from inflation), a government increased its credibility in its fight against inflation; opponents argued that, on the contrary, reducing the cost of inflation for savers set the stage for higher inflation. For instance, when, at the start of the 80s, the British Treasury decided to use this new type of instrument, its goal was to convince the markets that, after experiencing a peak in annual inflation of more than 20%, in the 70s, the government was committed to reducing inflation[10].

[6] The value of this risk premium is disputed as it cannot be directly measured. In addition, indexed bonds most often suffer from a lack of liquidity, which should be reflected in the payment of an illiquidity premium to the investor, reducing or cancelling out the value of the inflation risk premium. We will see in paragraph 3.3.7 how this problem is overcome through the concept of inflation breakeven.

[7] This formulation is only approximate, as the Fisher equation compounds the real yield and inflation: with a nominal yield of 4% and expected inflation of 2%, this calculation through subtraction gives a real yield of 2%, whereas the breakdown of expected inflation using the Fisher equation produces a real yield of 1.96%. Given the limited difference between these two results, the calculation of the real yield through simple subtraction is often used by the market, when large orders of magnitude are being calculated.

[8] Historians have recorded the existence of inflation-linked issues since the second half of the 18th century, notably with the issue of Depreciation Notes by the State of Massachussetts in 1780, launched during the war of independence, which was a source of high inflation. In paragraph 2 of this chapter, dedicated to describing the price index used by index bonds, we will look at the basket used for this 1780 issue.

[9] In 1997, the IMF published an article analysing the reasons why developed countries should issue inflation-linked bonds. This article, written a few months before the first issue of indexed Treasuries, described the optimum structure of these bonds.
http://www.imf.org/external/pubs/ft/wp/wp9712.pdf

[10] See the argument put forward by the Debt Management Office (DMO). This argument was also widespread in France, which is why an order dated 1958 banned the general indexing of contracts to the price index. This order is still in force, but when OATis were introduced, a law was enacted in France making an exception to this general ban for inflation-linked bonds.
http://www.dmo.gov.uk/documentview.aspx?docname=gilts/public/technical/epr1981.pdf&page=

1.2.2 Other indexed sovereign issues in OECD countries

The issuance of IL Gilts was followed 10 years later by the issuance of Canadian Real Return Bonds:

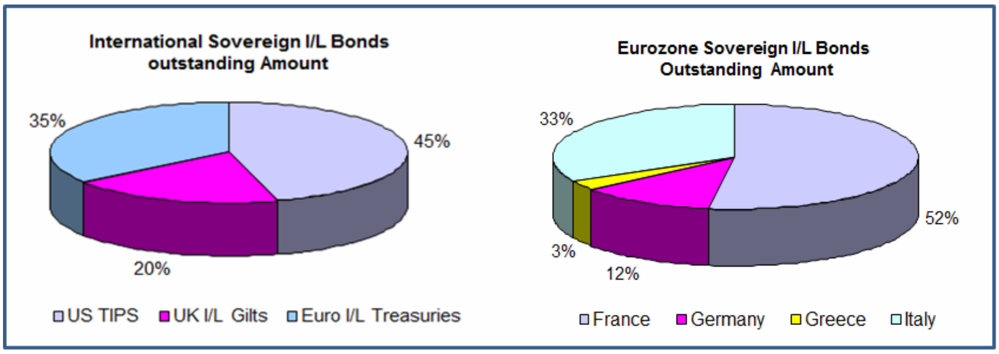
- These bonds, launched in 1991, imposed the current structure of sovereign indexed issues, by adopting post-fixed indexing of coupons and principal and reducing to 3 months the time lag in factoring in inflation when the indexed bond's cash flows are paid, whereas the inflation time lag for I/L Gilts was 8 months. This structure is described in detail in paragraph 3 of this chapter.

- This structure has since been taken up by all new sovereign issuers of inflation-linked bonds: Sweden in 1994, the US in 1997, France in 1998 with OATis indexed to the French CPI, then in 2001 with OAT€is indexed to the euro zone HICP[11], Greece and Italy in 2003, Japan in 2004 and Germany in 2006. In 2005, the DMO decided to adopt this structure for its new issues of indexed Gilts.South Korea and Turkey for instance also issued IL bonds.

1.3 Volumes of euro-denominated indexed sovereign issues

The following two charts show the main indexed sovereign issues worldwide (around €900 billion, in June 2010) and in euros (around €300 billion).

In both cases, these are the amounts issued, not adjusted for the rate of inflation since their issuance. The amount calculated for France includes OATi issues indexed to the French CPI, and OAT€i issues, indexed to the euro zone's HICP, each of these bonds representing around 50% of the AFT's indexed issues. The other sovereign issuers in euros only issue bonds indexed to the euro zone's HICP index.



1.4 Harmonisation of the euro-denominated indexed bond market

As already mentioned, the structure inaugurated by the Canadian Treasury with post-fixed indexing of coupons and principal, reducing the time tag in factoring in inflation to 3 months when the indexed bond's cash flows are paid, was then taken up by all sovereign issuers of inflation-linked issues. In 2005, the British debt agency, the DMO, also adopted this coupon calculation[12] for its new issues. British indexed issues launched prior to this change have nonetheless retained the previous method of coupon calculation.

This harmonisation, not only of euro-denominated indexed bonds, but also of bonds denominated in other currencies, has two main motivations:

[11] The HICP indices, or Harmonised Index of Consumer Prices, published by Eurostat, are described in the European Price Statistics brochure, at the following address:
http://epp.eurostat.ec.europa.eu/cache/ITY_OFFPUB/KS-70-07-038/EN/KS-70-07-038-EN.PDF

[12] The indexing of the semi-annual coupon of I/L Gilts launched prior to 2005 is determined at the start of the interest period, using an index published 2 months before. As the interest on I/L Gilts is semi-annual, there is therefore an 8 month time lag between the recording of inflation and its payment. This time lag is reduced to 3 months by the post-fixed calculation method inaugurated by Canadian I/L bonds.

- Firstly, investors wish to purchase securities offering them better protection and from this point of view the reduction of the indexing application time lag offered by the Canadian structure is certainly an advantage. In addition, investors in indexed bonds are most often professional investors who are often used to investing in indexed securities denominated in different currencies.

- Secondly, structural harmonisation enables the optimisation of back office systems.

This harmonisation, which relates to the choice of index, the general structure of the bond's indexing and the coupon calculation method is described in detail later in the document.

1.5 Reference price indices

Inflation-linked sovereign bonds are referenced against a consumer price index calculated monthly by a national statistics institute, the INSEE in the case of OATis, or a multinational statistics institute, Eurostat in the case of OAT€is and other indexed bonds in the euro zone.

When the first OATi was launched, in 1998, French regulations prohibited the indexing of a contract on a price index including tobacco. This is why the OATi and the OAT€i are respectively referenced against the consumer price index, the CPI, excluding tobacco, for all households resident in France, published monthly by the INSEE, and the harmonised index of consumer prices, the HICP, excluding tobacco, for the euro zone, also published monthly by Eurostat.

1.6 Choice of consumer price index

In theory, there are macro-economic indicators other than inflation that can be used to support bond issues. Amongst these, the industrial production index might have been worth exploring by government issuers, according to some experts, as their tax receipts are directly linked to this reference[13]:

- In 1983, the Italian Treasury launched certificates indexed to the GDP deflator, but these securities met with limited success and were ultimately abandoned: investors were not very familiar with this index, which also had the drawback of being published annually.

- Indexing to a price index offers several advantages. If there is inflation, the government's resources increase and an indexed bond protects savers. Consumer price indices are published monthly, are quickly available and above all are known to all investors. Despite their interest to economists, other references, such as property prices, suggested by Schiller, have not won over investors;

All sovereign issuers now issue index bonds referenced against the consumer price indices that are most commonly known to the general public.

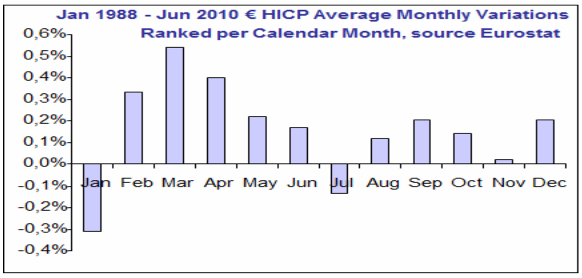
1.6.1 An index not adjusted for seasonal variations

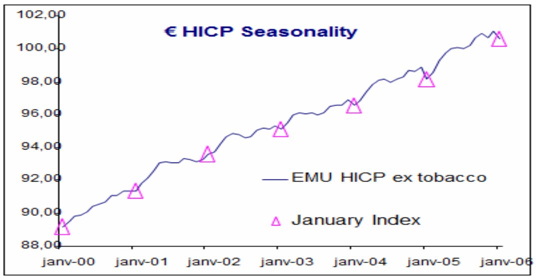
For historical reasons, the indices that are the most commonly accepted by the markets are indices not adjusted for seasonal variations. It is these indices that are used as a reference for bonds and interest rate swaps indexed to inflation. Within a given year, the month when these securities mature can affect their yield, compared to the yield of securities maturing in a different month within the same year:

- There may be considerable seasonal variations in these indices from one month to the next: the first chart below shows the average, for a given month compared to the previous month, of the euro zone's HICP indices, classed according to the calendar month of their publication, over 12 and a half years, for the period from January 1998 to June 2010. On average, every year over the period analysed, the index falls significantly in January and July, when sales are held in many European countries. However, over the last three years, particularly with the adoption by some countries of floating balances, the seasonal nature of European price indices has tended to decrease.

[13] On the other hand, from the investor's viewpoint, this index does not necessarily seem appropriate. If economic activity was to contract, such a bond might lose some of its value, while at the same time its holders could lose their job.

- As shown by the first issue of indexed Bunds in 2006, at a given calculation date, a bond's real yield will depend on its exact maturity date within the year. The second chart below shows the change in the euro zone HICP index from January 2000 to January 2006, when the Bund€i was launched, as, given its maturity date on 15 April, it is the January index that is used as the reference for coupon payments and repayment of the bond, as a result of the 3-month indexing time lag.





1.6.2 The index, excluding tobacco, of euro-denominated indexed sovereign bonds

Prior to the launch of the OATi in 1998, the French parliament enacted a special law authorising the issuance of inflation-linked French bonds, as an exception to the general principle of banning the inflation indexing of contracts, dating from 1958.

However, another law enacted in 1992, whose main objective is to ban tobacco advertising, also more broadly stipulates that, where the indexing of a contract is authorised, it must refer to an index that does not include tobacco. On the launch of the first OATi, the French authorities did not wish to make an exception to this rule[14]. This is why, in 1998, the AFT became both the first issuer of indexed bonds referenced against inflation in the euro zone and the first issuer of indexed bonds using a price index that excludes tobacco.

- All the inflation-linked sovereign issues launched in foreign currencies, prior to the introduction of the OATi and the OAT€i, used an index that included tobacco, and it might have been feared that the other euro zone countries would adopt a HICP index including tobacco. Furthermore, the first interest rate swaps referenced against the euro zone's HIPC used a reference including tobacco. However, the sovereign issuers which, after France, issued bonds indexed to the euro zone's HICP (Greece, Italy and Germany) chose a reference excluding tobacco and the euro-denominated indexed interest rate swap market finally got behind this decision, in the interests of harmonisation,

- In addition, from the issuer's viewpoint, an index that excludes tobacco is preferable, as the issuer can increase tobacco duties without bearing the cost on its indexed bond issues.

- Finally, as the index including tobacco entailed an annual rise of around 5 to 10 bps above the index excluding tobacco when Italian or Greek bonds were issued, as a result of arbitrage, as previously explained, issues indexed to an index including tobacco should have offered a real yield 5 to 10 bps below the indexed OAT€i yield, all things being equal moreover. Otherwise, after factoring in inflation, these issues would have offered a higher yield than OATis and €is.

- For ethical reasons, where an index excluding tobacco is available, a number of international investors say that they prefer to use such an index for their fund management. In 2000, the Californian teachers' pension fund, CALPERS, decided to opt for performance indices excluding tobacco, explaining that bonds issued by companies linked to the production or sale of tobacco present a unique and non-quantifiable financial risk.

[14] However, as explained in paragraph 1.1.1.4 of Volume A, the principle of contractual freedom to index debt securities has authorised the documentation of issues or financial contracts indexed to a price index including tobacco in French law since 2009.

1.6.3 Use of revisable indices

Price indices must reconcile two conflicting imperatives. They must be published as quickly as possible, but, at the same time, their calculations must be reliable.

For example, in principle, Eurostat publishes a flash estimate of inflation in the euro zone during the month, on the last day of a given month, the HICP indices being published around 15 days after the end of said month. For instance, the flash inflation estimate for July 2010 was published on 30 July 2010, and the various HICP indices were only published on 16 August 2010. This is why most consumer price indices are revisable. Once published, these indices can be adjusted if they appear to be incorrect:

- However, the French consumer price index, which is used for OATis and calculated by the INSEE, is not revisable: once a monthly index has been published, it is not officially changed and, if there are errors in the calculation for a given month, the adjustment will be made by the INSEE to the calculation for the next month. A unrevised index is a token of the stability of the inflation data used for indexed bonds.

- If an index is revisable, as is the case for indices published by Eurostat, the revision of monthly data already published also leads to the adjustment of the already published index. So that the indexing of cash flows already paid does not need to be recalculated, bonds indexed to revisable price indices use series of indices specific to the indexing of indexed bonds that are not revised. Once a monthly inflation figure has been published, it is kept in this specific index series. On the other hand, in the case of the French CPI, specific indices not yet published incorporate the adjustment to an index already published.

1.6.4 Indices increasingly harmonised at an international level

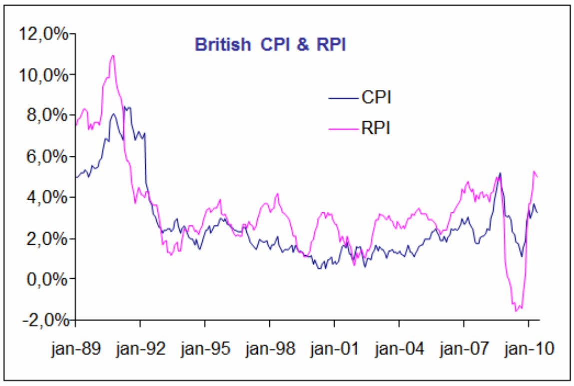
As a member of the European Union, the UK participates in the harmonisation of statistical methods under the aegis of Eurostat. At the end of 2003, the Bank of England decided to use the UK HICP as the main measurement of the inflation target and this index is now known as the CPI in Britain[15]. This change enables more effective comparison of the British monetary policy with that of the other member States.

However, since their issuance in 1981, I/L Gilts have been referenced against the RPI, the best known index in the UK, and British pension fund liabilities are also indexed to this reference, for the pensions that they pay out. For this last reason, in 2003, pension funds won agreement to maintaining the indexing of these bonds to the RPI.

The RPI is a cost of living index, whereas CPIs are consumer price indices and, as the graph below shows, since 1989, the UK RPI has been 0.70% higher on average than the UK CPI:

- The RPI includes property loans[16] and house prices and, with property inflation, this has led, amongst other things, to a rapid rise in this index.

- In addition, a different calculation methodology has contributed to the RPI's overvaluation. The RPI measures price differences arithmetically, whereas the CPI measures them geometrically.



[15] Like CPIs, the harmonised HICP indices published by Eurostat are in fact calculated by the various national statistical institutes. However, they are based on common statistical rules, whereas domestic consumer price indices do not necessarily follow the same rules.
[16] British property loans are mainly floating rate loans indexed to money market rates, which explains the RPI's erratic behaviour, affected by the Bank of England's monetary policy in a negative way: a rise in money market rates automatically increases the inflation measured by the RPI.

In 2003, the British government confirmed that the RPI would continue to be published and the change in the inflation target would not affect I/L Gilt cash flows. At the time, the DMO declared that it had no plans to launch new I/L Gilts referenced against the CPI. In January 2004, the Governor of the Bank of England compared the adoption of the CPI in place of the RPI as the main inflation measurement with the adoption in Britain of degrees centigrade in place of degrees Fahrenheit.

However, in July 2010, the DMO stated that the British government was going to launch a consultation on the adoption of the CPI instead of the RPI by pension funds and on the possible adoption of the CPI for indexed I/L Gilts. Several investors have expressed concern about this issue, without waiting for the launch of the official consultation.

1.6.5 Revision of the basket and independence of the index

1.6.5.1 The Boskin report

In 1996, shortly before the launch of the first index-linked Treasuries, the Boskin report ordered by the US Senate estimated that the annual percentage overvaluation of the US CPI compared to "real" inflation was 1.10%. This overvaluation was explained by the fact that the index's basket had not been revised since 1987 and finally this basket was revised in 1998. The report highlighted the disadvantages of not regularly revising the basket, particularly:

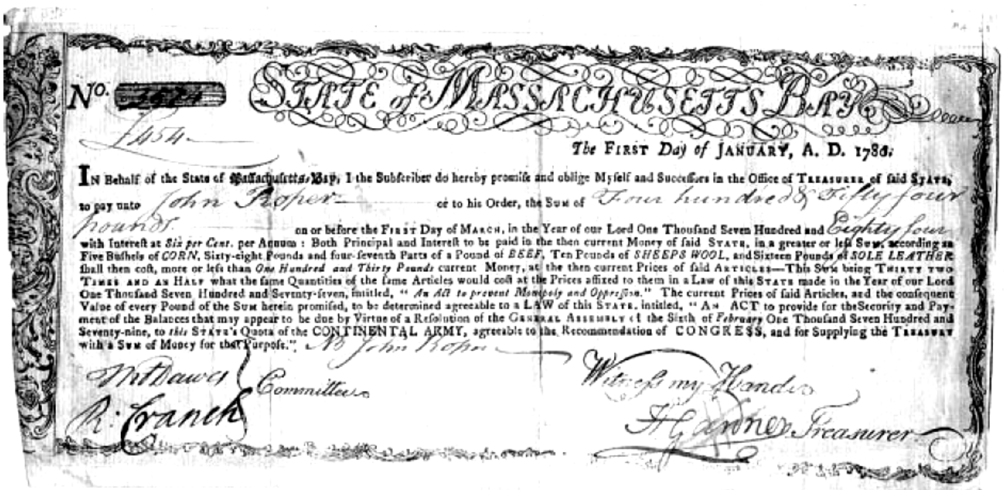
- The index does not factor in new, less costly products,
- Nor does it include improvements in product quality, such as reduced energy consumption.

In Europe, the basket used to determine the CPI is revised at the start of every year.

Some claim that this revision is tantamount to manipulating the index, in order to minimise price rises. In France, in 1972, the Confédération Générale des Travailleurs (CGT) union introduced its own index for calculating the French price index[17]. The CGT abandoned the publication of this index at the end of the 90s.

1.6.5.2 The basket of a US soldier in 1780

The indexing basket for Soldier Depreciation Notes, issued during the US war of independence by the State of Massachusetts, reveals the need to adapt the household basket to changes in consumer behaviour: in


No. [redacted] STATE of MASSACHUSETTS BAY

£454

The First Day of January, A. D. 1780.

In Behalf of the State of Massachusetts-Bay, I the Subscriber do hereby promise and oblige Myself and Successors in the Office of Treasurer of said State, to pay unto John Roper or to his Order, the Sum of Four hundred & Fifty four pounds on or before the First Day of March, in the Year of our Lord One Thousand Seven Hundred and Eighty four with Interest at Six per Cent. per Annum: Both Principal and Interest to be paid in the then current Money of said State, in a greater or less Sum, according as Five Bushels of CORN, Sixty-eight Pounds and four-seventh Parts of a Pound of BEEF, Ten Pounds of SHEEPS WOOL, and Sixteen Pounds of SOLE LEATHER shall then cost, more or less than One Hundred and Thirty Pounds current Money, at the then current Prices of said Articles—This Sum being Thirty two Times and an Half what the same Quantities of the same Articles would cost at the Prices affixed to them in a Law of this State made in the Year of our Lord One Thousand Seven Hundred and Seventy-seven, intitled, "An Act to prevent Monopoly and Oppression." The current Prices of said Articles, and the consequent Value of every Pound of the Sum herein promised, to be determined agreeable to a LAW of this State, intitled, "An ACT to provide for the Security and Payment of the Balances that may appear to be due by Virtue of a Resolution of the General Assembly of the Sixth of February One Thousand Seven Hundred and Seventy-nine, to this State's Quota of the CONTINENTAL ARMY, agreeable to the Recommendation of CONGRESS, and for Supplying the Treasury with a Sum of Money for that Purpose."

Witness my Hand, H. Gardner Treasurer

Committee

THE INVENTION OF INFLATION-INDEXED BONDS IN EARLY AMERICA By Robert J. Shiller October 2003
http://cowles.econ.yale.edu/P/cd/d14a/d1442.pdf

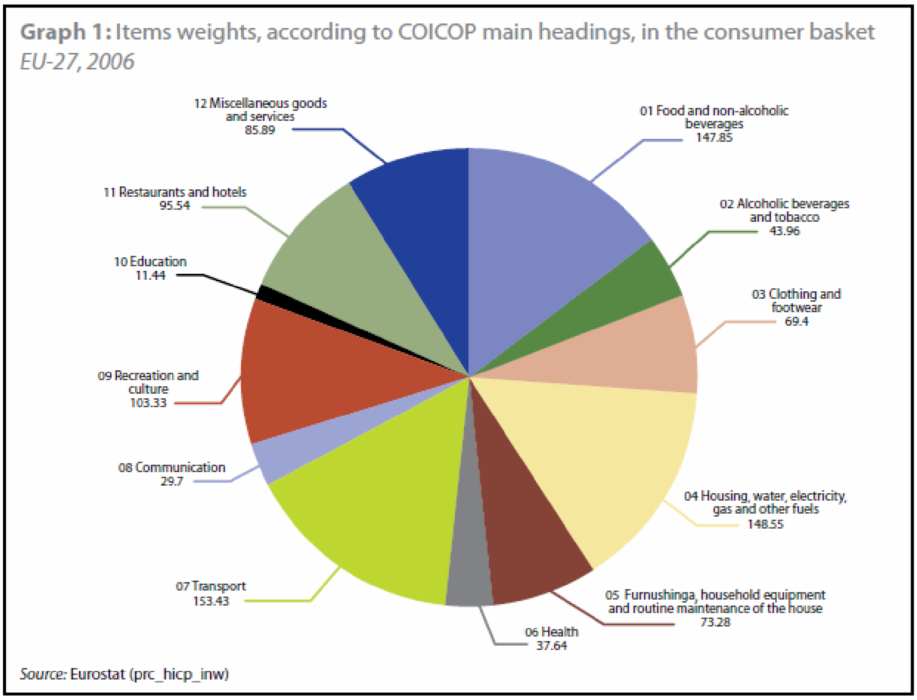
1780, this basket consisted of the following 5 products: 5 bushels[18] of corn, 68 pounds of beef, 10 pounds of sheep's wool and 16 pounds of leather soles.

[17] http://www.univ-paris13.fr/cepn/IMG/pdf/wp2008_14.pdf

[18] Unit used to measure the weight of US cereals equal to around 25 kilos.

1.6.5.3 The household basket in the 2000s

The chart below, taken from the document previously referred to published by Eurostat, presents the makeup of this basket in 2006.



Since 2000, the INSEE has published an indicator on the internet enabling individuals to create their own price index according to their consumption habits[19]. This indicator also gives the average weighting for each of these items in the calculation of the French CPI with tobacco.

Of course, the price index calculated nationally does not necessarily reflect the consumer behaviour of every individual. For example, tobacco, which on average is taken to represent 1.8% of this index, does not reflect either the basket of a non-smoker or the basket of a heavy smoker.

[19] http://www.insee.fr/fr/indicateurs/indic_cons/sip/sip.htm

1.7 The adaptation of the monthly calculation of CPIs to indexed bonds

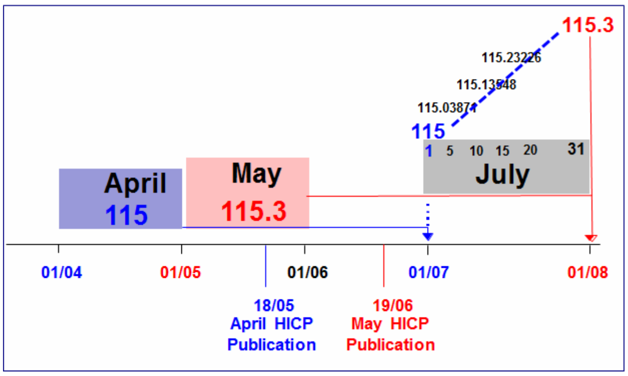
The statistical indices that are used as a reference for the indexing of I/L bonds were not originally created for this purpose. They therefore had to be adapted for daily use by the indexed bond market, in order to maximise the liquidity of these securities.

The market conventions described below are applicable to all euro-denominated sovereign bonds. They are also generally used for issues in other currencies with a Canadian Capital Indexed structure.

1.7.1 Definition of a daily inflation reference

The data used to index bonds are usually taken from price indices published monthly. Daily pricing of indexed bonds requires daily publication of an inflation index series.

To this end, if no consumer price index is published by domestic institutes, a daily inflation index is calculated by euro zone sovereign issuers, through linear interpolation between two monthly indices officially published by statistical institutes as follows:



- The reference applicable on the first day of the month *m* is the CPI for the month *m-3*. For example, the reference applicable on 1 July is the CPI for the month of April;

- The reference for another *day* of the month *m* is calculated through linear interpolation between the CPI for the month *m-3* and the CPI for the month *m-2*,

$$dref = \frac{(d-1)}{ndm} * (CPI_{m-2} - CPI_{m-3}) + CPI_{m-3} \qquad (A.2.2.1)$$

With:

dref	*: Daily reference index*
cd	*: Calendar date in the month*
ndm	*: Number of days in month m*
CPI_{m-i}	*: CPI Index month m-i*

Note. The values of this reference for each day of the month *m*, and that for the first day of the month *m+1* may be determined if the CPI for the month *m-2* is known.

Rounding rules applicable to daily inflation references: the daily inflation references published by euro zone sovereign issuers are truncated at the sixth decimal place, then commercially rounded to the fifth decimal place.

1.7.2 Definition of a base index applicable to the bond

The base index is equal to the value of the daily inflation reference prevailing on the date of entitlement to the first coupon paid by the issue[20]. This base index will be kept if the issue is later topped up. On the other hand, the various indexed issues, initially launched at different dates, have different base indices.

[20] Refer to paragraph 2.2.2.1 of chapter 1 for the definition of the date of entitlement to a bond's interest.

The following table shows the base reference, 2005 = 100, of the various OAT€is:

	OAT€i 3%	OAT€i 1,6%	OAT€i 2,25%	OAT€i 1,1%	OAT€i 3,15%	OAT€i 1,8%
Maturity date	25/07/2012	25/07/2015	25/07/2020	25/07/2022	25/07/2032	25/07/2040
Base index date	25/07/2001	25/07/2004	25/07/2003	25/07/2009	25/07/2002	25/07/2006
Base index value 2005 = 100	92.98393	98.05612	96.0856	108.08645	94.83337	102.37677

1.7.3 Definition of an index ratio

The index ratio applicable to each of the cash flows paid by the I/L bond is equal to the daily value of the inflation index on the payment date of each of its cash flows divided by the value of the base index specific to each issue, according to the following equation:

$$IR_d = \frac{dr}{Base_{Index}} \qquad (A.2.2.2)$$

With:

IR_d	*: Index ratio*
dr	*: Daily reference index*
$Base_{Index}$	*: Value of the bond CPI base index*

Rounding rules applicable to the index ratio: like the daily inflation reference, the inflation coefficient is truncated at the sixth decimal place, then commercially rounded to the fifth decimal place.

1.7.4 Publication of daily inflation references

The daily inflation references and index ratios of euro-denominated indexed sovereign bonds are calculated and published by their issuers. They are available on their websites and on the main financial information websites.

1.7.5 Definition of a substitute monthly price index

If a monthly price index used to construct the daily inflation reference on the payment date is not available, the CNO recommends applying the inflationary trend for the last known 12 months to the last monthly index published using the equation:

$$SI = CPI_{m-1} * \left(\frac{CPI_{m-1}}{CPI_{m-13}}\right)^{\frac{1}{12}} \qquad (A.2.2.3)$$

With:

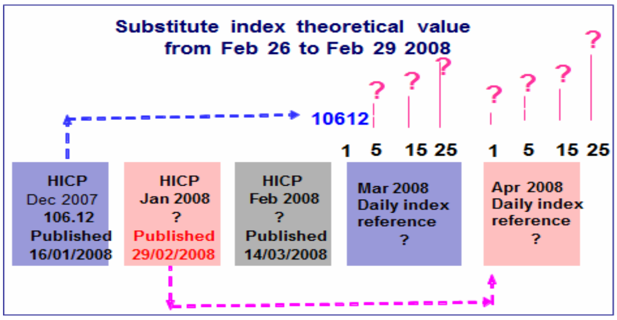
SI	*: Substitute Index*
CPI_{m-1}	*: CPI Index month m-1*
CPI_{m-13}	*: CPI Index month m-13*

Rounding rules applicable to the substitute index: Since March 2005, Eurostat has been publishing monthly inflation indices to two decimal places, and the FBA (Fench Bond Association) or CNO recommends publishing the substitute monthly price index to 2 decimals. Greater accuracy in the calculation of monthly indices was required by traders of indexed bonds and inflation-linked interest rate swaps to reduce market volatility when a monthly index is published and to make it easier to forecast the future value of the index[21].

Use of the substitute index: The CNO recommends explicitly labelling the substitute index as such when it is published. It will become the permanent reference for any transactions using this index. However, where the statistics office has published the official price index for the month concerned, this official index will apply, from the day following its publication, to transactions completed from this date.

Eurostat and the INSEE publish the consumer price indices for a given month around 2 weeks after the end of the month and use of the substitute index is theoretically not necessary.
However, these statistics offices publish the indices for the month of January later as, at the start of each year, the basket's makeup is adjusted to reflect the changes in the consumer behaviour of households. For instance, the INSEE decided to publish the January 2008 index on 21 February 2008, while Eurostat published its HICPs on 29 February 2008.

As the chart opposite shows, in the case of HICP indices, as from 26 February 2008, operators must use the substitute index for secondary transactions completed with a standard settlement/delivery date, i.e. T+3.



In fact, the HICP index for the month of January, which determines the value of the daily inflation reference dated 1 April 2008, was not yet known on 26 February 2008. This prevented the calculation of daily inflation references after 1 March, as the daily inflation references for the month of March are calculated based on the linear interpolation of the indices for December and January, then unknown, for 1 April.

However, rather than using the substitute index, most operators decided to bring the settlement/delivery date forward from T+3 to T+2 or even T+1, enabling the trading of bonds indexed to this reference until 28 February 2008.

1.7.6 Change in the base 100 applicable to a price index

Rebasing, which takes place every few years, and usually every 5 or 10 years, consists in choosing a new base 100 reference year for an index. For instance, the HICP indices currently published have a base year 2005 = 100, whereas their previous base year was 1996 = 100. The change in an index's base reference should not be confused with the changes to baskets regularly applied to price indices, and applied every year in France, to ensure that they are more representative.

Changing the base year of a price index does not affect the daily index ratio of indexed bonds and therefore has no impact on the yield, after indexing of these bonds. The 25 July 2009 OAT underwent rebasing of the French CPI in 1999 and the OAT€is issued prior to December 2005 also had their index rebased in January 2006. In most countries, a change in the base year is associated with a change in the index's methodology or coverage.

For instance, to justify the rebasing of the HICP indices at the end of 2005, Eurostat explained that it wished to facilitate the international comparison of these indices as, given that ten new members have joined the EU, some HICP indices had base indices starting on different dates. The new shared base year makes these indices more comparable.

[21] In the June 2005 report of the working group set up to standardise, develop and promote indexed bonds, the AMTE refers to this requirement as one of the improvements that need to be made to the indexed bond market.

When a base year is changed, the index rebasing key, between the old and the new base year, is calculated by dividing the index for the last month of December in the new base year by the index for the same month in the old base year. For example, for the change in base year in December 2005, the key is equal to the value of the December 2005 index in the new base year 2005 = 100 divided by the value of the December 2005 index in the old base year 1996 = 100.

The key is not rounded, which means that the index ratios of the bonds indexed to these references do not need to be changed.

$$IRK = \frac{HICP_{xt}{}^{base\,2005}_{Dec\,05}}{HICP_{xt}{}^{base\,1996}_{Dec\,05}} \qquad (A.2.2.4)$$

With:

IRK	*: Index Rebasing Key*
$HICP_{xt}$	*: HICP ex tobacco*

Example:

- The HIPC index excluding tobacco of December 2005, expressed in base 2005 is 101.10[22].
- The HIPC index excluding tobacco of December 2005, expressed in the old base year 1996 is 118.5.
- The rebasing key between the 2005 = 100 index and the 1996 = 100 index is therefore equal to:

101.10 / 118.5 = 0.853164556962025000.

This key enables the rebasing in base 2005 of the price indices previously published in base 1996.

Secondly, as already explained, Eurostat took the opportunity of this rebasing to publish price indices to 2 decimals, whereas the indices previously calculated had only one decimal, which, with the improvement in statistical methods, enables more accurate calculation of these indices.

The HICP price index series in base 2005 and base 1996 are available at the following address from the AFT's website: http://www.aft.gouv.fr/article_269.html?id_article=269

The rebasing of a price index has no financial consequences for investors. The only, minor, disadvantage is that the new base index applicable to each security must be entered in the systems for the calculation of the index ratio.

2 Sovereign issuers' I/L bonds

2.1 Structure adopted by euro-denominated indexed sovereign bonds

Indexed sovereign issues offer a standard structure, whereby, when they are paid, all of the cash flows (real coupon fixed on the issue's launch, repayment of principal at maturity and settlement of a transaction on the secondary market), are indexed to the change in inflation between the value of the price index on the launch of the issue, and the value of the index on the payment date of these cash flows. The table below presents the structure of euro-denominated indexed sovereign bonds.

[22] The base 100 applied to a reference year is the average of the monthly price indices for the year rather than the value of the index at year-end, which explains why the December 2005 index does not equal 100.

Structure of OATis and OAT€is, as well as GGB€is, BTP€is and Bund€is[23]	
Indexing method:	On their payment date, all of the cash flows (real coupon and repayment of principal at maturity) are indexed to the change in inflation between the value of the price index on the issue's launch and the value of the index on the payment date.
Reference index:	Monthly consumer price index excluding tobacco published by: • The INSEE, in the case of OATis • Eurostat, in the case of OAT€is and GGB€is, BTP€is and Bund€is.
Real coupon:	Fixed coupon equal to the real market rate applicable when the issue was launched.
Coupon paid:	Post-fixed annual coupon calculated using the following equation: *Real coupon * nominal * Index ratio*
Repayment:	Repayment calculated using the following equation: *Nominal * Index ratio*
Guarantee of repayment at par value:	If the daily inflation reference at the bond's maturity is less than the base reference, the amount repaid after indexing is guaranteed to be equal to par.

2.1.1 Comparison of Capital Indexed, Coupon Indexed and Nominal cash flows

2.1.1.1 Cash flows expected on issuance

The table opposite presents the cash flows expected on the issuance of Capital and Coupon Indexed structures by comparing them with the cash flows of a nominal issue paying a fixed rate of 5.06%.

	Anticipated inflation	Capital indexed Fixed coupon	Coupon Indexed Fixed coupon	Nominal bond Fixed coupon
	2	3	3	5,06
		IRR	IRR	IRR
		5,06%	**5,06%**	**5,06%**
0		-100	-100	-100
1	2	3,06	5,06	5,06
2	2	3,12	5,06	5,06
3	2	3,18	5,06	5,06
4	2	3,25	5,06	5,06
5	2	3,31	5,06	5,06
6	2	3,38	5,06	5,06
7	2	3,45	5,06	5,06
8	2	3,51	5,06	5,06
9	2	3,59	5,06	5,06
10	2	**125,56**	**105,06**	**105,06**

- With expected inflation of 2% over 10 years, the predetermined coupon representing the real yield has been set at 3%.

- All of the Capital Indexed structure's cash flows are inflated, by applying the index ratio (defined in paragraph 2.2.3 of this chapter) to them when they are paid.

- Under the Coupon Indexed structure, only the coupons are indexed, by applying the realised inflation over the last 12 months, according to the equation:

Coupon Indexed = (1+ Real Coupon) * (1+ Realised inflation over the last 12 months) – 1

- As we can see, Coupon Indexed bonds have the same forward-looking indexed coupon structure as nominal bonds; the Capital Indexed structure pays a lower coupon, but its principal is also indexed.

- In both cases, the internal rate of return of the indexed bonds is 5.06%, which is the same as for a nominal bond.

Of course, the cash flows paid every year on indexed bonds will vary according to the recorded change in inflation.

[23] Indexed issues made by Greece (GGB€i), Italy (BTP€i) and Germany (Bund€i).

2.1.2 Advantages of the Capital Indexed structure

- **Complete protection of all cash flows.** This structure offers complete protection of coupon and principal cash flows against inflation as the principal and coupons are indexed to the change in the price index since the bond was issued. This is not the case for the Coupon Indexed structure, where the principal is not indexed.

- **An always positive coupon.** The Capital Indexed structure's coupon can never be negative, as inflation is applied in the form of an index ratio. For instance, with a 3% coupon and an actual rate of inflation of less than 5% since the first year, the coupon remains positive at: 3% * 0.95 = 2.85%.

  On the other hand, the Coupon Indexed structure's coupon may become negative if, one year, inflation is negative by an amount in absolute terms higher than the fixed real yield for the issue. For example, with a real yield of 3% and negative inflation of -5%, the coupon calculated using the equation on the previous page:

  Coupon Indexed = (1+ Real Coupon) * (1+ Realised inflation over the last 12 months) – 1 = -2.15%

  As a bond cannot pay a negative coupon (see paragraph 1.4 of the first chapter), issues with a Coupon Indexed structure must include a floor rate , guaranteeing that the coupons will remain positive, whatever the rate of inflation. The presence of this floor, which is equivalent to buying an option on the level of inflation, comes at a cost, which is charged to the coupon paid.

- **A structure enabling the introduction of indexed STRIPS**. Under a Capital Indexed structure, the coupon and principal cash flows are indexed in exactly the same way, which has enabled, for example in the case of OATis and OAT€is, the introduction of a STRIPS market, described in paragraph 3.3.10 of this chapter.

- **Guaranteed repayment of the principal at par.** As with TIPS, euro-denominated indexed sovereign issues come with a guarantee of repayment at par, should the price index at maturity be below the base index that was set on the issue date of the indexed bond. The presence of this guarantee, which is beneficial for the investor in the event of deflation, is mainly due to accounting considerations: in a lot of countries, bonds must have a minimum redemption price:

  However, some countries, such as the UK, Canada and Japan, do not guarantee a minimum redemption price for their indexed issues. On the other hand, Sweden, which initially opted not to have such a guarantee in 1994, ultimately reversed its decision for indexed bonds issued since 1999.

2.2 International comparison of indexed sovereign issue structures

The table below compares the structure of the main indexed sovereign issues in the OECD countries:

International comparison of I/L sovereign bonds' structures

	UK 8 m lag	UK 3 m lag	Canada	USA	Euro-zone
Principal	Principal amount indexed at maturity				
Coupon	Real rate fixed at launch of the issue				
Fixing	Prefixed	Postfixed			
Coupon periodicity	Semi annual				Annual *
Lag	8 month	3 month			
Reference calculation	Monthly	Daily			
Minimum redemption amount	No			Yes	

* I/L BTPs pay a semi annual coupon

2.3 The Agence Française du Trésor (AFT)'s indexed issues

As with the description of fixed rate sovereign bonds, the remainder of this document mainly refers to issues by the Agence France Trésor for illustrative purposes. However, the calculations applicable to Italian bonds (BTP€is), which have the same structure as OAT€is but pay semi-annual coupons, will also be described.

2.3.1 Issue policy for the AFT's indexed bonds

For the AFT, indexed bonds are a diversifying component of its issue policy. They benefit from the regularity and liquidity commitment linked to all of the Treasury's securities. OATis and OAT€is are regularly auctioned, on the same days as BTANs, but during dedicated auction sessions, at 11.50am instead of 10.50am.

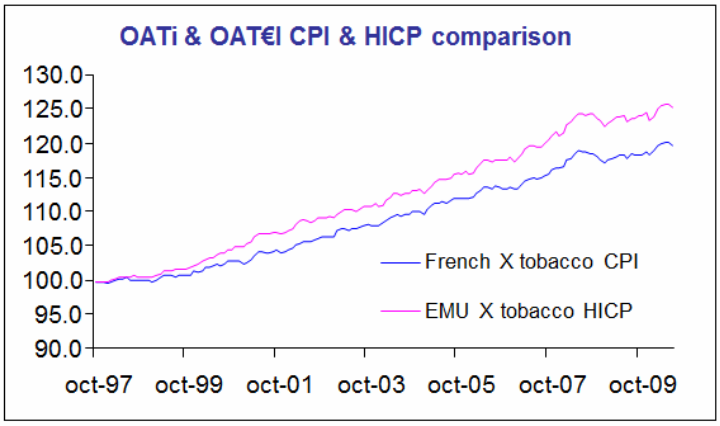
The AFT's 2010 issue programme, published in December 2009, provides that issues of bonds indexed to either French or European inflation will represent around 10% of net medium- and long-term issues. As in previous years, the AFT provides for the possibility of adjusting its issues to meet demand and ensure the liquidity of its securities. This programme states that the AFT will consider whether it is worthwhile making new inflation-linked issues, notably with a 10 to 15 year maturity.

2.3.2 The AFT, the only issuer indexing on the domestic CPI and the euro zone HICP

As the July 2009 OATi was launched 3 months before the euro was introduced, the AFT chose a domestic index as the indexing reference, which is the consumer price index calculated by the INSEE. However, in 2001, in addition to OATis referenced against this domestic index, the AFT launched a new series of indexed OATs, OAT€is, referenced against the euro zone HICP inflation published by Eurostat.

The AFT has since regularly auctioned these two series of indexed bonds, and this coexistence, far from reducing their liquidity, may have contributed to the development of a euro-denominated indexed bond and interest rate swap market, as investors are able to choose between euro-denominated bonds referenced against these various references[24]. This tends to invalidate the theory put forward by the IMF, which, in a document published in 1997, believed that use by the same issuer of several indexing references might reduce the liquidity of the indexed bond market[25].

The chart below compares the change in the indices used by OATis and OAT€is, scaled to base 100, in October 1997.



Investors buying indexed bonds may be classed in two categories. In the first category are investors trying to protect their liabilities against changes in domestic inflation, which is the case of French and other domestic pension funds. The second category consists of investors who above all want to benefit from the divergence between fixed rate yields in euros and real yields in euros. Indeed, the inflation differential between fixed rate bonds and bonds indexed to the euro zone HICP should reflect euro inflation expectations for the same issuer and the same maturity since the euro's introduction.

2.3.3 OATi and OAT€i market conventions

Generally speaking, the euro-denominated fixed rate bond market conventions defined in paragraph 2.1.3.2 of this chapter apply to euro-denominated indexed sovereign issues. However, in addition to these general conventions, specific conventions govern the indexed bond market.

[24] Guillaume Couzineau and Jean-François Borgy, “Hedging the euro”, Risk Magazine, Volume 14, No. 12
[25] “The rationale and design of inflation linked bonds, Robert Price, January 1997, http://www.imf.org/external/pubs/ft/wp/wp9712.pdf ".

2.3.3.1 Quoting I/L bonds' price in percentage of the real yield

Perhaps the most original inflation-linked bond market convention stipulates that these securities must be priced like fixed rate issues.

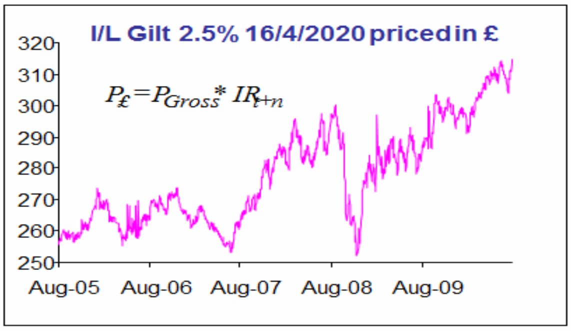
As a result, the equation to calculate the price of these securities in percentage uses the same equations as those previously described for bonds paying a fixed nominal yield. The only difference, in the case of indexed bonds, is that the rate of return used to discount their cash flows corresponds to a real yield, instead of the nominal yield used to discount fixed rate bonds. Other equations applicable to the analytics of fixed rate bonds are also used for indexed bonds.

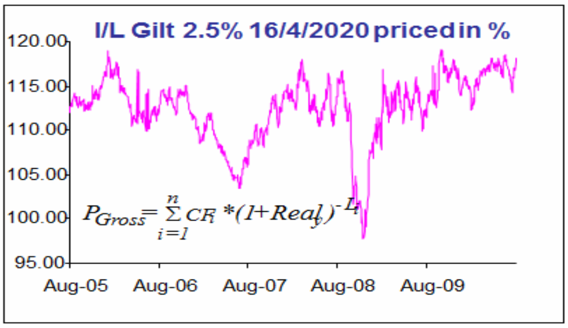
On the other hand, when it comes to calculating the price of a transaction in euros, the cash flow calculated in percentage of the real yield will be applied to the nominal amount of the transaction and will be indexed, as described below.

The convention for the calculation of the price in percentage of indexed sovereign issues was inaugurated with Canadian Real Return Bond issues. Previously, the market quoted the price of these securities after indexing.

This is notably the case for I/L Gilts issued prior to 2005 whose coupon had an 8-month indexing time lag.

The two charts below show the method for pricing the 2.5% 2020 indexed Gilt in £ and in percentage. This bond was issued in October 1983 and its price in £ reflects the very high level of UK inflation during the first few years following its issuance.





2.3.3.2 The benefits of pricing in percentage of the real yield

This pricing method offers a number of advantages:

- It is simply based on the standard equation commonly used to value traditional fixed rate bonds, by replacing the effective nominal rate with the real yield.
- It immediately shows the risk incurred and the investor's performance with regard to the real yield. In fact, investors bear no inflation risk as they will retrospectively receive the realised inflation over the security's lifetime.
- It enables an easy approximation of the expected change in inflation, for a given maturity, by calculating the difference between the nominal yield and the real yield for the same issuer and the same maturity.
- Investors are put in the real world where the value of the cash flows paid by the bond remains constant, as it is protected against inflation.
- This prevents the need to make inflation assumptions for price and yield calculations.

2.3.4 Coupon calculations

2.3.4.1 General remarks about coupons

The general calculation rules described in paragraphs 1.5.3 and 1.5.4 of the first chapter of volume A, on interest period calculation conventions, according to the timetable and conventions for the possible adjustment of interest amounts, also applies to indexed bonds. Similarly, the calculation of the full coupons and accrued interest of fixed rate bonds also applies to indexed bonds as described in paragraph 2.2.2.1 of the first chapter of Volume A.

However, there is a subtle distinction between the application of the index ratio to the calculation of the full coupon and to the accrued interest:

- Euro-denominated indexed bonds follow the market conventions applicable to fixed rate bonds, for the calculation of full coupons paid on an unadjusted Actual/Actual basis. For instance, OATis and OAT€is pay coupons on 25 July every year, whether or not it is a working day. 25 July 2010 fell on a Sunday and the full coupon of the 3%, 25 July 2012 OAT€i was paid in euros, applying an index ratio corresponding to this security on the date of Sunday 25 July 2010, which was 1.17957, even though, in actual fact, the coupon was only effectively paid on Monday 26 July 2010. This is why index ratio series are published for every day of the week, including Saturday and Sunday.

- On the other hand, accrued coupons are based on secondary transactions, which cannot be settled on a public holiday. Consequently, for a secondary transaction settled on the 26 July 2010 value date, the published index ratio of 1.17961 applicable at this date will be applied.

The two transactions, payment of the full coupon and secondary transaction, are not, however, directly comparable. Suppose an investor owns 10 million 3% 25 July 2012 OAT€is. On this date, the investor will receive the full coupon of 25 July 2010 and the index ratio of 25 July 2010 on this full coupon. If, furthermore, the investor sells his bond on 26 July 2010, the gross price of the bond that he will trade will include 1 day of accrued interest from 25 to 26 July 2010, to which the index ratio of 26 July 2010 will be applied.

2.3.4.2 Full coupons

- **The real coupon in percentage of indexed bonds** is a fixed rate determined on the issue's launch, according to the nominal yield paid, for the same maturity, by the same investor, and market inflation expectations corresponding to this maturity. The real yield is expressed as an annual interest rate. The calculation of the full coupon in percentage of the real yield of indexed bonds is made in the same way as for fixed rate nominal bonds. French, Greek and German sovereign indexed bonds pay an annual coupon, while Italian sovereign indexed bonds pay a semi-annual coupon.

- The periodic real full coupon in percentage to be paid at the end of the interest period is calculated using the following equation:

$$FC_{\%} = \frac{C_{Real} * 100}{h} \qquad (A.2.3.1)$$

With:

FC%	*: Full coupon expressed in percentage*
C_{Real}	*: Real coupon*
h	*: Number of periods in the year. In the case of annual coupons, h = 1*

The full coupon in percentage of the real yield is rounded commercially to the 5th decimal.

- **The full coupon of indexed bonds paid in euros**

As with fixed rate OATs, the nominal value of OATi and OAT€i denominations is 1 euro. However, although the real full coupon is calculated in the same way as for fixed rate OATs, denomination by denomination, the full coupon after indexing is calculated by applying the index ratio, not denomination by denomination as with fixed rate OATs, but to the amount of the transaction to which it applies. And in the case of payment of the full coupon on a non-working day, the applicable ratio on the theoretical payment date is the ratio used for the full indexed coupon calculation on that specific theoretical date, rather than the index ratio applicable on the next working day.

$$FC_{€} = FC_{\%} * NomTA * \ IR_{d} \qquad (A.2.3.2\ )$$

With:

FC€	*: Full coupon expressed in euro*
FC%	*: Full coupon expressed in percentage*
NomTA	*: Nominal amount of the transaction*
IR_d	*: Index ratio*

Example: in July 2010, an investor owned 10,000 3% 25 July 2012 OAT€is	
Calculation of the real coupon in percentage 3.00%	: 0.03000
Index ratio applicable on Sunday 25 July 2010	: 1.17957
Total amount of coupons paid: 10 000 x 0.03000 x 1.17957 = 353.871	: €353.87

2.3.4.3 Accrued interest

As with the calculation of fixed rate bonds, euro-denominated indexed bonds follow the Actual/Actual calculation convention. Since April 2005, on the French domestic wholesale market, the accrued interest expressed in percentage of the par value of the Agence France Trésor's bonds is rounded to the 7th decimal:

- **Accrued interest in percentage of the real yield:** this calculation uses the same equation as is used for nominal bonds:

$$AI_{\%} = \frac{FC_{\%} * \ nda}{N} \qquad (\ A.2.3.3\ )$$

- **Accrued interest in euros:** the accrued interest in euros is calculated by directly applying the accrued interest in percentage and the index ratio corresponding to the settlement/delivery date to the nominal amount of the transaction. This amount is rounded to the second decimal in euros, euro cents.

$$AI_{€} = FC_{\%} * \ NomTA * IR_{t+n} \qquad (\ A.2.3.4\ )$$

With:

AI€	*: Accrued interest in euro at settlement date*
$FC_{\%}$	*: Full coupon expressed in percentage*
NomTA	*: Nominal amount of the transaction*
IR t+n	*: Index ratio at settlement date*

Example: an investors sells 10,000 3%, 25 July 2012 OAT€is on 21 July 2010	
Calculation of the real coupon in percentage 3.00%	: 0.03000
Accrued interet payment date	: 26 July 2010
Number of days of interest accrued	: 1
Number of days within the interest period	: 365
Accrued interest in percentage	: 0.0082192%
Index ratio at 8 January 2008	: 1.17961
Amount of accrued interest in euros	: €0.97

2.3.5 Calculation of the price and yield of indexed bonds

$$P_{Ggross} = P_{Net}(t) + AI\%(t_{+n}) \qquad (A.2.3.5)$$

With:

P_{Gross}	: Gross price expressed in percentage at settlement date
P_{Net}	: Net price expressed in percentage at settlement date
$AI_{\%}$	: Accrued interest in percentage at settlement date
t	: Calculation date
t_{+n}	: Settlement date

2.3.6 Market price in percentage of euro zone indexed bonds

Currently, the price of most sovereign indexed bonds is quoted in percentage of the par value before indexing is applied, which is a practice that offers many advantages.

Similarly as for the description of fixed rate bonds, in the interests of simplification, the various equations used in the subsequent paragraphs to calculate the yield, duration, modified duration and convexity of bonds indexed to inflation will be expressly limited to annual or infra-annual coupon discount calculations based on effective interest rates compounded annually. In the equations based on a real discount rate compounded annually, the effective yield is denoted $Real_{ya.}$

2.3.6.1 Equations used in the case of an effective interest rate compounded annually

As with fixed rate issues, the equations below enable the calculation of the price of euro zone sovereign bonds, providing that these bonds use a discount method based an effective interest rate compounded annually, even in the case of Italian Treasury Notes that pay semi-annual coupons.

- The gross price in percentage of the real yield of an indexed bond is given by the following equation, in the case of annual compounding of the discount rate:

$$P_{Gross} = \frac{FC_{\%1}}{(1+Real_{ya})^{L_{ia1}}} + \frac{FC_{\%2}}{(1+Real_{ya})^{L_{ia2}}} + \frac{FC_{\%3}}{(1+Real_{ya})^{L_{ia3}}} + ... + \frac{FC_{\%n}+100}{(1+Real_{ya})^{L_{ian}}} \qquad (A.2.3.6)$$

With:

P_{Gross}	: Gross price expressed in percentage at settlement date
$FC_{\%}$	: Full coupon expressed in percentage
L_{ia}	date
$Real_{ya}$	: Real yield compounded annually
n	: Number of cash flows between the maturity date and the settlement date

- This equation may also be written:

$$P_{Gross} = \sum_{i=1}^{n} CF_i * (1 + Real_{ya})^{-L_{ia}} \qquad (A.2.3.7)$$

With:

P_{Gross}	*: Gross price expressed in percentage at settlement date*
Cfi	*: ith cash flow of the bond*
n	*: Number of cash flows between the maturity date and the settlement date*
$Real_{ya}$	*: Real yield*
L_{ia}	*: Time in interest period between the ith cash flow and the settlement date*

2.3.6.2 Real effective yield of euro-denominated indexed bonds

- **Price calculation equations:** As with fixed rate bonds, the real yield of indexed bonds is calculated using the equations above, by substituting the real yield for the nominal yield. Indexed bonds issued in euros by France, Greece and Germany pay an annual coupon and their yield is expressed as an annual effective yield. Italian indexed issues, on the other hand, pay a semi-annual coupon. However, in accordance with market practices, the real effective yield of BTP€is is expressed as an annual effective interest rate and the equations above are applicable to them.

- **The real yield of indexed bonds may become negative**

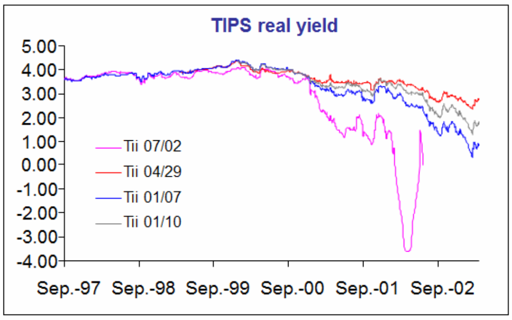
As a reminder, the nominal yield is broken down as follows according to the Fisher equation:

$$(1 + Nomy) = (1 + Realy) * (1 + EI) * (1 + IRP) \qquad (A.2.1.1)$$

With:

Nomy	*: Nominal yield*
Realy	*: Real yield*
EI	*: Expected inflation*
IRP	*: Inflation Risk Premium*

The yield of indexed bonds whose maturity is very close is very volatile and may become negative with the volatility of monthly inflation figures.

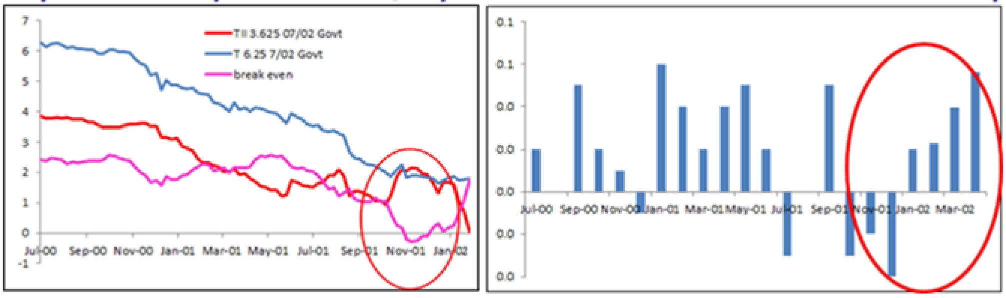


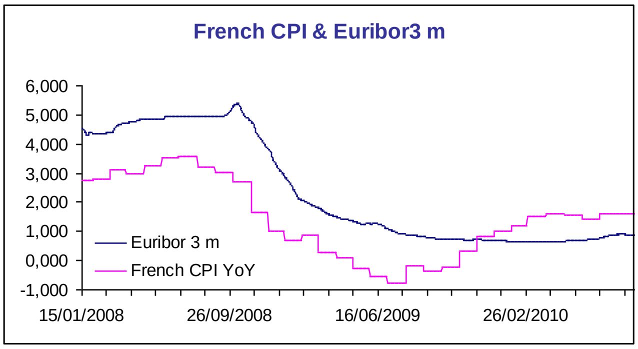
The chart opposite shows the real yield curve of TIPS from 1997 to 2002. In the 6 months prior to its maturity the yield of the 07/2002 TIPS notably deviated from TIPS of longer maturities.

The first of the two charts below shows the difference between the nominal yield of the July 2002 fixed rate Treasury and the real yield of the July 2002 TIPS.

The second shows the monthly change in the US CPI, in the months preceding repayment of these securities. As the delay in reporting the index is minimal, at the end of the month, the value of the index for the whole of the next month is known. As a result, market operators value the price of indexed securities like nominal securities, factoring in the realised inflation that will be applied on repayment of the bond's principal, therefore enabling arbitrage with the money market for the same maturity.

July 2002 Treasury Nominal Yield, July 2002 TIPS Real Yield & MoM inflation Volatility



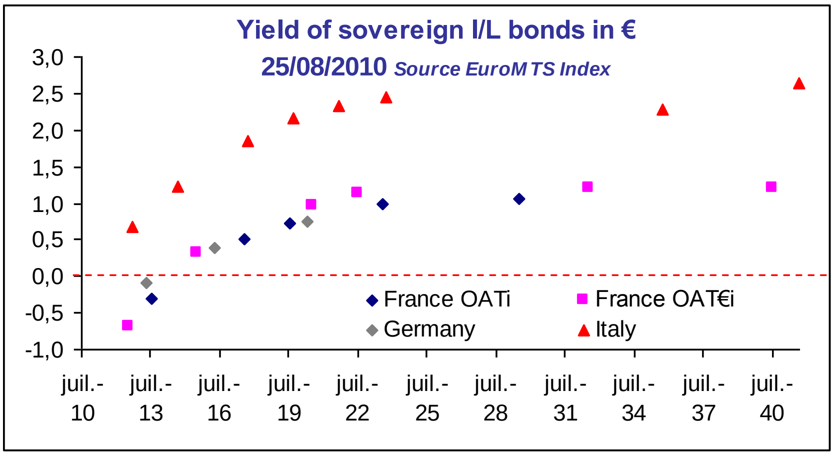


In some circumstances, effective inflation may be higher than the nominal rate. For instance, as the chart opposite shows, as of June 2010, since the second half of 2009, the quoted level of the 3-month Euribor has been below the actual annual percentage inflation for the last twelve months. This is explained by the very accommodating monetary policy followed by the central bank during this period.

Expected inflation may even exceed nominal rates for medium-term maturities. In August 2010, market expectations drove investors to take refuge in the highest rated and most liquid government bonds, sometimes pushing the nominal yield of these fixed rate bonds below the real yield of indexed bonds issued by the same issuer. On the US Treasury market, this phenomenon has extended to maturities of up to 5 years.

The same situation has been seen on the euro-denominated, AAA-rated bond market, as the chart below, dated 25 August 2010, shows.

This difference in the behaviour of indexed bonds compared to nominal bonds reflects the difference in the liquidity of these two markets, as described in paragraph 3.3.7.3 of this chapter.



2.3.6.3 Calculation of the amount paid in euros when a transaction takes place

<u>The total amount paid in euros when a transaction takes place on a given settlement/delivery date, is calculated using the following equation:</u>

$$TA_{€} = P_{Gross} * NomTA * IR_{t+n} \qquad (A.2.3.8)$$

With:

$TA_{€}$	*: Transaction amount in euro*
P_{Gross}	*: Gross price expressed in percentage at settlement date*
NomTA	*: Nominal amount of the transaction*
IR_{t+n}	*: Index ratio at settlement date*

This amount is rounded to the second decimal place, in euros.

Example: in January 2008, an investor owned 100,000 1.80%, 25 July 2040 OATeis

Ex coupon price in %	: 92.37%
Index ratio on the 8 January 2008 settlement/delivery date	: 1.02805
Principal transaction amount in euros 100,000 * 92.37% * 1.02805	: 94,960.98 euros
Amount of accrued interest in %	: 0.8213115%
Amount of accrued interest in euros	: 844.35
Total transaction amount = 94,960.98 + 844.35	: 95,805.33 euros

2.3.7 Inflation breakeven rate

The inflation breakeven rate concept enables a simple comparison of the expected returns from an indexed bond against the fixed rate yield paid by the same issuer for the same maturity.

2.3.7.1 The Fisher equation and the relationship between nominal and real yields

To recall:The Fisher equation has already been described. Use of this equation is complicated by the fact that there is no objective method for separating expected inflation from the inflation risk premium. In addition, since inflation-linked bonds are priced on the market, investors demand a lower liquidity premium on these bonds, reducing the inflation risk premium.

2.3.7.2 The inflation risk premium paid by investors and the Fisher equation

This premium would be demanded by buyers of nominal bonds to offset the inflation risk that these bonds expose them to. The existence of this premium is theoretically beyond doubt, as it is logical that an investor buying a nominal bond would demand an inflation risk premium, whereas inflation-linked bonds are perfectly protected against this risk.

The IMF article already quoted published in 1997[26], argues that the issuance of indexed bonds could help sovereign issuers to reduce their financing costs. Many theoretical studies have tried to measure the value of this risk premium[27].

[26] The rationale and design of inflation linked bonds : http://www.imf.org/external/pubs/ft/wp/wp9712.pdf
[27] These studies include the following publication by the BIS: "Inflation risk premia in the term structure of interest rates", Peter Hördahl and Oreste Tristani: http://www.bis.org/publ/work228.pdf?noframes=1

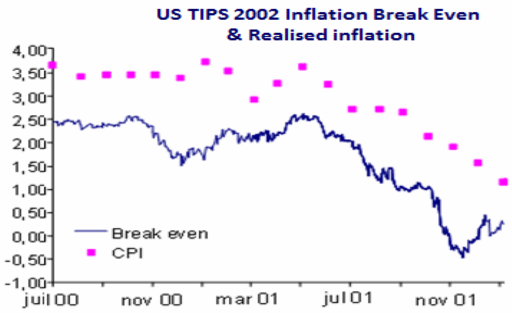
2.3.7.3 The lower liquidity premium received by I/L bonds' investors

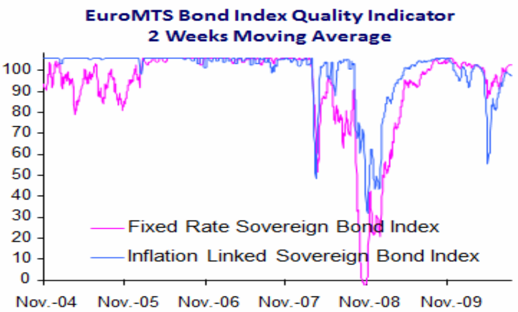
However, experience shows that the nominal and indexed bonds of the same issuer may also have different liquidity premiums, as highlighted by the ECB, amongst others, in a publication in June 2007[28].

- The first of the charts on the next page shows that the inflation breakeven rate, calculated on the July 2002 TIPS and the nominal Treasury with the nearest maturity, constantly underestimated realised inflation.

  In October 2008 a study by the New York FED[29] suggests that the valuation of the TIPS programme should focus on the *ex ante* cost of TIPS compared to that of nominal Treasuries, as inflation expectations on the launch of these issues may differ from realised inflation. This article concludes that the *ex ante* cost of TIPS is more or less equal to that of nominal Treasuries, as investors underestimate expected inflation[30].

  Other studies suggest that this underestimation of the inflation breakeven rate reflects the lower liquidity of US indexed bonds compared to that of nominal Treasuries. According to this logic, the US Treasury should be prepared to pay a premium to investors for them to try out this new product.





- The second chart above, which compares the quality index of euro-denominated fixed rate and indexed sovereign EuroMTS indices, reveals the generally lower liquidity of indexed bonds compared to nominal bonds. EuroMTS publishes daily quality indicators of its fixed rate and indexed bond performance indices[31]. The indicators state the percentage of the securities included in each of these two indices that were quoted at the time of fixing. In August 2010, there were 50 securities in the inflation index, compared to around three times more in the nominal index. As the chart shows, in a normal period, around 100% of the securities are quoted in both indices at the time of fixing, which is a token of these indices' quality. However, with the subprime crisis, the quality of the indexed bond index has proven to be lower. This might be explained by the smaller number of indexed bonds issued by some euro zone sovereign issuers that were the most affected by the crisis in spring 2010.

2.3.7.4 In practice, the market uses the concept of inflation breakeven

Using this concept means that the various premiums that may be linked to nominal or indexed issues do not have to be calculated. The inflation breakeven rate measures the future level of realised inflation enabling the equalisation at maturity of the yield of a nominal bond for the same issuer and the same maturity, assuming that the cash flow discount rate is the same for both cash flow series, in other words equal to the nominal yield for the maturity in question (which assumes that the nominal yield curve is flat, but is a good approximation).

[28] "As the liquidity of inflation-linked bonds, although growing fast, is likely to remain lower than that of comparable nominal bonds, this may lead to the presence of a higher liquidity premium in the yields of inflation-linked bonds. This liquidity premium would therefore tend to bias the BEIR downwards". ECB, Inflation Linked bonds from a central bank perspective, occasional paper series No. 62, June 2007.
[29] The case for TIPS: An examination of the Costs and the Benefits
[30] The "Growing Pains" of TIPS Issuance Jennifer E. Roush, 08/2008, Federal Reserve Bank.
[31] http://www.euromtsindex.com/index_new/content/index_data/fixing_data/EMTXi_G_1100_Fixing.csv
http://www.euromtsindex.com/index_new/content/index_data/historical/underlying_bond_prices__emtx.php

This is calculated using the following equation:

$$IBE = \frac{(1+\ Nomy\ )}{(1+\ Realy\ )} - 1 \qquad (A.2.3.9)$$

With:

IBE	*: Inflation Break Even*
Nomy	*: Nominal yield*
Realy	*: Real yield*

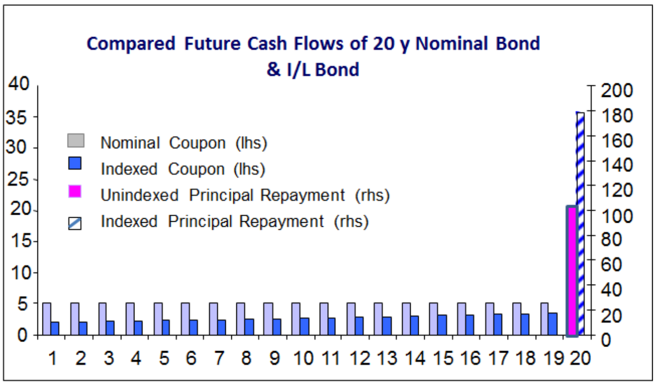
If, during the bond's lifetime, realised inflation was higher on average than the inflation breakeven rate, the performance of the indexed bond would be higher than that of the nominal bond. As the equation above shows, the nominal yield is equal to the compounding of the real yield and inflation.

In the interests of simplification, the market uses the following approximation to calculate the inflation breakeven rate, where, to calculate the nominal rate, inflation is simply added to the real yield instead of being compounded with the real yield

$$Nomy = \ Realy + IBE \qquad (A.2.3.10)$$

For example, the inflation breakeven rate, calculated based on a nominal bond offering a 5% yield and an indexed bond offering a 2% real yield, amounts to 3% using the addition-based equation and 2.94% using the exact equation:

- This approximation is all the more acceptable as very often the two securities used to calculate the inflation breakeven point do not have exactly the same maturity.

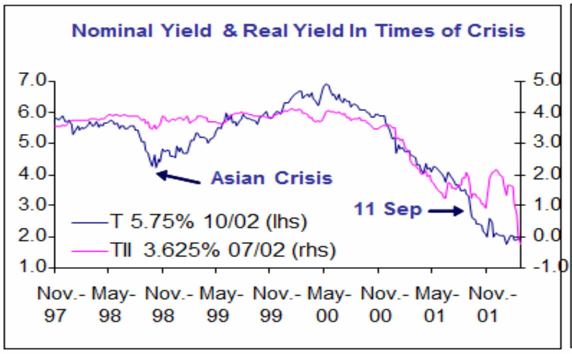


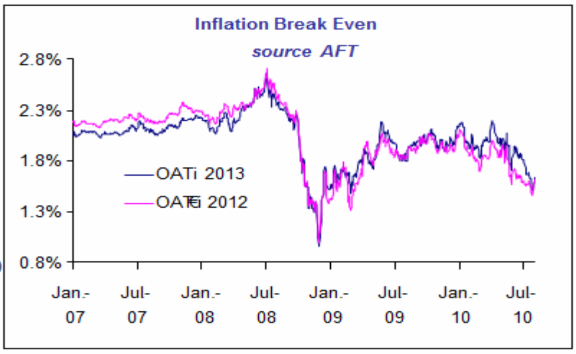
- In addition, as the chart opposite shows, the cash flows of nominal securities are not directly comparable with the cash flows of indexed bonds with a standard indexed sovereign bond structure, even in the case of securities priced at par. In this chart, the fixed rate bond offers a 5% nominal yield and the indexed bond a real yield of 2%. A constant inflation assumption of 2.94% enables the equalising of the two bonds' yields at maturity at 5%. However, if the future cash flows of the indexed bonds are calculated based on this constant inflation assumption, to transform them into a nominal bond, this theoretical bond has a higher duration than the bond paying a 5% nominal yield. If the cash flows of this crystallised theoretical bond are valued based on the zero coupon nominal yield curve deduced from the yield curve at par, its price, at 99.12%, is below par and its yield amounts to 5.05%.

Effect of the lower liquidity of indexed bonds on the inflation breakeven rate: the two charts below show the impact of the lower liquidity of indexed bonds on the inflation breakeven rate during a crisis period:

- The lefthand chart reflects the impact of the Asian crisis and of September 11 on nominal and indexed Treasuries. Because of the lower liquidity of these Treasuries, the inflation breakeven is automatically reduced, with the flight to quality focused on more liquid nominal bonds.

- The righthand chart illustrates the inflation breakeven of the 2013 OATi and the 2010 OAT€i. As we can see, following the failure of Lehman Brothers, the inflation breakeven falls considerably, reflecting the liquidity differential between nominal bonds and indexed bonds.





2.3.8 Analytics of duration, modified duration and convexity

2.3.8.1 Equations applying to the price in percentage of the real yield

The indicators used for indexed bonds priced in percentage of the real yield, involve the same equations as those used for fixed rate bonds. These equations are presented simply below, without specifying their notation, which is identical to that for fixed rate bonds developed in Chapter 1. Note simply that in the following equations, the interest cash flow CF_i is equal to the real coupon of the indexed bond and the discount rate $Real_{ya}$ is the effective real yield. This yield is an annual rate that is applied both to the calculation of euro-denominated indexed bonds paying an annual coupon, and to the coupon of indexed BTPs paying a semi-annual coupon.

A table at the end of this paragraph compares the result of these indicators for nominal and real bonds.

- **The lifetime of an indexed bond** is equal to the lifetime of a nominal bond of the same maturity, as this calculation concerns only the bond's principal cash flow at maturity.

- **The average lifetime of the interest and principal cash flows** of the bond is given by equation *(A.1.2.17),* used for fixed rate bonds, in paragraph 2.2.8.1 of this chapter.

- **Duration of an indexed bond:**

The duration of an indexed bond uses the fixed rate bond equation, by replacing the nominal discount rate with the real discount rate:

$$D = \frac{1}{P_{Gross}} * \sum_{i=1}^{n} CF_i * (1 + Real_{ya})^{-L_{ia}} \qquad (A.2.3.11)$$

- **Modified duration of an indexed bond:**

The modified duration, or Macaulay Modified Duration, of an indexed bond, is defined as the derivative of its price divided by its effective real yield. This modified duration uses the equation for fixed rate bonds, by entering the real discount rate:

$$D_{Modified} = -\frac{\partial P_{Gross}}{\partial y_a} = \frac{-1}{1+Real_{ya}} * \sum_{i=1}^{n} L_{ia} * CF_i * (1+Real_{ya})^{-L_{ia}} \qquad (A.2.3.12)$$

The modified duration of a bond is easily calculated from the duration using the following equation:

$$D_{Modified} = \frac{D}{1+ Real_{ya}} \qquad (A.2.3.13)$$

- **Convexity of an indexed bond**

The following equation applies to the calculation of convexity:

$$Cx = \frac{1}{P_{Gross}\,(1+Real_{ya})^2} * \sum_{i=1}^{n} \frac{CF_i}{(1+Real_{ya})^{Lia}} * (Lia^2 + Lia) \qquad (A.2.3.14)$$

2.3.8.2 Analytics between fixed rate and indexed bonds

The tables below compare the duration, modified duration and convexity of fixed rate bonds paying a 4% coupon with the same indicators applies to I/L bonds paying a 2% coupon, with 5 to 50 year maturities.

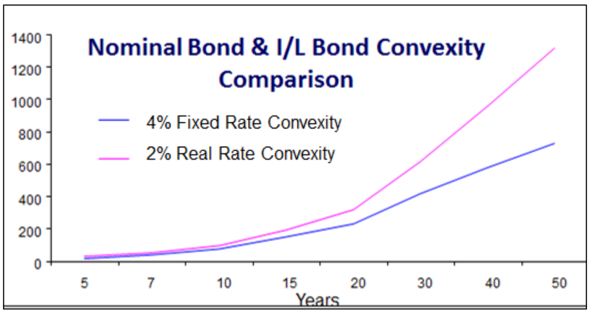
Analytics of Nominal Bonds Paying a 4% Fixed Coupon on various Maturities priced at par

Maturity	5	7	10	15	20	30	40	50
Duration	4.6	6.2	8.4	11.6	14.1	18.0	20.6	22.3
Modified Duration	4.5	6.0	8.1	11.1	13.6	17.3	19.8	21.5
Convexity	25	43	81	155	241	420	589	736

Analytics of I/L Bonds Paying a 2% Fixed Coupon on various Maturities priced at par

Maturity	5	7	10	15	20	30	40	50
Duration	4.8	6.6	9.2	13.1	16.7	22.8	27.9	32.1
Modified Duration	4.7	6.5	9.0	12.8	16.4	22.4	27.4	31.4
Convexity	27	50	94	192	316	616	960	1321

The chart opposite illustrates the higher duration of indexed bonds compared to nominal bonds of the same maturity.



An indexed bond paying a 2% real coupon quoted at par has the same duration and the same modified duration as a nominal fixed rate bond paying a 2% coupon quoted at par.

In fact, the cash flow structure of the two bonds is identical, if you consider that:

- the nominal bond is priced against a nominal yield, in a nominal world exposed to both the real yield and inflation,
- and that the indexed bond is priced against a real yield in a world without inflation. This will be developed in the next paragraph.

2.3.8.3 The CNO suggests measuring the sensitivity of I/L bonds to the real yield alone

In 1998, when the first indexed OAT was launched, the CNO recommended that the price of indexed bonds be calculated in percentage of the real yield, as was already the case for TIPS and Canadian indexed bonds.

In 2005, the AMTE set up a working group aimed at improving the indexed bond market[32]. The CNO was in charge of the "Standardisation and enhancement" sub-group. The AMTE's final report found that suppliers of indexed bond performance indices were continuing to use two different methods to calculate the modified duration of these bonds and encouraged participants to harmonise their indexed bond price calculation methodology:

- The first of these methods, which uses the calculation of sensitivity to the real yield alone, which is the method recommended by the CNO, considers an inflation-linked bond to be a separate asset class whose risk is not directly homogeneous with that of nominal bonds. This method is used by the Barclays and EuroMTS indices.

- A second method discounts the future cash flows of an indexed bond by making an inflation assumption, to compare nominal bonds and indexed bonds. This older method was developed on the market for indexed bonds, whose price, like that of former I/L Gilts which had an 8-month inflation time lag, was priced in sterling after indexing (see paragraph 3.3.3.1 of this chapter). It is used by the inflation indices of Merrill Lynch and Lehman Brothers.

- As for Bloomberg, by default the YA screen proposes the method based on an inflation assumption. This inflation assumption can however be overridden to calculate sensitivity to the real yield alone.

At the same time as the AMTE group's works, the CNO, after consulting its members, recommended using the sensitivity of I/L bonds to the real yield alone, for the following reasons:

- The main purpose of the sensitivity of a security to a change in the discount rate is to provide market participants with an indicator of the risk to which their investments are exposed at all times. The method for calculating sensitivity to the real yield alone is homogeneous with the method for calculating the market price of an indexed bond. It guarantees complete concordance between the sensitivity measured at a time *t* and the price, in percentage, that the owners of the security may receive on the secondary market at this time *t*, if they want to sell this security.

- To calculate the sensitivity of indexed bonds, the investors simply calculates the bonds' price sensitivity to the real yield, without making inflation assumptions, believing that there is no inflation risk as they should receive the realised inflation rate at the bond's maturity. These investors are in a real world where inflation does not exist.

- The CNO finds that pricing in percentage of the real yield is the pricing standard for the market price of inflation-linked bonds.

- Of course, at a given transaction date, the price in euros of an indexed bond incorporates the index ratio applicable on this date. This is how traders calculate their exposure to a transaction in euros. However, the calculation of the index ratio applied to a transaction on the settlement/delivery date is not based on an inflation assumption, as the two monthly markers used to calculate this ratio, the monthly CPI for m-3 and m-2, are in principle already known and if, exceptionally, they weren't, the substitute index would apply.

- Like the AMTE, the CNO notes that this specific standard for the calculation of sensitivity to the real yield alone confirms the status of indexed bonds as a new asset class.

[32] Inflation-linked products in the Euro area: an AMTE working group to standardise, develop and promote the asset class

2.3.9 The beta, β, of indexed bonds

The beta of indexed bonds reflects the sensitivity of real yield to the variation of nominal bond yields, for the same issuer and the same maturity. if the beta is lower than 1, any change of the nominal yield will partially impact the real yield. On the opposite, if beta is larger than 1, yield changes will be larger on the linkers than on the nominal bonds.
Beta could be very low (close to zero) or even negative as we saw during the recent crisis.
The calculation of this coefficient has long relied on the observation of historic correlations. Its value is also very depending to the rolling window as shown below.

2.3.9.1 The beta has been largely stable from 1981 to 2000

This stability brought the market to the conclusion that, during the first months following the launch of TIPS, in 1997, the real yield of indexed bonds equalled a fixed proportion of the nominal yields for the same maturity, as the I/L Gilts market seemed to indicate:

- This market, which developed starting in 1981, has in fact long considered that the change in the yield of I/L Gilts represented around 50% of that of nominal Gilts of the same maturity and, on the launch of US and French indexed bonds, in 1997 and 1998, this ratio seemed to be confirmed. During the months that followed the launch of TIPS, a dollar-denominated indexed private bond market quickly developed[33], backed by an inflation swap market betting on the lesser volatility of the yield of indexed bonds, despite the strong correlation of their yield with that of nominal bonds.

- As a result of this observation, a large number of funds mixing fixed rate and indexed bonds developed on either side of the Atlantic, the inclusion of indexed bonds in a nominal bond portfolio being deemed to reduce the overall volatility of these funds. Similarly, several large US funds have used leverage strategies to increase their return, by investing, for example, twice the amount managed by the fund in indexed bonds[34], using the repo technique.

- Retrospectively, this strong correlation seems to have resulted from a self-fulfilling phenomenon linked to the limited number of participants on the I/L Gilts market. This highly specialised market was in fact only made up of a limited number of market makers. In 2001, only 9 market makers responded to a DMO consultation on the possible reforming of the I/L Gilts[35] auctioning method and, according to the Bank of England, in 1996, 80% of the I/L Gilts market was held by pension funds and UK insurance companies. Although these companies hold their securities until maturity, they must revalue their investments at their market price. The stability of the correlation between nominal and indexed bonds could be viewed as a security-enhancing factor, possibly explaining why participants acquired the habit of using this 50% coefficient, as a matter of convenience.

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[33] As non-sovereign issuers do not wish to maintain exposure to the price index, a market for swaps protecting against inflation quickly developed. In the first 5 months, these issues totalled USD 2.5 billion, in other words 20% of the amount of TIPS issued. However, this market collapsed with the divergence of the nominal and real yields.

[34] Justification by one of the main US fund managers for this leverage strategy: "I/I bonds offer powerful risk reduction benefits to typical institutional investment portfolios. This risk reduction results from a combination of low interest rate volatility and a strong diversification benefit due to the low to negative correlation of I/I bond interest rates to the interest rates of traditional asset classes such as equities and nominal bonds…

A 2:1 leveraged I/I bond portfolio consists of two components – an un-leveraged component and a leveraged component. The expected real yield of the total leveraged portfolio will equal the sum of the expected real yields for each of these two components. The expected real yield of the un-leveraged component will equal the prevailing real yield, which at the time of this writing is approximately 4.00% on the 10-year US I/I bond. The expected real yield of the 2:1 leveraged component will equal today's real yield minus the expected real borrowing cost over the ten-year period. Assuming an average real cost of borrowing in the cash markets over the ten year period of 2.00%, the leveraged component will have an expected real yield of 2.00% (4.00% minus 2.00%). Adding the expected real yields of these two components provides an expected real yield of the total 2:1 leveraged portfolio of 6.00% (4.00% plus 2.00%). Interestingly, this is an expected real yield that is quite comparable to the long-term real yield that most investors expect for equities".

[35] http://www.dmo.gov.uk/documentview.aspx?docname=/publications/giltsmarket/consultationpapers/cons120301.pdf&page=consultation

2.3.9.2 However, the beta has been more volatile during the crisis and no rule can be settled in this regard

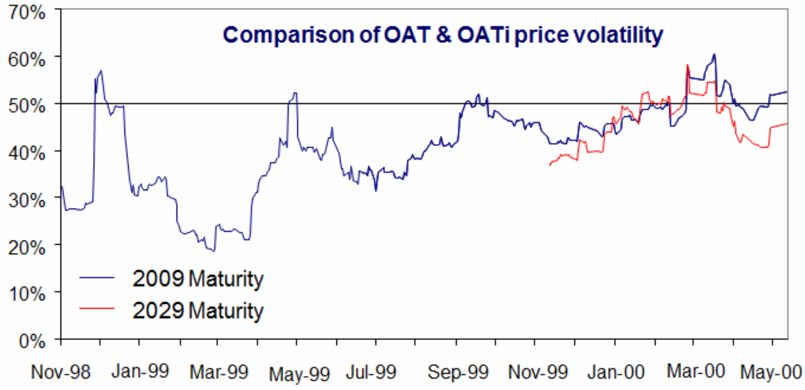
In 2001, after the AMF noted that French mutual funds investing in indexed bonds were not calculating the sensitivity of these securities in the same way, it wished that the CNO define a standard for calculating their regulatory sensitivity, enabling the inclusion of these securities in mixed bond portfolios composed of nominal and indexed bonds[36]:

- Some investors believed that the sensitivity of an indexed bond should be zero, or equal to that of 3-month money market instruments,

- Whereas other investors saw the sensitivity of inflation-linked bonds as being comparable with that of nominal bonds, arguing that the price of inflation-linked bonds is calculated by using the same equation as that used to calculate the price of traditional fixed rate bonds.

After comparing the volatility of the market yields prices of nominal OATis and OATs maturing in 2009 and 2029, in June 2001 the CNO therefore noted that the volatility of the real yields observed on the market was, on average, around two times lower than that of nominal rates for an equivalent maturity, partly justifying this 50% ratio:

- "On the French market we have a history of only 20 months to confirm this difference in volatility, but countries that have longer histories (UK, USA) confirm that indexed bond yields are around half as volatile. The graph below calculates the rolling month volatility ratio of indexed bonds compared to traditional fixed rate bonds. Note that this ratio is very stable and the fact that it is almost always below 50%".

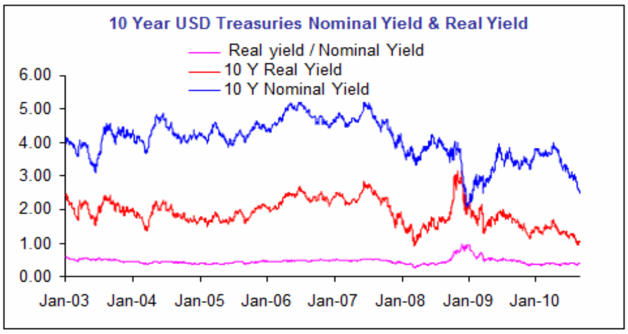


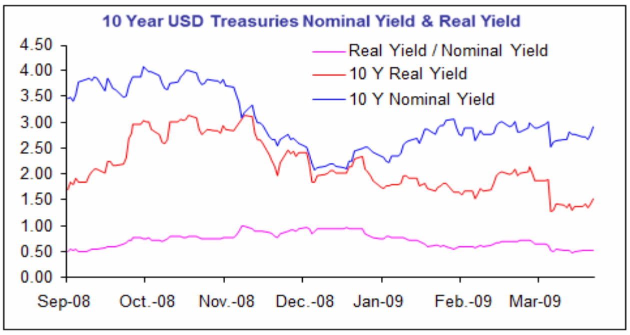
- The CNO also noted at that time that, from a more theoretical viewpoint, in recent years the real yield and inflation expectations were each equal to around 50% of nominal yields, such that they could be deduced from the inflation breakeven. This is why in July 2001 the CNO recommended using a standard beta of 0.50% of nominal bonds' sensitivity, for the regulatory declaration of the price sensitivity of indexed bonds of the same maturity.

[36] French mutual funds must declare the sensitivity of their portfolios to the AMF on a monthly basis.

Since 2003, however, the yield sensitivity of indexed bonds has been very close to that of nominal bonds, as shown in the two charts below, on the dollar and euro markets.

The first of these charts illustrates the correlation of nominal and real yields for 10-year US Treasuries, over the period January 2003 – August 2010. The second analyses this same correlation during the months following the failure of Lehman Brothers.

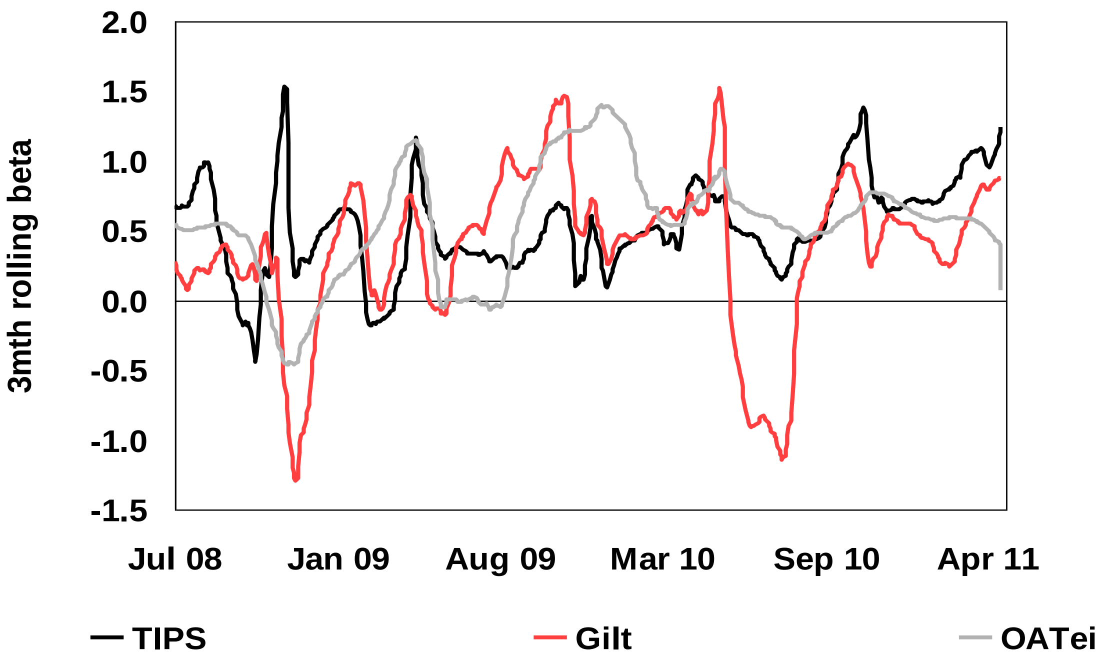




During the crisis and presently, the beta has been even more volatile. This is partly due to the fact that as stated before:

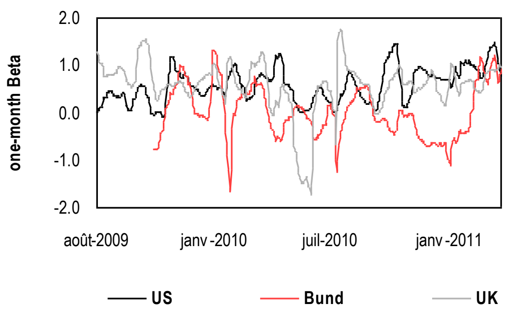
- Liquidity of IL bonds and of nominal bonds can be significantly different and furthermore not correlated in a stable manner over time (e.g. due to different movements regarding inflation expectations and fly- to-quality)
- IL bonds management in an ALM (hedged) vision or in a pure trading 'naked' positioning both exist and their relative importance as their potential interaction can move in time.

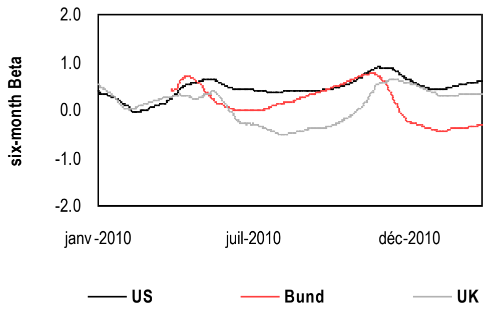
The chart below shows how large could be beta fluctuation since 2008.



(Source: HSBC)

The value of the beta is also very depending to the rolling window as shown below where the beta has been calculated respectively with a 1 month and 6 month rolling window.





Average beta values are the following:

	10 yr US TIPS	10 yr Bund ei	10 yr UK IL Gilt
1 month rolling window	0.556	0.016	0.569
6 month rolling window	0.510	0.145	0.175

(source: HSBC)

Whilst under unconditional probabilities regimes 0.5 would probably be the possible best estimate, for these above reasons and as beta could be significant different over times**, the CNO would like to consult again market participants on this matter**.

2.3.10 OATi and OAT€i STRIPS[37]

Since 2007, OATis and OAT€is have been eligible for stripping. The principles that govern the stripping of fixed rate OATs described in chapter 1 paragraph 2.2.9 of this volume apply to the STRIPS of indexed OATs.

However, the reform of fixed rate OAT STRIPS introduced in 2009 ensuring the fungibility of principal certificates and coupons does not cover indexed OAT STRIPS.

2.3.10.1 Application of the stripping programme to indexed OATs:

Ever since their launch, the possibility of later stripping French inflation-linked securities, when they had become sufficiently liquid, was considered[38]. With a monthly average transaction volume of €37 billion in 2006 and indexed government bond outstandings of €111 billion at the end of 2006, the AFT believed that the securities were now liquid enough to allow their stripping. OATis and OAT€is pay annual coupons on 25 July. The payment at maturity of each of these cash flows corresponds to a zero coupon bond indexed to the change in the price index since the launch of the security. Stripping enables the creation of these various zero coupon securities of maturities 25 July 2007 to 25 July 2029 on the real yield curve linked to French inflation, and of maturities 25 July 2007 to 25 July 2040 on the real yield curve linked to European inflation.

A working group consisting of primary dealers and the central depositary, Euroclear France, settled on the following stripping method, which was approved by the CNO.

- Each indexed security has a specific base index corresponding to the index's value on its date of entitlement. This lack of homogeneity of the different base indices attached to these different bonds might have prevented the fungibility of the coupons of different issues.

- To overcome this difficulty, it was decided to choose 100 as the base index of every coupon certificate created when an indexed OAT is stripped. Providing that calculations are made without intermediate rounding, this method, which had already been adopted by the US Treasury for the stripping of indexed

[37] In paragraph 2.2.9.9 of chapter 1 of this volume, we analysed why sovereign issuers did not directly issue nominal zero coupon bonds. However, in 1994 and 1995, the first issues of Swedish I/L bonds adopted a zero coupon structure. But, given the lack of success of these issues, Sweden subsequently issued indexed bonds paying an annual coupon.

[38] This would not have been the case with a Coupon Indexed structure, which makes yearly payments of the real yield plus realised inflation since the previous coupon date, while the principal isn't indexed.

Treasuries, TIPS, ensures the fungibility of coupon certificates originating from different parent issues. **Of course, this method of factoring in indexing, without intermediate rounding, only applies to coupon certificates resulting from the stripping of inflation-linked bonds[39].**

- When an indexed OAT is stripped, the value of its coupons must be adjusted to scale it to the base 100 of the index.

Example:

A primary dealer wishes to strip a nominal amount of €1 million from the 3% 2012 OAT€i. The base index of this OAT€i is at 92.98393. The adjusted value of each of the coupon certificates is equal to:

1 million * 3% * 100 / 92.98393 = 32,263.63953.

This amount rounded to the 2nd decimal place and multiplied by 100 corresponds to the 3,226,634 certificates of 1 centime expressed in the index's base 100 that will be paid to the investor in exchange for each coupon. When these certificates mature, the daily value of the index corresponding to this date will be applied to the base 100 adjusted value of these certificates.

By eliminating the rounding of the index ratio, this method ensures the coupons' fungibility, regardless of their origin, even for large amounts.

2.3.10.2 Pricing of indexed STRIPS in percentage of the real yield:

Like indexed bonds, which are priced in percentage of the real yield, indexed bond STRIPS are valued on the real yield curve and indexing is only applied at the security's maturity.

With a real yield of 1.95% applied to the principal of the 2040 OAT€i at maturity, the net price of the zero coupon bond repaying €100 of principal at maturity amounted to €52.54 in 2007.

And if, at maturity, realised inflation is 2.30%, this 33-year security will be reimbursed at a rate of 211.79%,
100% * (1+ 0.023)^33.

The yield calculations and the analytics calculated for OATs indexed to the real interest alone also apply to indexed OAT STRIPS.

2.3.10.3 The non-fungibility of the principal certificates and coupons of indexed STRIPS

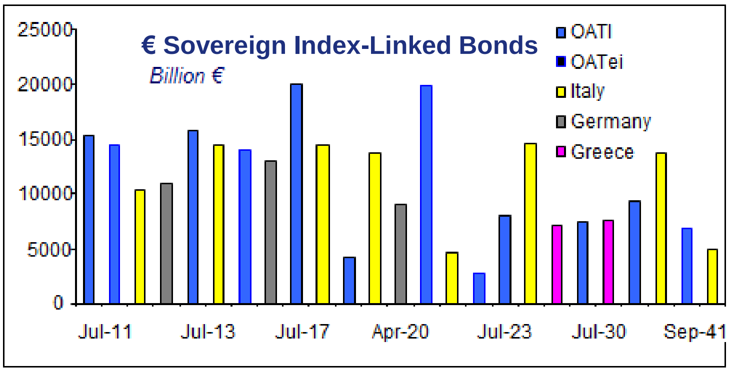
Unlike nominal STRIPS, indexed STRIPS are not financially homogeneous. In fact, only principal certificates give a guarantee of reimbursement at par. This should prevent the application to indexed STRIPS of the fungibility of the coupon and principal certificates introduced for fixed rate OAT STRIPS.

[39] Non-stripped indexed securities, like principal certificates, maintain their base index corresponding to the date of these issues' launch. They will continue to apply the index ratio to 5 decimals calculated based on these base indices, for reasons of consistency wth the other indexed bond markets and compliance with the systems used by investors. The coupons of the various OAT€is are therefore fungible. The coupons of the various OATis are also fungible. On the other hand, there is no fungibility between coupons indexed to different inflation rates (European or French).

2.4 The indexed issues of other sovereign issuers in euros

As already explained, the AFT's initiative was followed by other euro zone sovereign issuers, i.e. Italy, Greece and Germany. Since 2007, all of the G7's sovereign issuers have been issuing inflation-linked securities.

The chart below illustrates euro-denominated issues in August 2010:



2.4.1 These issues follow the OAT€i conventions

They have therefore adopted:

- The euro zone HICP index excluding tobacco,
- A capital indexed structure in line with the structure inaugurated by Canadian I/L bonds,
- Guaranteed reimbursement at par,
- Price quotations in percentage of the real yield.

Some differences remain, however; Italian BTP€is pay semi-annual coupons and the maturity date of these securities, given the seasonality of inflation, affects their yield.

2.4.2 BTP€i semi-annual coupons

As already mentioned, the gross price in percentage of the real yield of a BTP€i is given by the same equation as that used to calculate the price of an OATi or OAT€i as, regardless of their coupon frequency, these securities use a real discount rate compounded annually.

In the case of a BTP€i, the equation used to calculate the price and the yield of an indexed bond paying annual coupons assumes that:

- The full coupon in percentage corresponds to half of the nominal rate of the BTP€i's coupon expressed as an annual percentage,
- The period separating the cash flows paid by the bond is expressed in whole years and fractions of a year,
- Which means that the real rate of return used for discounting is also compounded annually.

The price and yield of a BTP€i is therefore calculated using the following equation:

$$P_{Gross} = \frac{FC_{\%1}}{(1+Real_{ya})^{L_{ia1}}} + \frac{FC_{\%2}}{(1+Real_{ya})^{L_{ia2}}} + \frac{FC_{\%3}}{(1+Real_{ya})^{L_{ia3}}} + \ldots + \frac{FC_{\%n}+100}{(1+Real_{ya})^{L_{ian}}} \qquad (A.2.3.15)$$

2.4.3 Factoring in of inflation seasonality in yield calculations

To smooth their repayment at maturity cash flows, sovereign issuers of euro-denominated indexed bonds usually opt to issue these securities with a maturity other than that chosen for their fixed rate issues.

For their indexed securities, France and Greece have chosen 25 July, Italy, 15 September and Germany, 15 April. As already explained in paragraph 2.1.1 of this chapter, the seasonality of inflation may affect the yield of these securities paid on these different dates.

3 Indexed issues of non-sovereign issuers

3.1 Description of the indexed issues of non-sovereign issuers

On the British market, many AAA-rated utilities[40] issue bonds indexed to the RPI. However, inflation-linked bonds denominated in euros are relatively less frequently issued by non-sovereign issuers. The indexed bonds of these issuers use either the capital indexed structure, already described in paragraph 3.1 of this chapter, as with sovereign issues, or the coupon indexed structure, which will be presented below.

- Capital Indexed issues: in June 2005, Veolia launched the first corporate issue in euros with the same structure as sovereign issues, in the amount of €600 million. This issue indexed to the euro zone HICP index excluding tobacco had a 10-year maturity. On its launch, it was rated Baa1 / BBB by Moody's and Standard & Poor's and offered a 65 bps spread over the 1.60% July 2015 OAT €i. The issuer kept its exposure to inflation risk, as, being a utility, a large proportion of its contracts are inflation-linked.

- Coupon Indexed issues: alongside the standard sovereign issue structure, some private issues pay a coupon equal to the sum of the fixed real yield on the security's launch and realised inflation over the interest period. Their principal isn't indexed, however. These issues, whose amounts are usually smaller, often adopt a private placement format. They are intended for investors looking for a current yield. As for their issuers, they do not usually keep the inflation exposure and enter into interest rate swap contracts enabling them to ultimately convert the proceeds of these securities into debt referenced against the Euribor.

3.1.1 Description of Coupon Indexed issues

The comparative cash flows of Capital Indexed and Coupon Indexed structures have already been described in paragraph 1.1 of this chapter.

Structure of Coupon Indexed issues	
Indexing method:	Only real coupon cash flows are indexed to the change in inflation over the interest period, which is usually annual, on their payment date, while the principal repaid at maturity is not indexed.
Reference index:	Monthly index of consumer prices excluding tobacco published by: • The INSEE, in the case of OATis • Eurostat, in the case of OAT€is and GGB€is, BTP€is and Bund€is.
Real coupon:	Fixed coupon equal to the real market interest rate when the issue was launched.
Coupon paid:	Post-fixed annual coupon calculated using the following equation: *Real coupon + realised inflation during the interest period*
Reimbursement :	Reimbursement at par at maturity
Minimum coupon payment amount:	If, on a given coupon payment date, the realised inflation was negative over the interest period by an amount in absolute terms exceeding that of the real coupon paid by the bond, it is contractually provided that the coupon may not be below a certain level, at least equal to zero or higher.

[40] A utility is an organisation with a public service mandate, for example to distribute water or electricity.

3.1.2 An issue policy catering for different management strategies

3.1.2.1 The natural hedge of some utilities

Like sovereign issuers, which have a natural hedge against inflation, given that their tax receipts are correlated with the change in inflation, some utilities, such as Veolia, show a strong correlation between their level of activity and inflation. Including indexed issues in their liabilities enables them to diversify their sources of financing and to reduce the overall volatility of their liabilities.

3.1.2.2 Opportunistic policy of issuers who do not want to keep their inflation exposure

However, many industrial and commercial companies do not wish to keep their inflation exposure, either because they believe that they are able to make productivity gains in relation to inflation, or because they wish to protect their assets against inflation. The structures issued by these issuers vary widely, often in response to investors' private placement needs.

3.1.3 The need to floor the coupon

As recalled in paragraph 1.2.1.1 of chapter 1 and paragraph 3.1.2. of chapter 2 of this volume, a bond cannot pay a negative nominal coupon. In the case of bonds with a coupon indexed structure, this minimum return covers each of the coupons paid by the security. In the case of a security paying an annual coupon, a minimum level of return must therefore be protected against a fall in the price index from one year to the next. Depending on the minimum coupon level provided for in the contract and the expected inflation volatility, this option may prove to be more or less costly for the investor.