Government Bonds Protected from Inflation Risk

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Summary: In this article the author defines and represents the methodology of index-linked state securities based on foreign experience that ensure protection from inflation risk. These groups of securities include two kinds of government bonds – Index-linked Bonds and Inflation Savings Bonds. The article explains the index-linked government bonds, issued in European monetary union and the United States. There are made some comparisons between practice in different countries, which governments are issuers of that type of financial assets. There are shown the advantages of index-linked securities in investors' point of view.

Key words: inflation risk, index-linked government bonds, consumer price index, real yield.

JEL: H81, G10.

Introduction

The government of some countries use *two types* of debt securities to finance their budget deficit, providing opportunities for protection from *inflation risk*. In the specialized literature, inflation risk is understood as a possibility to incur losses resulting from the decrease of the purchasing power in money terms. This risk is also called purchasing power risk[1]. The first type of bonds is often called index-linked bonds, and the second type is savings bonds, intended to be bought only by households.

In the present article, the object of research is the characteristics of bonds protected from inflation risk. The article treats the issues related to: their issue; primary market; indexation mechanism; main investors; the concepts referred to in their analysis.

The index-linked bonds are known under different names and abbreviations, but, in essence, they are debt securities, issued by a central authority, where a particular mechanism is employed to calculate the due interest and nominal values. Another important characteristic of the index-linked bonds is that they can be freely transferred between all investors without restrictions. This defines them as *market type* securities. Unlike them, inflation savings bonds are intended to be purchased only by households and are not traded on an organized secondary market. This makes the latter a part of the *non-market government securities* group. In addition to the absence of a secondary market, there are also differences in the mechanisms of adjustment to inflation, as well as in the issue process.

Presentation

Origin, characteristics and methodology of the index-linked bonds. The practice of index-linked bonds for deficit financing of state

[1] See 1. Marshall, J., Bansal, V., "Financial Engeneering", InfraM, Moscow,1998, p. 238-239.

expenditures has been known throughout the last twenty-five years. Their origin can be explained by government intervention aimed at overcoming certain market failures. Together with forgone public welfare, resulting from a monopoly in price formation, other factors, determining state intervention, are considered, such as negative externalities, incomplete markets. Insurance and capital markets are incomplete and imperfect markets[2]. The participation of several government agencies in the USA mortgage loans market is a typical example of overcoming the incompleteness of capital markets. The government participates in insurance markets through insurance of bank deposits and import-generated revenues. We define the practice of index-linked bond issue as an attempt to overcome the incompleteness, or a financial asset deficit, of capital markets and bring income in line with inflation.

The 'index' part of these instruments' name explains the specific mechanism, used to recalculate all payments and thus account for the inflation rate. The first countries to have issued index-linked bonds are Great Britain (1981) and Australia (1985). On the American continent, the first countries, issuing index-linked bonds were Canada (1991) and USA (1997). Canadian bonds of this type are known under the abbreviation RRB[3], and US bonds – as TIPS[4]. One year after USA (1998), such securities were also issued by the French government. The first country in continental Europe, where an issue of index-linked bonds took place was Sweden (1994).

The differences between countries are expressed in the choice of:

- the securities period;
- the price index;
- the indexation mechanism;
- the payment frequency of the coupon interest during the year;
- the types of auction, etc.

Index-linked bonds are mainly issued with an over ten-year maturity. In the Eurozone, five-year bonds are also used, but their share is small. The longest maturity is up to thirty years. Indeed, there is no limitation for longer periods, but fixed coupon rate bonds are regarded as model examples in this respect. As the longest bond issues to finance budget deficit are of a fifty-year maturity period, it is likely that issues of inflationtied securities for the same period will be observed in the future. In 2006, France – a leader in this field – issued index-linked bonds of a five-, ten-, fifteen-, and thirty-year maturity.

The monthly consumer price index (CPI) has been selected everywhere as an inflation measure. In Great Britain, this index is defined as a retail consumer price index (RPI). Index-linked bonds, issued in certain countries of the European Monetary Union (like France, for example) have been based on the harmonized consumer price index in the European Union (HICP), excluding the prices of tobacco products. The indexes are determined and published by a specialized statistical institution in the respective countries. This is Eurostat for the European Monetary Union. As to the choice of the calculation period, Australia is an exception with adjustment on the basis of *three-month CPI values*.

The coupon interest is most often paid out twice (per six-month periods) or once a year. A six-month payment is a practice common in USA and Canada, but in France and Sweden payments are effected on an annual basis. Australia has particular features, where payment of interest is made once in a three-month period.

2 See 2. Stiglitz, J., "State Sector Economy", Univ. Edit. "Stopanstvo", Sofia, 1996, p. 87-89.
3 Real Return Bonds.
4 Treasury Inflation Protected Securities.

The indexation mechanism differs with respect to two main features. The first is the period used for the correction index – in practice, most commonly applied is a daily index calculation, as it allows for a permanent up-dating of money flows in relation to inflation. An exception in this respect is Australia, where indexation is performed every three months. The second difference is the lag of the inflation index, used for the monthly indexation where the respective money flow arises. The most commonly used lag is a three-month one. Great Britain is an exception, using an eight-month lag.

According to the existing legal basis in USA, each payment on debt securities, indexed in relation to inflation, is the multiplication of two values: the amount payable in case there is no inflation or deflation, and the ratio between the values of the reference index, measuring the inflation rate on the day of payment and the reference index on the day of issue[5].

The consumer prices index (CPI – U[6]) is used as a basis to determine the values of reference indexes for each coupon payment. This index is the most comprehensive measure of the price dynamics in USA; it is published at least once a month by the Bureau of Labor Statistics. Its uneven seasonal variation values for the base period 1982-84 are used in the calculations.

The TIPS securities have the following distinctive features:

- they are issued at fixed coupon rates, which remain unchanged from the issue to the maturity date;
- the securities' nominal value is adjusted to inflation and is paid upon maturity;
- coupon payments are effected every six months and are a product of the fixed coupon rate and the rate, recalculated with regard to the nominal inflation value.

Single price auctions are used for the issue of TIPS. In this type of government securities auctions, classified investors are required to pay their orders at a single price. According to USA auctions rules, this price is the price of the highest yield order among all classified orders. In addition, the paid coupons may be part of STRIP programs, introduced for a large number of debt instruments.

Indexation mechanism. The indexation mechanism is extremely important. It is the tool through which all money flows on the bond, with respect to inflation-related variations within the respective period, are adjusted. These money flows are: due coupon interests for each six months, accrued interest, when a ownership transfer is made on days, other than those, when payments of coupon interests and nominal values, payable upon maturity, are effected. Indeed, the structure of TIPS is analogous to conventional bonds – there are fixed coupon rates, six-month payment of interests and final settlement of the nominal maturity value. *The only difference is the presence of an indexation mechanism of nominal value and coupon payments*.

As trade in these securities has a permanent character, the first requirement is that the inflation-related indexation mechanism is adjusted on a daily basis.

Money flows, generated by index-linked securities are corrected using a coefficient, which is a ratio between two reference consumer price indexes – on settlement day and the day of issuance. This coefficient is presented by the following action[7]:

5 See Federal register /Vol. 62, No 3/ Monday, January 6, 1997, p. 616.
6 The full name of the index is "U.S. City Average All Items Consumer Price Index for All Urban Consumers".
7 See Federal register /Vol. 69, No 144, July 28, 2004, p. 217.

$$\text{Index Ratio}_{\text{Date}} = \frac{\text{Ref CPI}_{\text{Date}}}{\text{Ref CPI}_{\text{Issue Date}}} . \quad (1)$$

In determining the reference index, there is a rule applicable, according to which its value for the first day of the month is equal to CPI–U, which is related to the third prior month (i.e. the value of the reference index for May 1, for example, would be equal to the consumer price index for the month of February). For every next day of the month, the reference index is calculated using linear interpolation between its values for the first day of the month and the first day of the next month after payment. The following function is applied for this purpose[8]:

$$\text{Ref CPI}_{\text{Date}} = \\ = \text{Ref CPI}_{M} + \frac{t-1}{D}(\text{Ref CPI}_{M+1} - \text{Ref CPI}_{M}) , \quad (2)$$

where:

$\text{Ref CPI}_{\text{Date}}$ – value of the reference consumer price index for the day, when the payment of the coupon interest is effected;
Ref CPI_{M} – value of the reference consumer price index for the first day of the month, in which a payment of the coupon interest is effected (i.e. CPI–U for the third prior month);
Ref CPI_{M+1} – value of the reference consumer price index on the first day of the month following the month when payment of the coupon interest is effected (i.e. CPI–U for the month following the third prior month);
D – the number of days in a month, in which payment is effected;
t – the consecutive day of the month in which payment is effected.

In determining the value of the reference index and the correction coefficient, the obtained fractions are quoted up to the sixth digit after the decimal comma, and then are rounded up to the fifth digit.

To calculate the due coupon interest, we can use the following example[9]. Lets take an issue of index-linked bonds at a 3.5 % coupon rate. The day in which payment of the coupon is to be effected is 10/05/2006, that is the issue date is 15/11/2005. For the calculation, we need data on CPI–U for the third and second month prior to the month of coupon payment, as well as the analogous indexes, referring to the month of issue. The first two values are used to obtain the reference index on payment day, and the second two – for the reference index for issuance day. In conclusion, these are February and March 2006, and August and September 2005. For February and March, the uneven seasonal values of CPI-U for a base period 1982-84 are 198.70 and 199.80, and for August and September, respectively, they are 196.40 and 198.80[10]. In such case, the reference index on the day of payment of the coupon interest will be equal to:

$$\text{Ref}_{10.05.06} = 198{,}70 + \frac{10-1}{31}(199{,}80 - 198{,}70) = \\ = 199{,}019354 . \quad (3)$$

And the reference index in the day of the issue will respectively be:

$$\text{Ref}_{15.11.06} = 196{,}40 + \frac{15-1}{30}(198{,}80 - 196{,}40) = \\ = 197{,}520000 . \quad (4)$$

The obtained values are taken into account up to the sixth digit after the decimal comma and are

8 Ibid, p. 217.
9 The example below does not relate to a specific emission, it just demonstrates the indexation methodology for a given payment under TIPS.
10 See http://data.bls.gov

rounded to the fifth one. Therefore, the indexing coefficient for 10/05/2006 will be equal to the ratio between the reference indexes, calculated above:

$$\text{Index Ratio}_{10.05.06} = \frac{\text{Ref CPI}_{10.05.06}}{\text{Ref CPI}_{15.11.06}} =$$

$$= \frac{199,01935}{197,52} = 1,007590 . \quad (5)$$

Rounded to the fifth digit, the index will be 1.00759. As a result, the nominal value, corrected with respect to inflation is 1007.59 USD for 1000 nominal value units. For the accrued interest within the period 15/11/2005 – 10/05/2006, under the condition that the bond is not index-linked and has a nominal value of 100 000 U. S. dollars, we obtain:

$$\text{Accrued interest} = 3,5\ \% .100\ 000 . \frac{176}{365} =$$

$$= 1\ 687,67 \text{ U.S. dollars.} \quad (6)$$

Accounting for inflation, the accrued interest grows proportionally to the indexation coefficient, i.e.:

$$\text{Accrued interest} . \text{Index Ratio}_{10.05.06} =$$
$$= 1687,67 . 1,00759 = 1700,48 \text{ U.S. dollars.} \quad (7)$$

It can be seen from the above functions that on the first day of the month, when coupon interest is paid, that the reference index is equal to the consumer price index of three months before. For every next day, its value is accrued by one thirtieth or one thirty-first part (depending on how many days the respective month has) of the difference between the consumer price index of two days before and the one of three months before. Thus, the longer the time period between beginning of the month and the day when interest is payable, the stronger this difference's influence on the value of the reference index. This continues up to the first day of next month, when the reference index is equalized with the consumer price index for the third prior month (it had been the second prior month in the calculations for the prior days).

Specific characteristics of index-linked bonds, emitted in the Eurozone. In the European monetary zone, government securities, providing possibilities of adjustment of income to inflation are issued by the French, Italian and Greek government. The bonds, issued by France, have highest credit rating (AAA). They are also known under the abbreviation OAT€i[11]. The first issue took place in October 2001, with a ten-year maturity. Inflation adjustment was made using the harmonized consumer price index in the Eurozone, including prices of tobacco products (HICP). It is essential to note that, in addition to bonds based on inflation in the Eurozone, France also issues bonds, indexed with respect to the national consumer price index (OATi).

The centralized auctions in France are carried out according to a time schedule published in advance. The index-linked bonds (OATi and OAT€i) are issued every third working Thursday of the month, the preliminary notice is placed four working days in advance. The Settlement Date is the following Tuesday. Index-linked bonds are acquired on the primary market with the mediation of primary dealers. Auctions are of an open type, with a lower and upper limit for the quantity, offered for placement, and applications for participation are submitted to the Central Bank. Their classification is made in a descending order according to the declared prices. Payment of classified applications is not

[11] Obligations Assimilables du Trésor, the addition to the abbreviation €i means that the securities are based on the harmonized consumer price index in the Eurozone.

Table 1. Specification of index-linked bonds issued by the French Government.

Abbreviation	Index	Period	Maturity date	Real coupon	Base reference index[12]			
					Date	Value using 2005 as a basis	Value using 1996 as a basis	Value using 1998 as a basis
OATei	HICP	10	25.7.2012	3 %	25.7.2001	92,98393	108,98710	
OATei	HICP	30	25.7.2032	3,15 %	25.7.2002	94,83337	111,15484	
OATei	HICP	15	25.7.2020	2,25 %	25.7.2003	96,08560	112,62258	
OATei	HICP	10	25.7.2015	1,6 %	25.7.2004	98,05612	114,93226	
BTANei	HICP	5	25.7.2010	1,25 %	25.7.2005	99,93309	-	
OATi	CPI in France	10	25.7.2009	3 %	25.7.1998			100,17406
OATi	CPI in France	10	25.7.2013	2,5 %	25.7.2002			105,55484
OATi	CPI in France	30	25.7.2029	3,4 %	25.7.1999			100,60000

The table has been prepared on the basis of data from http://www.aft.gouv.fr

done at a single price, as is the USA practice, but at a price specified for the purpose. Prices are indicated as a percentage of 100 euro nominal value and must not include accrued interest. Table 1 shows the main characteristics of index-linked securities issued by the French treasury.

Similar to US index-linked bonds, OAT€i are also market type bonds. All characteristics of French index-linked government securities are analogous to those of American ones. They have a fixed coupon rate; the functions determining nominal value and interest adjusted to inflation are regulated by the same rules (see formulas 1 and 2). As we have already mentioned, this is done in order to determine coupon payments – on the day of their payment by the issuer, as well as the accrued coupons. For both American and French index-linked government securities, upon maturity payment is effected at the indexed nominal value, obtained according to formula (1); if there is a discount, however, it is ignored. In other words, the last payment includes the last coupon interest, the nominal value and a possible premium, as a function of the indexation mechanism. In Sweden and Canada such issues are subject to the same indexation rules.

In cases where, as a result of force majeure, the current monthly value of HICP has not been announced by the end of the following month, the indexation rules require that a substitute index be used. Its values are influenced by the geometric mean of HICP rate of change for the previous twelve months. For its calculation, the last announced index – CPI_m is used, multiplied by the geometric mean of the inflation rate for the last twelve month, i.e.[13]:

$$\text{Substitute } CPI_m = CPI_{m-1} \cdot \left(\frac{CPI_{m-1}}{CPI_{m-13}} \right)^{\frac{1}{12}} . \qquad (8)$$

[12] The base reference index participates as a divider in equation (1) and is made permanent (unchanged) until the expiration of the bond period. Its value is obtained using function (2). Its values with a base, respectively, 2005 and 1996, are shown in the Table for bonds based on inflation in the Eurozone, indexed with respect to the French CPI, with reference indexes, where 1998 has been used as a base.

[13] See "Investors Guide: OAT€I – The first government bond to the Eurozone consumer price index", Agency France Trésor and information, October 2001, p. 20.[14] Ibid, p. 10.

The substitution index is used for all transactions until the actual HICP is announced. The actual index is used starting from the next day of its announcement.

The base year of the consumer price indexes in the Eurozone is changed every five to ten years. The last actualisation of the Eurostat base year was in the beginning of 2006, when 2005 was taken as a basis (1996 was the old basis).

Price and yield of the index-linked bonds. Quotation. The price of the index-linked bonds depends on their demand and supply. It can be considered to be a sum of the present values of *non-indexed* coupon payments and the nominal value, discounted by a yield rate, called *real* in this case. The market yield to maturity at a given moment for the index-linked bonds can be accepted as the *real yield level*, as their nominal value is indexed according to inflation, which also is the source of the payment of coupon income, adjusted to inflation. Therefore, if there are positive inflation rate expectations, the index-linked bonds' yield to maturity will be lower than that of the conventional bonds, and the nominal rates will be higher than real ones in case of positive inflation.

If we take two types of bonds – conventional and index-linked bonds of the same maturity and coupon rate, the yield to maturity of the index-linked bonds will be lower than that of conventional ones. This is so, because the income of the non-indexed bonds is not adjusted to inflation, and to hedge against the falling purchasing power of money, investors will trade in these bonds among themselves at lower prices (respectively, with a higher yield), so as to guarantee a return, including premium for the inflation risk. In this respect, the difference between two such bonds in terms of the yield to maturity can be regarded as a *premium for the inflation risk in the respective period.*

The appearance of index-linked bonds resulted in the use of new concepts. One such concept is the so called *break-even inflation*. It is defined as the difference between market yield up to maturity of conventional and index-linked bonds of similar maturities. The dynamics of this indicator is presented together with the dynamics of the nominal and real yield of the respective securities on the secondary market. In this sense, break-even inflation is a measure of inflation expectations of investors for the respective period up to maturity. Another new term is the so called *real coupon rate*. This is index-linked bonds' coupon rate of a given issue, which remains unchanged up to maturity. As a rule, the real coupon rate is lower than the nominal (i.e. the one of conventional bonds with the same maturity).

The price of index-linked bonds on different markets is quoted according to established traditions. The price of French index-linked bonds is quoted as a percentage of the 100 euro nominal value, the one of US bonds – as a mixed fraction with a step equal to 1/32. Quotations do not include the accrued coupon interest up to the current moment.

Duration and risk of the index-linked bonds. The duration of index-linked bonds is determined by applying the same functions as the duration of conventional ones. The relatively lower level of real coupon rates would result in the index-linked bonds' higher sensitivity compared to that of the conventional ones of the same maturity. This conclusion, however, has no particular practical value, as calculation of the duration is based on different yield rates – a real yield rate for index-linked bonds and a nominal yield rate for conventional bonds. From this point of view, more appropriate measures for the risk, associated to index-linked bonds, is the standard deviation of the variables price and yield. Empirical data in this field have provided evidence that the factual price and yield of index-linked securities have a lower spread around their average values compared to conventional ones. These conclusions have been verified for

both French and American index-linked bonds[14]. Thus, we can consider index-linked government bonds as the relatively least risky class of financial assets. On one hand, being government liabilities, they bear the lowest degree of credit risk; on the other, they apply an indexation mechanism to hedge against the changes in the purchasing power of money. Another important investment characteristic of the index-linked bonds is their *low correlation* with yield and prices of other bonds and shares, which makes them preferred assets for better portfolio diversification.

The introduction of the index-linked bonds ensures, first of all, better opportunities in asset management for institutional investors. These opportunities are defined in several aspects[15]:

- protection from the falling purchasing power of money and preservation of the credit value of wealth;
- forecast and play of the real yield curve;
- arbitrage between bond markets;
- better portfolio diversification.

There has been a high interest in index-linked bonds of longer maturity on the part of pension funds, life insurance companies, personal investors and different investment funds, particularly those specialized in the field of bonds. The latter are key investors in this market segment.

Index-linked government bonds are considered as a preferred investment instrument within STRIP[16] programs. The independent trading of coupons and nominal strips of index-linked securities are regarded an efficient form of financing future liabilities such as pensions. In case index-linked bonds are beyond the scope of strip programs, investors acquire higher nominal value, receive income during the period of holding, and upon retirement, sell the purchased securities in parts to finance pension payments. In this case, they take the usual reinvestment and price risks. In the case of the strip approach, investors buy a series of single coupon payments, selected in such a way that they are received during pension years. As a result, the reinvestment risk is reduced and real wealth is protected, together with providing for an index-linked coupon income.

Conclusion

Index-linked bonds are more complex than conventional financial assets. The payable coupon income depends on inflation; therefore their fair price is difficult to determine. There are views, for this reason, that issues should be effected at a single price as, for example, in USA and Great Britain. The price on the primary market corresponds to the price of the highest-yield classified securities (the lowest of all classified applications)[17]. Many authors present arguments for the use of a single price auction. According to Milton Friedman, the main advantage is the upward shift of the "winners' curse" – a situation when those who have won are classified at a much higher price than the real one – a Pyrrhic victory[18]. A Pyrrhic victory has much higher probability in case of a multiple price auction than for a single price one, especially because the fair price for these instruments is hard to decide.

The trade in inflation risk-protected bonds is not well known in our country. Nevertheless,

[14] Ibid, p. 10.
[15] See "30 Year OATi: Developing a real rate yield curve in Euro", Agency France Trésor and information, September 1999, p. 19-21.
[16] Separate Trading of Registered Interest and Principal Securities.
[17] See Federal register /Vol. 69, No 144/, July 28, 2004, p. 9.
[18] Quoted after Coeuré B., "Treasury Bond Auctions: The Issuer's Viewpoint", Agency France Trésor, CREST seminar, May 2003, p. 14.

their possible application in the near future should not be an end in itself. Their use can be determined by the real needs of at least some of the biggest institutional investors, such as insurance and pension companies. And yet, index-linked bonds are not to be introduced on the basis of an institutionally well-established and highly liquid secondary market for government bonds. Another factor, determining a successful issue of such securities in terms of meeting the demand of both local and international investors is the maintenance of a high credit rating. In this respect, it could be noted that Greek bonds have an A rating, Italian ones have AA, and French hold the highest rating. All three cases are within the investment class. Therefore, it is important that a sustainable improvement of the government credit rating is maintained (it has recently increased from A-3 to A-2 by S&P, with stable prospects). For the most part, the rating level depends on debt indicators, on the government's financial position, and the expected economic growth rate. In this sense, decisions on issues of bonds, protected from inflation risk must be in line with the fiscal policy implemented up to that moment. Bulgaria's EU membership will have a beneficial impact on future ratings. From this point of view, it can be estimated that there is real potential for the issuance of bonds, protected from inflation risk.

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