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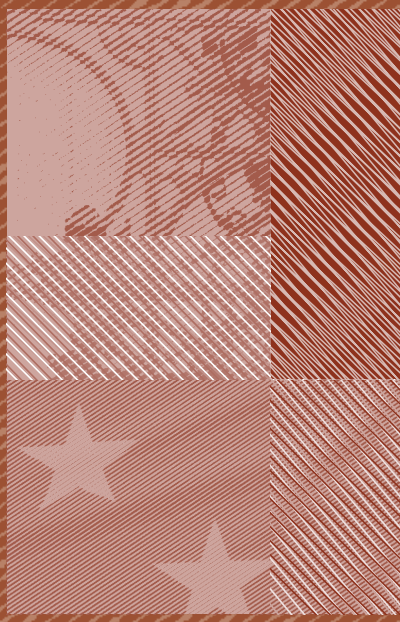

INFLATION-LINKED BONDS FROM A CENTRAL BANK PERSPECTIVE

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Abstract

Inflation-linked bond markets have experienced significant growth in recent years. This growth is somewhat surprising, for inflation-linked bonds cannot be considered a financial innovation and their development has taken place in a period of historically low global inflation and inflation expectations. In this context, the purpose of this paper is twofold. First, it provides a selective survey of the key arguments for and against the issuance of inflation-linked debt, and some of the factors that help to understand their recent growth. Second, it illustrates the use of these instruments to better monitor investors' inflation expectations and growth prospects from a central bank perspective.

JEL codes: E44, E52, E58, G10

Keywords: Central banks, monetary policy, inflation-linked bonds, break-even inflation rates.

1 Introduction

Inflation-linked bonds[1] can by no means be considered a new financial instrument: a bond whose principal and interest were linked to the price of a basket of goods was issued by the State of Massachusetts in 1790. The economic rationale behind denominating interest payments on debt contracts in real rather than nominal terms was already well developed in the nineteenth century (by for example Joseph Lowe in 1822 and William S. Jevons in 1875; see Bagehot, 1875; Humphrey, 1974; Schiller, 2003) and has since then been advocated by many others (famous proponents have been Alfred Marshall, Irving Fisher, John M. Keynes and Milton Friedman; see also Bach and Musgrave, 1941)[2]. The main reason why debt payments should be made in real terms is that it would reflect more closely the intertemporal exchange of resources embodied in a debt contract, whereas, if specified in (nominal) money terms, the value of the debt payments may be more difficult to ensure over time. Indeed, it has been often argued that the efforts made to protect investors from potentially high and volatile inflation over long periods of time lead to an inefficient allocation of resources that could easily be corrected by the issuance of inflation-linked debt. Notwithstanding these efficiency arguments, indexed debt has remained the exception rather than the rule in global financial markets.

The last few years, however, have seen a change in the relative position of inflation-linked bonds in the global financial landscape. The market for inflation-linked debt has experienced significant growth not only in the euro area but also in other major bond markets, and inflation-linked bonds play a growing and important role in the management of public debt (De Cecco et al., 1997; Favero et al., 2000). This may, at a first glance, seem somewhat paradoxical, for it has taken place against the background of relatively low and stable inflation not only in the euro area but in almost all industrialised countries. However, the growth of the inflation-linked bond market can be seen as a consequence of the credibility of central banks in delivering price stability in the respective countries, rather than a signal of "mistrust" of their price stability-oriented policies. The credibility of the central banks and their clear mandate to preserve price stability has indeed helped to significantly diminish uncertainty about future inflation. Yet, inflation risks have not disappeared altogether, and, consequently, demand for these instruments does exist. However, central bank independence and the strict mandates of central banks to maintain price stability have *de facto* neutralised the incentives for governments to engage in inflationary surprises as was the case in the past. Furthermore, it is important to bear in mind that the risk of high future inflation goes against the interests of the issuers of inflation-linked bonds: just as these bonds protect the investors against inflation risks, they expose the issuers to these risks. Therefore, a credible monetary policy focused on delivering price stability over the medium term also encourages the issuance of inflation-linked instruments.

At the same time, while the issuance of inflation-linked bonds in the past may have triggered fears of widespread indexation, such fears seem much less likely to materialise

1. In this paper, the terms "inflation-linked" and "index-linked" bonds are used synonymously. In the financial markets, these instruments are typically referred to as "linkers".

2. Keynes advocated the use of inflation-linked bonds by the British Treasury in his testimony before the Colwyn Committee on National Debt and Taxation in 1924. On the recommendation of Fisher, the Rand Kardex Co. issued in 1925 a 30-year purchasing power bond with interest and principal linked to the wholesale price index. Friedman advocated indexed government debt in the mid-1970s, for example in various columns for Newsweek magazine. See Sarnat (1973) and Humphrey (1974).

nowadays in an environment of low and stable inflation. The credibility of monetary policy, reinforced by the independence of the central banks and the consistent delivery of price stability, should discourage any attempt to extend indexation beyond financial assets. In this respect, the increasing use of inflation-linked debt supports the argument which has been put forward in the academic literature that countries whose central banks are truly independent, with impeccable anti-inflationary credentials, have little reason to fear indexation of government debt and a spillover of indexation to the economy as a whole. As a matter of fact, there is no evidence whatsoever of widespread indexation in countries with a relatively long tradition of indexed security issuance and well-established central bank independence.

The purpose of this paper is twofold. First, a selective survey of the key arguments for and against the issuance of inflation-linked debt is provided, which should help the reader to understand better the recent growth of these markets. This review is focused on those arguments that are the most relevant from a central bank perspective. Second, the potential uses of inflation-linked bonds to gauge investors' inflation and growth expectations for the implementation of monetary policy are illustrated on the basis of the European Central Bank's (ECB) experiences during the past few years.

Chapter 2 provides a brief synopsis of the history and current size of the sovereign inflation-linked bond markets in mature economies, reviewing with particular detail the structure and depth of the euro area inflation-linked market. The overall conclusion is that inflation-linked bond markets have experienced a very significant growth in the last few years and that this trend is likely to continue in the near future.

Chapter 3 then provides an overview of some of the main arguments for and against issuing inflation-linked bonds and assesses them both from the perspective of the issuer and investor and from a social welfare perspective. In addition, the role of indexed debt in the context of pension asset management and the choice of the reference price index used when indexing sovereign debt are also covered. This review should therefore be interpreted as complementary to other overviews, particularly (but not only) those by large commercial banks, which have often stressed other aspects such as the role of inflation-linked debt in risk diversification and portfolio optimisation.[3] In addition, the arguments for and against the issuance of inflation-linked bonds from the strict point of view of their interaction with price stability, a factor of obvious interest from a monetary policy perspective, is also provided.

Chapter 4 illustrates some of the uses of inflation-linked bonds to better monitor investors' inflation expectations and the outlook for economic growth. The analysis is based on the ECB's experience in monitoring developments in the euro area inflation-linked bond market over the last few years, but the analysis could be easily adapted to other markets. The evidence presented in this chapter highlights the growing importance of break-even inflation rates as a source of information on inflation expectations for a central bank. However, some caution is warranted when interpreting break-even inflation rates for monetary policy purposes, as they are likely to include variable liquidity premia and a time-varying inflation risk premium which are difficult to quantify. At the same time, their importance is likely to grow over time with the increase in available maturities and liquidity in the inflation-linked bond markets.

Finally, Chapter 5 concludes.

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3. See for instance The National Bank of New Zealand (1995), Deutsche Bank (2001), Morgan Stanley (2002), Barclays Capital Research (2006) and BNP Paribas (2005).

2 The development of inflation-linked bond markets

Inflation-linked bond markets have experienced significant growth in recent years. However, inflation-linked bonds are much less innovative than they are often believed to be. One of the first bonds, whose principal and interest were linked to the price of a basket of goods, was issued by the State of Massachusetts in 1780, and, in essence, the formulation of that contract captured all the essential features of inflation-linked bonds as they exist today.[4]

The perception that inflation-linked bonds are a recent innovation owes to a large extent to the fact that they rarely have been used to any significant extent in the history of finance. This is in direct contrast with an abundant stream of economic literature, dating back to Lowe, (1822), and Jevons, (1875), which argues in favour of indexing debt in general, and public debt in particular (see for example Humphrey, 1974, and Shiller, 2003). In their footsteps, a long list of economists including John M. Keynes, Richard Musgrave and Milton Friedman all argued, at one time or another, in favour of the issuance by the government of inflation-linked bonds.[5] With a few exceptions, however, those economists failed to convince government officials of the merits of the issuance of inflation-linked bonds.

2.1 Major inflation-linked bond markets

In the post-war era, the relatively few examples of sovereign issuance of inflation-linked bonds can be grouped in three broad categories. The first includes countries experiencing high and volatile inflation, which made inflation-linked instruments their best —if not the only— available option to raise long-term capital in the bond market. Chile (in 1956), Brazil (in 1964), Colombia (in 1967) and Argentina (in 1973), for instance, all issued inflation-linked bonds in similar circumstances. France and Finland had done the same in the immediate post-war era, the latter continuing to do so until 1968, when indexing of financial instruments became prohibited by law. Italy issued one inflation-linked bond in 1983 with a ten-year maturity, at a time when it was unable to issue nominal bonds with long maturities. Highly indexed economies, such as Israel or to a lesser extent Iceland, also have a long history of issuing indexed debt.

The situation of the second group of countries, which started issuing indexed debt in the 1980s and early 1990s, is fundamentally different in that they used inflation-linked bonds not out of necessity but as the result of a deliberate policy choice. The United Kingdom (in 1981), Australia (in 1985), Sweden (in 1994) and New Zealand (in 1995) all started issuing inflation-linked bonds in the context of more or less credible disinflationary policies. The issuance of inflation-linked debt served both to add credibility to the government's commitment to these policies and to reduce its cost of borrowing, by capitalising on excessive inflation expectations in the market.

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4. The contract of that note stipulated that "… both principal and interest [are] to be paid in the then current money of the said State, in a greater or lesser sum, according as five bushels of corn, sixty-eight pounds and four-seventh parts of a pound of beef, ten pounds of sheep's wool, and sixteen pounds of sole leather shall then cost, more or less than one hundred thirty pounds current money, at the current prices of said articles". For a detailed account of the circumstances that led to the issuance of the Massachusetts note, see Fisher (1913) and Issing (1973).

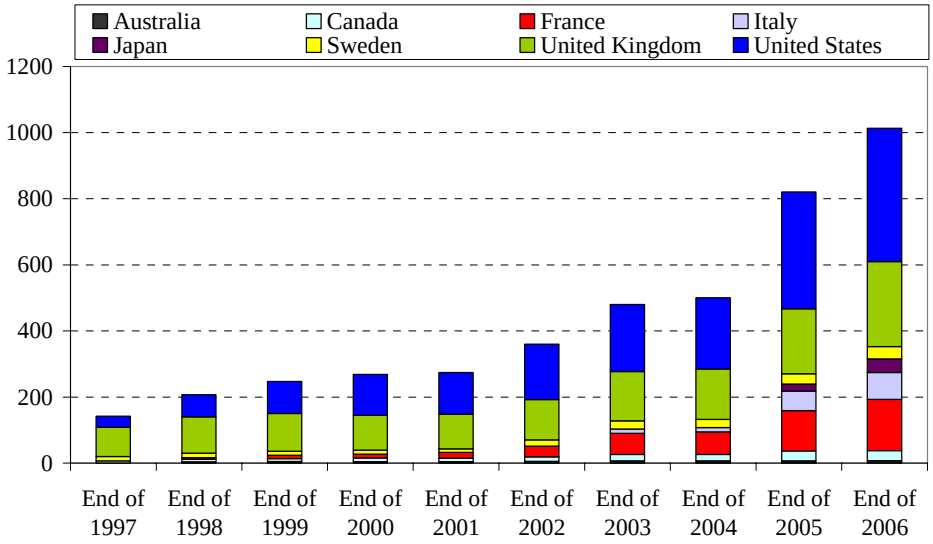
5. See inter-alia Price (1997). The list of proponents of indexing of (government) debt is almost endless. It also includes the likes of I. Fisher, S. Fischer, J. Tobin, R. Barro, J. Campbell, S. Hanke, E. Bomhoff, etc. Alston et al. (1992) suggest however, on the basis of the results of a survey, that the desirability (or lack thereof) of issuing indexed government debt is one of the least consensual topics among economists. See also Bomhoff (1983), Bogaert and Mercier (1984) and Mercier (1985).

Partly overlapping with the previous category, a third group of industrialised countries developed an inflation-linked bond programme in more recent years, in the context of fairly low and stable inflation and inflation expectations. By contrast with the arguments put forward by the previous group, more weight was often attached here to the social welfare benefits of indexed debt. Issuance of inflation-linked bonds was presented in particular as a further step towards completing financial markets by providing an effective hedge against inflation in the long-term (especially in the context of pension management). Most notable among this group of countries to start raising funds by issuing inflation-linked bonds were Canada (in 1991), the United States (in 1997) and more recently France (in 1998), Greece and Italy (in 2003), Japan (in 2004) and Germany (in 2006). Many of the countries mentioned in the previous category continued (United Kingdom) or revived (Australia) their issuance programmes using similar arguments.

While the global inflation-linked bond market includes a number of developing countries (e.g. South Africa), the major markets are those for developed economies, even though they enjoy relatively low and stable rates of inflation and inflation expectations. Narrowing the field of interest to this group, the main sovereign issuers of inflation-linked bonds are Australia, Canada, Sweden, the United Kingdom, the United States, Japan and a number of the euro area countries, so far France, Italy, Greece and most recently Germany.[6]

As can be seen in Chart 1, the global inflation-linked market has gone through a rapid growth phase in the last few years. The US market for Treasury Inflation-Indexed Securities (TIIS, also referred to as Treasury Inflation-Protected Securities, or TIPS) is now the largest inflation bond market. Despite its relatively recent start, the euro area market has been the second largest sovereign "linker" market since 2003, in terms of both outstanding volumes and turnover, having already overtaken the UK market. Moreover, euro-denominated inflation-linked bond issuance by the euro area countries exceeded that of the United States for the first time in 2003 and it has remained at a high level since then, with the available maturities and the number of issuers increasing.

Chart 1: Value outstanding of inflation-linked government bonds in major industrialised markets



6. See also Persson (1997), Townend (1997), Wilcox (1998), HSBC (2003), Deutsche Bank (2001), (2004a) and (2004b), Dresdner Kleinwort Wasserstein (2004), Mizuho Securities (2004) and Finanzagentur (2006). Greece has issued only one inflation-linked bond (see Table 1 for details).

A striking feature of the various sovereign inflation-linked bond markets is that they still account for a minor, although in most cases rising, share of government debt. In other words, even the sovereign issuers with the longest and most sustained tradition of issuing indexed debt (e.g. the United Kingdom and Sweden) do not pursue a policy of full indexation of debt. Thus inflation-linked bonds perform a role complementary to nominal debt, which remains dominant in every country.

A second and possibly more significant feature is that inflation-linked bonds tend to be typically concentrated at the long end of the yield curve, often with maturity at issuance of ten years or more. This should not be too surprising though, as these bonds offer protection against the effects of (unanticipated) inflation developments.

2.2 The development of the euro area sovereign inflation-link bond market[7]

The issuance of sovereign bonds linked to euro area inflation began with the introduction of bonds indexed to the French consumer price index (CPI) excluding tobacco (Obligations Assimilables du Trésor indexées or OATis) in 1998. Investors in OATis were initially mainly domestic, but later on the availability of inflation protection also attracted other euro area investors who were willing to accept the mismatch between French and their domestic inflation. It was clear at the time that the ECB's definition of price stability in the euro area would be based on the Harmonised Index of Consumer Prices (HICP), an index regularly published by Eurostat; the choice of the French CPI as reference index was largely motivated by the lack of a track record for the HICP prior to 1999. However, there was a growing perception that it would be difficult for markets for country-specific indices (apart from the French market) to develop.

The growing imbalance between supply and demand for inflation-linked bonds in the euro area market was noted by the French Treasury which decided to issue a new ten-year bond indexed to the euro area HICP. Furthermore, although the index in terms of which the ECB's quantitative definition of price stability is defined is the overall HICP, i.e. including tobacco, compliance with French regulations on the issuance of inflation-linked instruments has led to the choice of the euro area HICP index excluding tobacco. The latter index has become the market benchmark in the euro area since then and has been used as the reference for all the bonds indexed to euro area inflation which have been issued so far. It has also become the standard for some other financial products such as inflation-linked swaps, HICP futures and economic derivatives on inflation releases.

The first bond whose coupon payments were indexed to euro area inflation was issued by the French Treasury in October 2001, with maturity July 2012 (OATei 2012). Following a relatively slow start, the market for inflation-linked bonds in the euro area has since 2003 experienced significant growth. Three additional euro area countries, namely Greece, Italy and Germany, have decided to issue inflation-linked bonds, and several other euro area governments have said they are considering the issuance of inflation-linked debt.[8]

The Italian, Greek and German bonds share most of the technical characteristics of the French inflation-linked bonds, namely that they are linked to the euro area HICP

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7. For further information on the euro area inflation-linked bond market and its prospects see the Euro Debt Market Association (AMTE), 2005.

8. Occasionally, some inflation-linked bonds were issued in earlier years and/or by other governments (Finland in the early 1990s, Greece in 1997, Austria in 2003 and Belgium in 2004). Regarding the new EU Member States, the Czech Republic and Hungary issued some inflation-linked bonds in 1996-97, and Poland in 2004.

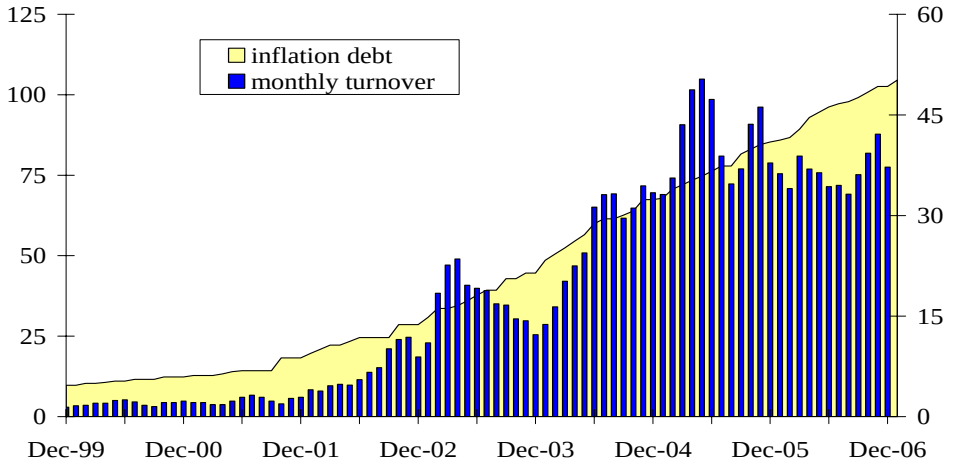
excluding tobacco and also offer guaranteed redemption at par, implying deflation protection. However, the Italian and Greek bonds are perceived by rating agencies as bearing a different level of credit risk compared with the French and German bonds. In addition, coupon payments for the Italian inflation-linked bonds take place at semi-annual frequency, rather than at the annual frequency standard for the French bonds. Table 1 summarises the existing inflation-linked bonds in the euro area.

Table 1: Existing bonds linked to the euro area HICP excluding tobacco

Issuer	Maturity date	Issuance date	Amount outstanding *(EUR billions)*	Ratings *Moody's/S&P/Fitch*
Italy	Sep. 2008	Sep. 2003	13.40	Aa2/AA-/AA
France	July 2010	Apr. 2006	3.30	Aaa/AAA/AAA
Italy	Sep. 2010	Sep. 2004	12.80	Aa2/AA-/AA
France	July 2012	Nov. 2001	14.50	Aaa/AAA/AAA
Italy	Sep. 2014	Feb. 2004	14.50	Aa2/AA-/AA
France	July 2015	Nov. 2004	9.27	Aaa/AAA/AAA
Germany	Apr. 2016	Mar. 2006	5.50	Aaa/AAA/AAA
France	July 2020	Jan. 2004	8.72	Aaa/AAA/AAA
Greece	July 2025	Mar. 2003	7.20	A1/A/A
France	July 2032	Oct. 2002	7.47	Aaa/AAA/AAA
Italy	Sep. 2035	Oct. 2004	8.42	Aa2/AA-/AA

Source: Reuters, end-April 2006.

Chart 2: Amount outstanding (left-hand scale) and monthly turnover of sovereign French bonds indexed to the euro area HICP (right-hand scale)



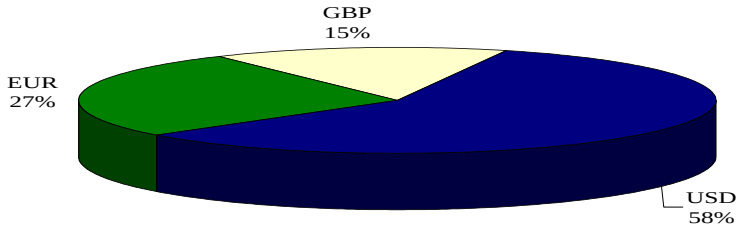
Source: BNP Paribas. Monthly turnover refers to three-month moving average.

Liquidity in the euro area inflation-linked bond market has been enhanced by the larger number of issuers and available maturities, and turnover has increased substantially in the last few years (see Chart 2). Indeed, investors' interest in inflation-linked securities has recently increased significantly. Certain regulatory changes seem to have played a major role in boosting demand for such instruments, mainly from insurance companies and pension

funds, which may have led to some shortages in the market despite the growing issuance volume (see Group of Ten, 2005).[9]

As highlighted above, the growing number of issuers and maturities has triggered a very rapid development of the market, with the euro area government inflation-linked bond market having overtaken the United Kingdom to become the second largest linker market in the world behind the United States, both in terms of outstanding amounts and turnover (see Chart 3).

Chart 3: Relative turnover in major inflation-linked markets in 2006



Source: BNP Paribas.

The outlook for the euro area inflation-linked market remains very promising. Market liquidity and depth are likely to strengthen significantly with the increase in the number of sovereign issuers and available maturities. There is also some potential for additional supply coming from private sector enterprises, although this is negligible so far. On the basis of experience in the United Kingdom, obvious candidates would be companies whose revenues are strongly linked to inflation, such as revenues from infrastructure projects and retail business. The rental income of property owners is frequently linked to inflation by law, but also municipalities' tax revenues tend to be more or less linked to inflation. These additional market players might increasingly hedge their inflation exposure by entering the inflation-linked market.

Demand is also expected to grow fast. French institutional investors, particularly insurers, banks and mutual funds, have been the main investors in continental Europe. Yet it is also likely that pension funds from other continental European countries will become more active in the future, following the example of the Netherlands, which seems to be leading the way in the provision of private pensions. Looking ahead, potential pension reforms in major European countries could also further boost demand for this asset class, since life insurers need to hedge long-term inflation-indexed liabilities. In its work to estimate the potential size of the demand for inflation-linked bonds, the Euro Debt Market Association, suggested that an overall asset allocation to these products of 5% would be a relatively conservative investment strategy for pension funds (see AMTE, 2005). In the United Kingdom, for example, indexed gilts account for over 8% of pension funds' managed assets and for 35%

9. For instance, anecdotal evidence suggests that changes in French regulations towards an indexation of the interest rate paid on certain deposits led to a need for inflation hedging for financial institutions offering such products.

of their fixed-income assets. When applied to French, Italian, German, Belgian, Dutch and Luxembourg institutional investors alone, a hypothetical allocation of 5% produced a figure of over €360 billion in investments in inflation-linked bonds by these investors, compared with a value outstanding of about €120 billion at the time.

However, it is important to bear in mind that, given the nature of inflation-linked products and their differences to conventional bonds, the remaining obstacles to the development of this asset class should not be underestimated. Certain barriers exist that may affect both investors and new issuers and which could make the difference between a very successful inflation-linked market that increases its role in financial markets and an inflation-linked market that is considered to be a marginal asset class. A working group assembled by AMTE in 2004 to study this market conducted a survey on euro-denominated inflation-linked bonds among more than 60 investors and banks, as well as auditors. The aim of the survey was to identify the existing obstacles to inflation-linked investment, obstacles that could be of a regulatory, accounting, fiscal, legal or system-related nature. Although it has to be borne in mind that, since those investors were already active in the inflation-linked market, the results of the survey might have underestimated the existing obstacles or demand for new products, they nonetheless highlighted the need to enhance transparency and harmonisation, and to develop awareness of this product class. These recommendations were related to the impact of the new International Accounting Standard 39 framework for inflation-linked products, and were aimed at improving communication and awareness of the "ex-tobacco" inflation index releases used by the linkers markets by contrast with the current focus on headline or core inflation releases. In addition, a clear commitment from sovereign issuers to steadily increase their inflation-linked issuance so that a liquid real yield curve could be established in the euro market was seen as a prerequisite for more activity on the part of corporate and financial investors and issuers (see AMTE, 2005).

3 The issuance of inflation-linked bonds: conceptual considerations

The main conclusion of the previous chapter is that inflation-linked bond markets have experienced significant growth in recent years. This growth is somewhat surprising, in particular because it has taken place against the background of historically low global inflation and inflation expectations. In the light of this situation, this chapter provides a selective survey of the various considerations involved in the issuance of inflation-linked bonds, from both a theoretical and a practical perspective. Particular emphasis is placed on the arguments that are believed to be the most relevant from a central bank perspective.

3.1 Considerations of issuers

The first standard argument in favour of issuance of inflation-linked bonds by a government is that it allows it to reduce its cost of financing. The rationale is that, if investors are willing to pay a premium for protection against inflation, then this premium will be reflected in a lower yield paid by the government on debt instruments that provide such protection. Sovereign issuers have put forward this argument to justify their decisions to issue inflation-linked bonds, and, almost without exception, issuance of inflation-linked bonds effectively appears to have generated ex-post savings in the real cost of financing of these governments.[10]

It has also been argued in the academic literature that issuance of inflation-linked bonds may have an indirect positive effect on the government cost of financing by reducing the inflation risk premium borne by the rest of the (nominal) debt. The argument relies on the idea that if governments issue part of their debt in the form of inflation-linked bonds, they have less to earn from inflation, and therefore a low-inflation policy becomes more credible. In this respect, it is important to bear in mind that the risk of high future inflation goes against the interests of the issuers of inflation-linked bonds: just as these bonds protect the investors against inflation risks, they expose the issuers to those risks. Of course, this theoretical argument may have been particularly relevant in the past, but today, when central bank independence has been widely accepted, it has lost most of its relevance.

Ex-post savings in the real cost of financing the debt of governments that have issued inflation-linked bonds may be the result of a lower inflation risk premium, but also of investors making sustained errors in forecasting inflation. Empirical estimates of the inflation risk premium generally assume the existence of a positive inflation premium, but, in part because of the lack of reliable data over extended periods of time, these estimates should be interpreted with some caution.[11] This assumption cannot be ignored in the context of

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10. Reschreiter (2004) finds for the United Kingdom that government long-run borrowing costs can be significantly reduced by issuing inflation-linked debt. A counter-example is the United States, where issuance of inflation-linked bonds seems to have come —at least initially— at a net cost, as documented by Sack and Elsasser (2004). The authors stress that the high relative cost of inflation-linked debt may reflect the difficulties associated with launching a new type of asset, the lower liquidity of indexed debt relative to nominal Treasury securities and the considerable growth in the supply of indexed debt. However, they claim that the importance of some of these factors is likely to have weakened in more recent years. See also Hunter and Simon (2005). A study group set up by the Dutch government concluded that the issuance of inflation-linked bonds instead of long-term nominal bonds could lead to an ex-ante cost reduction of 20 to 35 basis points (on the basis of UK and French data for the past three years this would be around 45 basis points), However, compared with short-term paper, inflation-linked bonds would be more expensive. See Werkgroep Reële Begroting (2005).

11. Shen (1995) and Price (1997) quote a number of empirical studies on the issue, in particular a study in 1986 by Bodie, Kane and McDonald, who extract from the price of long-term US bonds an inflation premium varying between 53 and 420 basis points. Gong and Remolona (1996) find significant positive inflation risk premia for US government bonds over the period 1984-96. Shen (1998) finds himself that the inflation risk premium borne by nominal government bonds is sizeable. From a theoretical perspective, however, the case is not quite as clear-cut

disinflation that characterised many countries at the time of first issuance (see Chapter 2). As a matter of fact, capitalising on such forecast errors often proved to be a powerful trigger for issuance.

Running against previous arguments, it has been pointed out that issuing inflation-linked bonds either in place of or in addition to nominal debt could result in a segmentation of public debt into a larger number of less liquid categories. This would in turn raise the cost of financing for the government by the amount of a liquidity premium, which could offset the gains on the inflation premium. In practice, inflation-linked bonds are effectively less liquid than nominal bonds, as evidenced for example by bid-ask spreads.[12] But the effect of this lower liquidity on the cost of financing for the government is unlikely to be significant, because the nature of inflation-linked bonds implies that they are generally purchased by "buy-and-hold" investors, for whom liquidity is a matter of secondary concern. Segmentation of government debt does not seem to be an obstacle that has been considered ex-post as crucial by any of the major sovereign issuers of inflation-linked bonds, or by participants in their sovereign debt markets.

A second argument in favour of indexing the government's debt is that it allows a more precise matching of the government's assets and liabilities. This argument is in a sense the mirror image of the previous argument. A large share of the government's income is *de facto* more or less indexed to inflation, because taxes are levied in nominal terms. Value added tax is possibly the most obvious example of *de facto* indexed income, but income taxes, stamp duties, etc., follow essentially the same logic. Issuing indexed liabilities therefore allows the risk of a discrepancy between the government's assets and liabilities to be reduced. To the extent that a more precise matching of assets and liabilities reduces the financial risks to which the government is exposed, it is per se to be assessed positively. This view was taken inter alia by Barro, 1997, who suggested that an optimal tax approach to public debt, taking into account both the government's assets and liabilities, would favour the issuance of long-term inflation-linked bonds.

Asset/liability matching is considered a sound practice in the private sector, and debt indexing of one form or another is not an unusual practice, although indexing on inflation is rare. To take but one example directly affecting central banks, gold mining companies routinely finance their activity through gold borrowing (often from central bank stocks), which is similar to raising debt indexed to the price of gold. As their income is obviously linked to the price of gold, such practice allows them to reduce their financial risk. Other examples of indexed debt may be quoted. In 1863 the Confederate States of America issued a bond indexed to the price of cotton (which formed the bulk of their tax base). In 1980, the US-based Sunshine Mining Company issued USD 30 million of bonds indexed to the price of silver. More recently, Tesco Plc., a UK supermarket chain (and whose nominal income is therefore highly correlated to consumption good prices), started issuing inflation-linked bonds.

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as it seems. As argued by Shen (1995), the inflation risk premium can be negative because not only investors but also issuers are exposed to inflation risk. For additional evidence, see also Box 1 in Chapter 4.

12. Townend (1997) reported a bid-ask spread of 16 ticks for large (GBP 50 million) trades on inflation-linked gilts, as opposed to two ticks for similar nominal bonds. The gap has narrowed since (if only because nominal gilts have lost in liquidity), but the general fact that inflation-linked bonds are less liquid than nominal bonds remains. Similar observations are made in other mature markets where inflation-linked bonds are issued. See for example also Sack and Elsasser (2004).

3.2 Considerations for investors

Private investors benefit from the availability of inflation-linked bonds for two main reasons. The first and most obvious benefit is that inflation-linked bonds provide arguably the only true hedge against the risk of inflation. The argument that inflation-linked bonds are superfluous because there are other means for investors to hedge themselves against unanticipated fluctuations in prices does not stand up to empirical verification. Holdings of Treasury bills rolled over indefinitely, of foreign currency debt, and of real assets (e.g. real estate) all provide a partial form of protection against inflation, but none of them, taken alone or combined in a portfolio, provides an effective and stable hedge over long periods.

Derived from the previous argument is the idea that, from a standard portfolio diversification point of view, there are benefits for households from holding part of their assets in the form of inflation-linked bonds if inflation is uncertain. Fischer (1975) in particular raised this argument to support the issuance by the government or by other issuers of inflation-linked bonds. He equally argued that the diversification benefits for holders of the bonds justified a positive inflation risk premium.

From an empirical point of view, Kothari and Shanken (2004) conclude that US TIPS may have potential benefits for investors and that substantial weight might be given to these instruments in an efficient portfolio. Hunter and Simon (2005) find that the volatility-adjusted returns of TIPS relative to nominal US Treasury bonds have been significantly higher, although the former instruments have not enhanced the mean-variance efficiency of portfolios including both nominal and inflation-linked bonds. The latter conclusion has been questioned by Mamun and Visaltanachoti (2005), who show that TIPS provide a diversification benefit to investors when added to a diversified portfolio. These authors find support for Kothari and Shanken, 2004, and the conclusion of Roll (2004) that an investment portfolio diversified between US equities and nominal bonds would be improved by the addition of TIPS.[13] With respect to the euro area, Bardong and Lehnert (2004a) provide evidence that the market for French inflation-linked bonds indexed to the French CPI excluding tobacco (OATis; see Section 2.2) offers additional return. Thus all in all, although the empirical evidence is not yet fully conclusive, inflation-linked bonds may offer interesting advantages to diversified (long-term) investors.[14]

3.3 Costs and benefits from a social welfare perspective

While private benefits from the issuance of inflation-linked bonds should not be ignored, whether the existence of inflation-linked bonds generates social welfare gains is also relevant. The description of the potential welfare gains draws in particular on the works of Bach and Musgrave (1941), Bohn (1988), Viard (1993), Campbell and Schiller (1996) and Price (1997).

3.3.1 PORTFOLIO DIVERSIFICATION AND MARKET COMPLETENESS

As already indicated, inflation-linked bonds fill a void in financial markets in the sense that they are the only asset to provide a true and perfect hedge against the risk of unanticipated inflation. The corollary of this is that the coexistence of nominal bonds and inflation-linked bonds also allows agents to take speculative positions on inflation expectations. This per se is a non-negligible addition to the financial system.[15]

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13. Lamm (1998) and Lucas and Quek (1998) provided further support for TIPS from an investor's perspective.
14. For further discussion on the determinants of (investor) demand for inflation-linked bonds see Artus (2001).
15. See Willen (2005) for a general theoretical examination of the impact of new financial markets on welfare.

That argument would justify the existence of indexed assets, but it does not explain why the government should issue them. Three answers have been provided to this question. The first is on moral grounds, as expressed by Milton Friedman: "The government (cum monetary authority) created inflation in the first place and therefore has the responsibility to provide means by which citizens can protect their wealth".

The second answer is that the "entry cost" is high, as investors need to become accustomed to the properties of the new asset class, and the government can lead by example. This is suggested by Campbell and Schiller, 1996, p. 41: "It is widely acknowledged that the proper role of the government is to provide public goods, and the demonstration by example of the potential for new financial markets and instruments is really a public good".

The third answer is that the role of sovereign bonds goes one step further than that of privately issued bonds. They are unique in that they are the only asset that can provide simultaneously perfect protection against both credit risk and inflation risk. In other terms, from the point of view of long-term investors, sovereign inflation-linked bonds are true risk-free assets.[16]

Furthermore, the introduction of one financial innovation may in turn facilitate other innovations which would help to complete financial markets. For example, following the introduction of US government inflation-linked bonds, the Chicago Board of Trade introduced futures and options referenced to these bonds (five and ten-year maturities). Mutual funds benchmarked on these bonds also developed, and inflation-linked investment plans and annuities were introduced by pension funds. This suggests that the introduction of sovereign inflation-linked bonds allowed the development at the retail level of instruments that it would otherwise have been too costly (or risky) to develop. In the case of the euro area inflation-linked market, the recent development of the inflation-linked swap market and the recent introduction by the Chicago Mercantile Exchange of HICP (excluding tobacco) futures are two good examples of these externalities.

3.3.2 INCENTIVES TO SAVINGS

When Bach and Musgrave argued in favour of issuance of inflation-linked bonds in 1941, one of the points they put forward was that, by providing a hedge against inflation, these instruments would help prevent the transfer of wealth from financial into real assets in periods of rising concern over future inflation (see also Sarnat, 1973). The reason for this is that, in the absence of inflation-linked bonds, real assets would be the most likely safe-haven alternative. This would imply that the existence of indexed debt alongside of nominal debt would contribute both to raising and stabilising the savings rate. This argument may be more relevant for countries suffering from an insufficiency of savings and/or volatile inflation expectations than for a stable and mature economy. Nevertheless, when Robert Rubin announced in May 1996 the decision of the US Treasury to start issuing inflation-linked bonds in the United States, one of the arguments put forward was the potential of these assets to raise the national savings rate.

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16. Campbell and Viceira (2002) phrase this argument as follows: "… the safe asset for a long-term investor is not a Treasury bill but a long-term inflation indexed bond; this asset provides a stable stream of real income, and therefore supports a stable stream of consumption, over the long term". See also Campbell et al. (2003). It is clear from this quote that the notion of a risk-free asset is heavily dependent on the (implicit) liability structure of the investor (in this case consumer spending) and on its time-horizon (here long-term).

3.3.3 DISTRIBUTIONAL ARGUMENTS

Distributional arguments for the issuance of indexed debt are highly complex and cannot be explored here in full.[17] It suffices to say that unanticipated inflation (or deflation) implies unintended transfers of wealth from lenders to borrowers (or borrowers to lenders). Indexing the debt does not eliminate the uncertainty effects of inflation, but it does allow —partly at least— its unintended redistributive effect to be reduced.

This redistribution of risk in itself may have positive welfare effects if agents have different levels of aversion to risk. In particular, it could be assumed that a government is less inflation-adverse than old age pensioners (for the reasons already mentioned). By allowing a transfer of risk from pensioners to the government, the existence of inflation-linked bonds may therefore generate welfare gains. This argument was put forward both in the United Kingdom and in Australia when inflation-linked bonds were first issued.

3.4 The role of inflation-linked bonds in matching pension liabilities

It has been argued that inflation-indexed bonds should be seen as an important component of any funded pension management arrangement. In a portfolio approach, social security pension benefits can be interpreted as an asset that forms part of the assets of pensioners, alongside other real and financial assets that they may own. Social security pension benefits have the important characteristic that they are typically indexed to the general level of prices. By contrast, private pension funds rarely distribute indexed annuities. This makes it less attractive for pensioners to opt for funded pensions for at least three reasons.

The first reason is the standard portfolio diversification argument, which suggests that pensioners should prefer to hold an indexed asset rather than a non-indexed asset to substitute for their wage-earning "human capital".

The second reason is that non-indexed annuities are inefficient, because they do not allow pensioners to efficiently match their income with their liabilities (i.e. their current spending), which are indexed by definition. To match inflows and outflows, pensioners would have to invest part of their annuities during the first years of retirement in the money market (or preferably in an indexed instrument) in order to compensate for the erosion of the purchasing power of the annuity in later years. This would of course be a second-best solution compared with direct access to indexed cash flows in the first place, such as provided by inflation-linked bonds.

A third reason is that the aversion to inflation risk (or any other form of risk) of pensioners should rise as time goes by. The reason for this is that, in the event that an individual loses part of his/her financial assets (in real terms) at a mature age, it would be progressively more difficult to find a salaried activity to compensate for that loss in real income. If aversion to inflation is conditioned by the ability to use one's human capital as a hedge (i.e. the ability to find a job), then aversion to inflation should rise with age.

The existence of inflation-linked bonds eradicates the disadvantage of funded pensions, because it means that pension holdings can be created with the same characteristics as social security pensions, i.e. the provision of inflation-indexed annuities (and government guarantees). Incidentally, the existence of these assets also allows the gap to be closed between defined-contribution and defined-benefit pension plans, because

17. Distributional effects of inflation-linked contracts are discussed extensively in Issing (1973), in particular on pp.10-39. See also Drudi and Giordano (2000).

defined contributions invested in inflation-indexed government bonds allow benefits (expressed in terms of, for example, monthly real income) to be defined with absolute certainty. The conclusion that scholars and practitioners alike have drawn from this analysis is that governments would considerably facilitate the reform of pension systems if they were to provide the instruments to allow a frictionless shift from one system to the next (see for example Scobie et al., 1999; IFR, 2002).

Another argument raised by numerous academics in favour of the issuance of inflation-linked bonds by the government relates to money illusion. Irving Fisher argued in 1928 that private individuals do not trust indexation because they are used to thinking of money as a standard of value and feel intuitively more comfortable with certain cash flows in nominal terms. They consequently misapprehend the resulting uncertainty of cash flows in real terms. It has been further argued that money illusion is more marked in the context of low inflation than high inflation. When inflation is high and volatile, the effects of inflation are easy to identify and agents are keen to find a hedge against them. When inflation is low, by contrast, it becomes more difficult to appreciate the resultant erosion in the value of money, especially over long periods of time. Bodie (1997) argued that this leads to a potentially inadequate pension structure, because pensioners have *de facto* a long time horizon but fail to anticipate the loss in purchasing power that nominal annuities imply over their remaining life. As an illustration, the average life expectancy at age 60 in Europe is around 20 years. Assuming a maximum average inflation rate of 2% over that period, a pensioner receiving a nominal annuity would see his income lose one-third of its value over this period.[18] Should he/she live to become 100 years of age, more than half of the real purchasing power of his/her annuity would have evaporated.

In this context, some authors have argued that it is the role of the government to educate individuals and encourage them to protect themselves against risks of which they may not be sufficiently aware.[19]

It has often been argued that if inflation-linked bonds were as desirable as economists argue, then they would already be more widespread than they are. The reasons why inflation-linked bonds have not been issued more often have been thoroughly analysed on numerous occasions and include a very broad range of arguments (see for example Fisher, 1975; Liviatan and Levhari, 1977; McCulloch, 1980; Munnell and Grolnic, 1986; Pecci and Piga, 1997; and Price, 1997). For instance, it has been suggested that the inflation risk premium is too small for issuance of inflation-linked bonds to generate large gains for the issuer. Money illusion has also been put forward as a reason why demand for these instruments would be low. Another typical argument is that investors would fear that the government may manipulate the reference consumer price index or simply that they would not understand the reference index.

If inflation-linked bonds represent an appropriate instrument for pension liability matching, then there is a very strong argument to suggest that demand for these assets will grow nonetheless, because of demographic trends. The evident ageing of the population

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18. The real income would be 1/(1+0.2)20, i.e. around 67%, of the nominal income, implying that income would have lost around one-third of its value in real terms.

19. Campbell and Schiller (1996), p.43, argue that "… opinion leaders have not yet impressed on the public the importance of indexed private debt, to overcome their habitual impulse to money illusion". This argument was raised with reference to the possible suboptimality of nominal mortgages compared with inflation-indexed mortgages, in a context where the income (salary) of homeowners is itself largely indexed on prices over the comparatively long period that applies to mortgages. It applies just as well to the case of indexed assets.

as well as an increase in life expectancy suggests that the demand for appropriate assets to match pension liabilities has to rise. Furthermore, the trend towards a lengthening of life expectancy at retirement age argues in favour of demand for long-term pension vehicles.

All in all, demand for inflation-linked bonds has become relatively strong in recent years, particularly from institutional investors such as pension funds and insurance companies which regard these bonds as a very suitable instrument in their asset-liability matching policies. A report by the Group of Ten on the implications of ageing and pension system reform for financial markets and economic policies concluded that potential investor demand for long-term and inflation-linked bonds is high and not matched by supply (Group of Ten, p. 30ff.).

3.5 The potential for private issuance of inflation-linked bonds

Most of the considerations regarding the issuance of inflation-linked bonds have been discussed from the perspective of sovereign or public sector issuance. Yet the issuance of these instruments may also be interesting for private entities. In fact, over the past few years, private sector issuance of inflation-linked bonds has been increasing.

Issuance of inflation-linked bonds may be of particular interest to private sector entities whose activities are relatively closely linked to developments in inflation. In this respect, issuing inflation-linked debt would allow them to achieve a better hedge between assets and revenues on the one hand and debt on the other. The issuance of this instrument would have the additional benefit for the private issuer that the structure of its debt outstanding would be more diversified. As a result, the issuer may find it easier to place its debt in the market, as potentially a larger group of investors would be interested in it. For example, inflation-linked instruments may be particularly interesting to investors with a long-term horizon, such as pension funds.

There also may be a need for both public and private issuance of inflation-linked bonds at the same time. For example, for extremely risk-adverse investors, a government guarantee on their pension assets may be even more precious than protection against inflation. Inflation would erode part of their assets, but a default would wipe them out entirely. Therefore, not all categories of investors would be willing to substitute sovereign bonds with private bonds, independently of the yield on the assets.

There have been a number of examples of issuance of private indexed debt, at times even in the absence of similar sovereign debt. A very old example is the issuance of inflation-linked bonds by the Rand Kardex Company in the United States in 1925. A more recent example, still in the United States, was the issuance of indexed certificates of deposit by the Franklin Savings Association. The same institution also issued several indexed bonds with longer maturities. It is, however, in the United Kingdom and in France that private issuance of inflation-linked bonds is now best developed. For example, the market value of sterling corporate linkers in the Barclays Capital Sterling Index at the end of 2005 was over GBP 11 billion. In France, the main non-governmental issuer has been the social security fund Caisse d'Amortissement de la Dette Sociale (CADES), which, however, can be more appropriately regarded as a quasi-governmental than a private issuer. The market value of its inflation-linked debt was almost €12 billion at the end of 2005 (Barclays Capital, 2006). In 2005 the French company Veolia Environnement became the first private issuer of a euro-denominated inflation-linked corporate bond (€600 million, ten-year; see Credit, 2005).

A number of lessons can be drawn from both experiences, and in particular from the experience in the United Kingdom. Firstly, private issuers of inflation-linked bonds tend to be issuers whose income base is strongly correlated with the general price index, either because of their business (e.g. supermarkets, such as Tesco Plc.) or because prices relating to their activities are administered (e.g. hospitals such as King's College Hospital and utility companies such as Anglian Water and National Grid Transco Plc.). Other potential issuers of inflation-linked bonds should be mortgage lenders, to the extent that they are able to match assets and liabilities by providing indexed mortgages. There have been a few experiments in this area but never on a widespread scale.[20]

Second, private issuers of inflation-linked bonds tend to be institutions whose productive assets naturally have a very long duration, so that issuing similarly long-term liabilities makes sense (e.g. utilities in particular).[21] Short-term inflation-linked bonds tend to be scarce, if only because inflation uncertainty is lower in the short term, so that there is less need for hedging. In practice, inflation-linked bonds tend to be issued with fairly long initial maturities. Here again, mortgage lenders, particularly if mortgages are indexed, would be a natural candidate to issue inflation-linked bonds.

Third, private issuers of inflation-linked bonds tend to be institutions with low financial risk, which is consistent with the point raised at the start of this chapter.

The conclusion from the UK and French experience so far could be that while there is a potential for the development of a private inflation-linked bond market, including in particular with respect to asset-backed bonds and bonds issued by mortgage lenders, private bonds are unlikely to fully substitute for government issued inflation-linked bonds.

3.6 The choice of the reference index

The choice of the price index used as reference for inflation-linked bonds is one technical feature that plays a considerable role in the success or lack thereof of issuance of inflation-linked bonds. Other relevant technical features are the form of taxation, the mode of calculation of coupons (typically based on lagging measures of prices), the calculation of accrued interest and the protection —or not— of the principal in the event of deflation.

It is not the purpose of this occasional paper to enter into these latter technical features, which are extremely relevant for issuers and investors but less directly so from a central bank point of view. However, it is useful to give some consideration to the specific question of the choice of the reference price index. The reasons for this are twofold. First, the choice of a specific price index may focus the attention of the public on that index. Given that the central bank itself privileges one measure of prices in the definition of its policy (e.g. the index used in the ECB's quantitative definition of price stability), it may not be entirely neutral about the index used by market participants for indexing debt. Second, standardisation of financial products often facilitates the integration and development of financial markets, which is a concern of the ECB. The choice of a common price reference index by several issuers of inflation-linked bonds could be interpreted as a form of standardisation of these instruments.

Indexed bonds could in principle be referenced to any index. In practice, it would be preferable for issuers to use an index closely correlated to their income structure, while

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20. In the United States, in particular, indexed mortgages have been issued by the Timbers Corporation, in 1980, and the Utah State Retirement Board, in 1981 (see Viard, 1993).

21. E.g. Anglian Water Plc., Scottish Power UK Plc. or Severn Trent Water Utilities Finance Plc.

investors would benefit from an index appropriately representative of their liability structure. The examples of bonds indexed to the price of silver or cotton answer to this logic. The choice of the reference index is, however, often the result of a compromise between the preferences of the issuer and those of the investors. Their asset/liability structures may not entirely coincide, so that an index appropriate for the issuer may not be entirely adequate for the investors. In the case of the euro area, for instance, the French Treasury may prefer to use the French price index that would best reflect its income base rather than a euro-area wide index. For a Greek or Finnish investor, however, the use of French prices as a reference is obviously less relevant. Euro area-wide prices may therefore be a compromise acceptable to all. Indeed, the French government, which initially issued bonds indexed to the French CPI (excluding tobacco), started in October 2001 to issue bonds indexed to the euro area HICP (excluding tobacco).

A second factor bearing on the choice of the reference index is that it must be clearly understood and accepted by investors. In 1983, the Italian government issued ten-year inflation-linked bonds referenced on the value added deflator, a concept that was not very comprehensible to the retail investors at whom the bond was targeted. This was one of the reasons for the relative lack of success of this experiment. Almost without exception, issuers of inflation-linked bonds are currently using broad measures of the consumer price index, well understood by investors, as reference for their indexed debt.

It is against this background that the benefits of using the euro area HICP may be underlined. The use of one index by a sovereign issuer tends to focus the attention of the public (at least investors) on that particular index. So does the use of a particular index (e.g. the euro area HICP) by the central bank. It may be argued that —all other things being equal— it is preferable that the same index be used in both cases to concentrate the attention of the public on *one* measure of inflation. The use of different measures could be perceived as creating confusion among the public as to what is the true level of inflation.

Since the ECB's quantitative definition of price stability in the euro area is based on the euro area HICP, it seems logical that a euro area-wide measure such as this is used as main reference index for inflation-linked bonds. The argument that from an investor's perspective better inflation protection would be achieved by indexation to national price indices seems marginal in the light of the substantial convergence in actual inflation and inflation expectations within the euro area over recent years.[22]

A third crucial factor for the success of inflation-linked bonds is the need for reliability and integrity in the computation of the index. One argument that has sometimes been raised in the past against indexing of public debt is that the government may be able to manipulate the value of the index to effectively default on its liabilities. However, it is generally perceived that full transparency in the coverage and calculation of the reference index is sufficient to alleviate investors' fears. The computation of a broad index by an institution not directly controlled by any individual government should be seen as positive in this context.

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22. Dispersion in inflation rates as measured by the (unweighted) standard deviation has decreased significantly since the early 1990s and was around 0.8 in 2005 as a whole (for the euro area countries excluding Greece). The picture is similar for the dispersion of long-term inflation expectations: for example, the standard deviation of inflation expectations among the five largest euro area countries was around 0.5 in the October 2005 survey by Consensus Economics, which is about four times lower than in 1995.

A fourth argument in favour of euro area issuers of inflation-linked bonds using the euro area HICP rather than a national index as reference index is that it may be highly beneficial from the point of view of promoting financial market integration and market liquidity. That is, the use of a common reference index would facilitate comparison —even arbitrage— between inflation-linked bonds issued by different issuers, and would therefore probably widen the investor base. Such standardisation of inflation-linked bonds would even have a positive impact on the liquidity of these bonds, precisely because it would facilitate trading or hedging with other similar bonds.

Moreover, the use of a common price reference would make it easier and more cost-effective to develop derivative instruments based on inflation-linked bonds (e.g. futures, options and swaps), because they could be used as an effective hedging instrument for a broader range of assets. Inflation swaps referenced on the euro area HICP were introduced some years ago and their trading has expanded significantly. Furthermore, in September 2005, the Chicago Mercantile Exchange introduced the possibility of trading euro area HICP (excluding tobacco) futures.

3.7 Inflation-linked bonds, debt indexation and the maintenance of price stability

Most central banks have traditionally been hostile to the issuance of inflation-linked bonds. This attitude, however, has tended to turn in more recent years in favour of a benevolently neutral attitude, and even of explicit support in some cases (see Townend, 1997). In this context, this section reviews the arguments for and against the issuance of inflation-linked bonds from the point of view of their interaction with price stability.

The standard argument against indexing government debt is that it may set an example, leading to widespread indexation of financial contracts as well as wages and, in an extreme case, to a full indexing of the economy. Stanley Fischer argued on the basis of a theoretical model that indexation may put in place various destabilising mechanisms that would worsen the impact of an inflationary shock, given specific monetary and fiscal policies that link money growth to the budget deficit (Fisher, 1983). At the same time, Fisher emphasised that the link between inflation and indexing is not inevitable, and that appropriate policies can prevent indexation from leading to higher inflation. Indeed, Fischer tested empirically the relationship between debt indexing and inflation in the aftermath of the 1974 oil-price shock using data covering 40 countries with various degrees of indexing. He found no evidence that higher debt indexing as such resulted in higher inflation, which he attributed to the implementation of specific monetary and fiscal policy responses in those countries with more widespread indexing.

Another argument against indexing is that, if pursued to the full (i.e. as far as the indexing of cash balances as originally supported by Jevons in 1875), it could lead to the indeterminacy of prices. The risk that the indexing of government debt would spill over to other sectors of the economy as often presented in older academic discussions is much less of an issue in more recent work, not because theoretical arguments have changed, but rather because practical experience with these bonds suggests that the risk of spillover is low in reality. The risk that initiating issuance of indexed debt would lead to full indexing seems therefore more theoretical than real. More telling is that the issuance of inflation-linked bonds by the government has not led, in any of the countries mentioned in Chapter 2, to widespread debt indexing by the private sector.

A closely related but more subtle argument against indexing of the public debt is that its issuance could reduce support for the central bank in its efforts to maintain price stability by making it easier to live with inflation. This concern is slightly paradoxical, however. Indeed, as recalled by Samuelson (1988), indexing does not eliminate the uncertainty effects of inflation but rather shifts them. In other words, if inflation-linked bonds make it easier for investors to live with inflation, they make it more painful for the government to do so. If inflation is perceived as the outcome of a political struggle between an inflationary and an anti-inflationary constituency, then the key element is who —the government or its creditors— is most capable of influencing the level of inflation. The intuitive answer is that it is the government, so the issuance of inflation-linked bonds is likely to reduce, not increase, the inflationary risk.

Fischer and Summers (1989) studied the possibly perverse effects of policies that reduce the costs of inflation within a Barro-Gordon time-consistency framework and concluded that governments whose ability to maintain low rates of inflation is uncertain should not reduce the costs of actual inflation, or undermine opposition to it, for it may significantly increase equilibrium inflation rates and reduce welfare. They stressed, however, that in practice this is likely to hinge on whether such policies reduce political opposition to inflation. If this is not the case, the inflation-raising effects of the issuance of inflation-linked bonds should be less pronounced. All in all, these authors concluded that governments with impeccable anti-inflationary credentials have little reason to fear indexation and may even favour it.

Some scholars have suggested that the virtues of indexed debt as a "sleeping policeman" are less relevant in an environment where the central bank is fully independent, pursues an objective of price stability and is viewed as pursuing credible policies (see for example Hetzel, 1992). In such a situation, the ability of the government to generate inflation unilaterally, or fears that it may be able to do so, would be weak. This applies also to the ability of private agents to unilaterally generate inflation, so that the question of who is part of the inflationary constituency and who is not becomes a secondary concern. This last comment is less innocuous than it seems at first glance. It implies that, in the situation of a fully independent central bank such as the ECB, the central bank should be indifferent as to whether the government issues indexed or nominal bonds.

Thus, the academic argument that has been raised in the past of inflation-linked debt being helpful as the above-mentioned "sleeping policeman" in supporting price stability-oriented monetary policies is irrelevant where there is an independent central bank whose primary objective is to maintain price stability. This is unequivocally the case with the ECB, as explicitly laid down in the Treaty establishing the European Community, Article 105(1).

Indeed, the increased credibility of central banks we experience today is – somewhat paradoxically compared with the historical view of inflation-indexed debt – one of the key factors that may explain the development of inflation-linked bond markets over recent years. The credibility of the central banks and their clear mandate to preserve price stability has indeed helped to significantly diminish uncertainty about future inflation.

Yet, inflation risks have not disappeared altogether, and, consequently, for the reasons discussed in previous sub-sections, demand for these instruments does exist. However, central bank independence and the strict mandates of central banks to safeguard

price stability have *de facto* neutralised the incentives for governments to engage in inflationary surprises as was the case in the past. Therefore, the paradoxical situation that the inflation-linked bond markets started to experience strong growth at approximately the same time as central banks established their credibility in maintaining price stability can be explained by the fact that governments recognised that they no longer needed to fear the costs of unexpected surges in inflation, essentially because giving central banks independence has considerably reduced the risk of inflationary episodes. As a result, governments themselves may also find it more attractive to issue inflation-linked debt under independent central banks and price-stability oriented monetary policies.

The independence of central banks and stability-oriented monetary policies are also likely to curb to the potential spread of indexation in the economy as a whole. While the issuance of inflation-linked bonds in the past may have triggered fears of widespread indexation, such fears seem much less likely to materialise nowadays in an environment of low and stable inflation. The credibility of monetary policy, reinforced by the independence of the central banks and the consistent delivery of price stability, should suffice to discourage any attempt to extend indexation beyond financial assets.

4 Extracting information from inflation-linked bonds for monetary policy purposes

In addition to the arguments outlined in the previous chapter, a number of economists from both academia and the central bank community have argued in favour of issuance of inflation-linked bonds by the government on the grounds that the ability to derive a market-determined measure of real rates and inflation expectations from inflation-linked bonds can provide the central bank with useful information for the implementation of its policy (as well as a gauge of its credibility).[23]

This chapter provides an overview of how inflation-linked bonds can be used to monitor changes in market participants' macroeconomic expectations for monetary policy purposes (see also Hetzel, 1992; Breedon, 1995; Deacon and Andrews, 1996; Barr and Campbell, 1997; Kitamura, 1997; Emmons, 2000; and ECB, 2004b). Given their forward looking nature, asset prices in general and long-term government bond yields in particular incorporate investors' expectations for inflation and future economic activity. In addition, investors are likely to require certain premia to hold long-term bonds, which are also reflected in the levels of bond yields. These premia can be understood as a compensation for bearing the uncertainty related to their macroeconomic expectations and should also be expected to vary over time. Long-term nominal bond yields thus can be thought of as comprising three key elements: the expected real interest rate, which is often regarded as being closely linked to expectations for economic activity, the expected long-term rate of inflation and risk premia. However, disentangling those different pieces of information from the observed bond prices (or yields) is often far from straightforward.

Inflation-linked bonds offer central banks and private investors additional ways to disentangle the information contained in long-term nominal bond yields. In this chapter, the focus is on bonds indexed to the euro area HICP excluding tobacco in order to illustrate the use of inflation-linked bonds from a central bank perspective. References to other inflation-linked bond markets, mainly US TIPS, are included for comparison purposes or to highlight specific episodes that could help to better understand developments in the euro area inflation-linked market. However, this should not be taken as a thorough description of those markets (for the TIPS market, see for example Wrase, 1997; Kopcke and Kimball, 1999; Emmons, 2000; Taylor, 2000; Gapen, 2003; Laatsch and Klein, 2003; Carlstrom and Fuerst, 2004; Kitamura, 2004; Roll, 2004; Bardong and Lehnert, 2004b; and Hunter and Simon, 2005). For a recent comprehensive overview, the interested reader may consult Deacon et al. (2004) and references therein.

4.1 Break-even inflation rates as indicators of inflation expectations

Reliable indicators of private sector inflation expectations are particularly important for a central bank committed to maintaining price stability. In this regard, the presence of a mature

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23. R. Hetzel, in particular, argued that the US Treasury should issue half of its debt in the form of inflation-linked bonds, almost entirely on this ground (see Hetzel, 1992). As early as June 1992, the then Federal Reserve chairman Alan Greenspan referred to these positive externalities of sovereign indexed debt for monetary policy-makers on the occasion of a hearing before a Committee of the US House of Representatives. From a different perspective, J. Tobin suggested that inflation-linked bonds could be used in monetary policy operations to help the central bank to steer the real interest rate (see Tobin, 1963). However, inflation-linked bonds do not play an active role in current monetary policy implementation frameworks. For specific uses of inflation-linked bonds for monetary policy purposes and monetary policy assessments see for instance also Woodward (1990), Barr and Pesaran (1997), Remolona et al. (1998) and Spiegel (1998).

market for inflation-linked bonds represents an important instrument with which to extract market participants' inflation expectations. The spread between the yields of a conventional nominal bond and an inflation-linked bond of the same maturity is often referred to as the "break-even" inflation rate (BEIR), as it would be the hypothetical rate of inflation at which the expected return from the two bonds would be the same. Therefore, BEIRs provide information about market participants' average inflation expectations over the residual maturity of the bonds used in their calculation.

BEIRs present two main advantages as a source of information on private sector inflation expectations. First, they are the timeliest source of information on inflation expectations since they are available in real time on every trading day. Second, as conventional and inflation-linked bonds are usually issued over a variety of maturities, they in principle allow information to be extracted about inflation expectations at several horizons, which is of considerable interest for a central bank and private investors alike.

Despite these advantages, some caution is warranted in the interpretation of BEIRs as direct measures of market participants' inflation expectations. First, the difference between comparable nominal and inflation-linked bond yields is likely to incorporate an inflation risk premium required by investors to be compensated for inflation uncertainty when holding long-maturity nominal bonds (see Box 1 for additional details).

Second, as the liquidity of inflation-linked bonds, although growing fast (see Chapter 2), 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.

Third, the specific price index to which the bonds are linked matters not only for the hedging activities of private investors (see Section 3.6) but also for the use of indexed-linked bonds for monetary policy purposes. For example, in the euro area the reference index used for all bonds linked to euro area-wide inflation issued so far is the HICP excluding tobacco. As the inflation rate measured by the overall HICP (i.e. including tobacco) has been slightly higher than that of the HICP excluding tobacco over recent years, this may imply a negative bias in the BEIRs as an indicator of expectations for (overall) HICP inflation. In the case of the US market, it also has been argued that while TIPS are indexed to the overall CPI index, US policymakers are often more interested in "core inflation" measures for monetary policy decisions (Bernanke, 2004).

Finally, movements in BEIRs may occasionally reflect institutional and technical market factors such as tax distortions and changes in regulations affecting investors' tax liabilities or incentives, which may influence the prevailing demand for inflation-linked instruments. This may reduce the information content of BEIRs as indicators of inflation expectations.[24] Such distortions, although difficult to isolate and quantify, should always be taken into account in the interpretation of these rates. In this regard, a comparison of developments in BEIRs in other markets may be useful.

24. For an illustration of such episodes in the case of a more mature inflation-linked bond market such as, for example, that of the United Kingdom, see Scholtes (2002).

Box 1. The role of inflation uncertainty in the interpretation of break-even inflation rates: technical and conceptual considerations

Inflation-linked financial instruments provide central banks with useful information about market participants' inflation expectations. However, the spread between the yields of a conventional nominal bond[1] and an inflation-linked bond of the same maturity should not be taken as a direct measure of the market participants' inflation expectations. This box presents some theoretical and conceptual considerations regarding the practical interpretation of BEIRs for monetary policy purposes.

Inflation uncertainty and the calculation of break-even inflation rates

BEIRs are often calculated as the spread between the yield of a conventional nominal bond (denoted by *i*) and an inflation-linked bond (denoted by *r*) of the same maturity (denoted by *M*), that is

$$BEIR_{t,M} = i_{t,M} - r_{t,M} \qquad [1]$$

which is a linear approximation of the Fisher equation linking the ex ante nominal and real (zero coupon) interest rates (respectively *i* and *r*) with the average expected inflation rate (denoted by π)

$$(1 + r) = (1 + i)/(1 + \overline{\pi}) \,.$$

There are, however, several considerations regarding this calculation that are worth noting.[2] Some further insights can be obtained from a comparison of [1] with a formulation of the Fisher equation allowing for inflation risk premia (denoted by ρ) reflecting the uncertainty about future inflation

$$(1+i)^M = (1+r)^M[(1+\overline{\pi})(1+\rho)]^M \qquad [2]$$

If investors were risk-neutral and demanded the same expected return from the two kinds of security, the inflation compensation required would (approximately) equal the average rate of inflation that investors expect over the maturity of the bond. However, investors are typically risk-averse. As future inflation will erode the payments on a nominal security, but not those on an inflation-linked bond, investors are likely to demand a higher expected return on nominal securities when future inflation is uncertain. The required inflation compensation would then comprise not only the expected inflation rate over the life of the bond, but also a premium to compensate investors for bearing that inflation risk.

From a comparison of [1] and [2] it is then clear that, even taking [1] as a valid linear approximation of [2], BEIRs calculated as [1] are an imperfect measure of inflation expectations $\overline{\pi}$, for they do incorporate the inflation risk premium ρ that biases BEIRs upwards as a measure of inflation expectations.[3]

Yet, even assuming away the presence of an inflation uncertainty premium, the complication for the calculation of expected inflation stemming from the convexity of the Fisher relationship in presence of inflation uncertainty remains.[4]

Assuming away inflation risk premia (that is $\rho=0$) [2] gives

$$(1+r)^M = E_t\left[\frac{(1+i)^M}{(1+\overline{\pi})^M}\right],$$

which (approximately) implies that

$$i - r = \frac{1}{E_t\left[\frac{1}{(1+\overline{\pi})^M}\right]^{1/M}} - 1.$$

While the latter expression is fairly similar to [1], an important difference is that, by the well-known Jensen's inequality,

$$E_t\left[\frac{1}{(1+\overline{\pi})^M}\right] > \frac{1}{(1+E_t(\overline{\pi}))^M},$$

which, in turn, implies that $i_t^M - r_t^M < E_t\left(\overline{\pi}\right)$, i.e. the yield spread underestimates the mathematical expectation of inflation.

Therefore, inflation uncertainty leads to the presence of two opposed effects: while convexity may bias BEIRs downwards, the presence of an inflation uncertainty risk premium required by investors helps to bias BEIRs upwards as an indicator of inflation expectations. To the extent that it is unlikely that both effects exactly offset each other at any given point in time, yield spreads between conventional and inflation-linked bonds are therefore likely to incorporate some effect from inflation uncertainty and do not reflect purely inflation expectations.

Conceptual considerations regarding the information content of break-even inflation rates

The simple analysis conducted above leads to several considerations regarding the interpretation of BEIRs for monetary policy purposes. First, the yield spread between nominal and inflation-linked bonds should be interpreted as reflecting the *inflation compensation* required by market participants, rather than a "simple" expected inflation rate to break even. Second, the required inflation compensation comprises information about both the level of market participants' (long-term) inflation expectations and the perceived uncertainty surrounding those inflation expectations (as inflation risk premium). It should consequently be interpreted as an indicator of market participants' inflation expectations in a broad sense rather than a single point estimate.

Changes in BEIRs over time could reflect either changes in the level of expected inflation, changes in the perceived uncertainty about future inflation or a combination of both.[5] From a central bank's perspective, both components are of relevance. A central bank's credible commitment to price stability should anchor the level of expected inflation to its policy objective, with the degree of perceived uncertainty about future inflation developments determining how firmly inflation expectations are anchored. In this regard, changes in the inflation compensation required by market participants as reflected in BEIRs provide a way for

policymakers to gauge the market's perception of inflation uncertainty that is difficult to obtain elsewhere.

1. The calculation of BEIRs requires finding the appropriate nominal security to compare with the inflation-linked bond. The usual practice is to use a nominal coupon bond with a similar maturity and from the same issuer, but even in that case it has to be borne in mind that the two bonds have different cash flows, leading to different "durations". Sack (2000) however investigates this problem in the measurement of BEIRs and concludes that the differences are fairly small.
2. Even ignoring any uncertainty and risk premia, it is worth noting that the yield spread calculation is just a (linear) approximation and that its use introduces a compound bias with respect to the calculation of the expected inflation rate as a function of the (compounded) yields-to-maturity of the nominal and the real bonds. As a result, the yield spread calculation tends to be higher than the BEIR calculated on the basis of the Fisher equation by a few basis points. To illustrate, a 4% nominal rate and a 2% real rate would imply a Fisher BEIR of 1.96%, that is, 4 basis points lower.
3. For reference, recent estimates put the inflation risk premium embodied in US long-term bond yields at between 20 and 140 basis points (see Ang et al., 2006, or Buraschi and Jiltsov, 2005), but this is found to change substantially over time when estimated over long samples. Kim and Wright (2005) focusing on a more recent sample starting in 1990, suggest that, despite some fluctuations, the inflation risk premium has declined in the United States over the last 15 years, estimating it at about 50 basis points by mid-2005.
4. For empirical investigations of the (long-run) relationship between nominal interest rates and expected inflation, see for example Lahiri et al. (1988), Mishkin (1992), Evans and Lewis (1995), Kandel et al. (1996), Laatsch and Klein (2003), and Goto and Torous (2003).
5. From a technical point of view, it is not straightforward to break down movements in BEIRs into those two components. From a central bank's perspective, however, it seems more important to understand the extent to which yield spreads between inflation-linked bonds and conventional bonds accurately reflect the inflation compensation required in the market instead of other technical and institutional biases.

Unfortunately, disentangling and quantifying the impact of the different factors outlined above in order to assess the reliability of BEIRs as indicators of inflation expectations is far from straightforward. There are nevertheless some results available from research that has tried to shed some light on these issues.[25]

Deacon and Derry (1994) was among the first to provide a methodology to derive a term structure of inflation expectations to be constructed from the underlying term structures of real and nominal interest rates, but their analysis was carried out under the assumption of a zero inflation risk premium. Evans, 1998, extended their analysis by using the estimation of the real term structure to investigate its relationship to nominal rates and inflation, finding a significant and time-varying inflation risk premium in the UK term structure.[26]

Studies on the US TIPS market have mostly focused on the shortcomings of BEIRs mentioned above.[27] For instance, there is substantial evidence that the large and variable liquidity premium between US TIPS and conventional securities may have prevented BEIRs from providing a good measure of market participants' inflation expectations (Shen and Corning, 2001; and Sack and Elsasser, 2004). Indeed, US BEIRs were until 2004 systematically below survey measures of inflation expectations, for example the surveys by Consensus Economics and the Federal Reserve Bank of Philadelphia Survey of Professional Forecasters.

Publications using euro area data are even more scarce, which is not surprising given the relatively short time horizon of the data available. The paper by Alonso et al. (2001) focuses on the French inflation-linked bonds indexed to the French CPI excluding tobacco

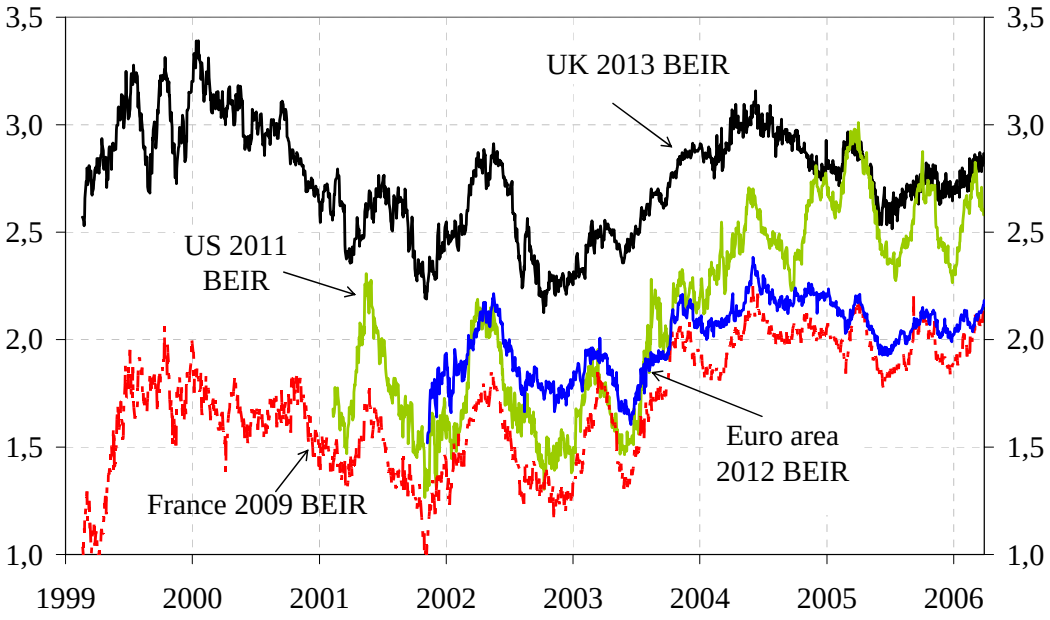
25. Other issues have also been investigated, such as the forecast accuracy of break-even inflation rates for future inflation (Breedon and Chadha, 1997, for the United Kingdom, and Christensen et al., 2004, for Canada) and their ability to predict future policy rates through a Taylor rule (Sack, 2003).
26. In turn, the methodology of Evans (1998) was extended by Anderson and Sleath (2001) using a modified version of the Waggoner (1997) variable penalty spline-based model. Their analysis underlies the derivation of the inflation term structure regularly presented in the Bank of England Inflation Report.
27. McCulloch and Kochin (2000) is an exception.

and explicitly aims to correct BEIRs for some of the potential biases mentioned above, namely the compound, idiosyncratic (liquidity) and coupon biases, along the lines suggested by Sack (2000). Its results, however, suggest that the inflation compensation measure used does not differ much from the standard BEIR calculated as the yield spread. Cappiello and Guéné (2005) estimate the inflation risk premia embodied in French and German long-term bonds to be around 20 and 10 basis points respectively.

Overall, this evidence suggests that some caution is warranted when interpreting BEIRs for monetary policy purposes, as they are likely to include variable liquidity premia and a time-varying inflation risk premium. At the same time, BEIRs are in most respects the best available indicators of expected inflation, and their importance as a tool for monetary policy will increase over time.

The usefulness of monitoring BEIRs for a central bank, however, hinges on the information they may provide about inflation expectations among market participants in real time. Indeed, their timeliness allows changes in long-term inflation expectations to be identified as they occur, which is of clear interest to a central bank. In this regard, and despite the relatively short sample available and the ongoing development of the euro area inflation-linked bond market in the last few years, BEIRs have already provided some interesting insights, particularly since 2004, a point at which the market may have reached sufficiently large trading volumes on both sides of the Atlantic (see Chapter 2).

Chart 4: Break-even inflation rates in some major industrialised economies



Sources: Reuters and authors' calculations.

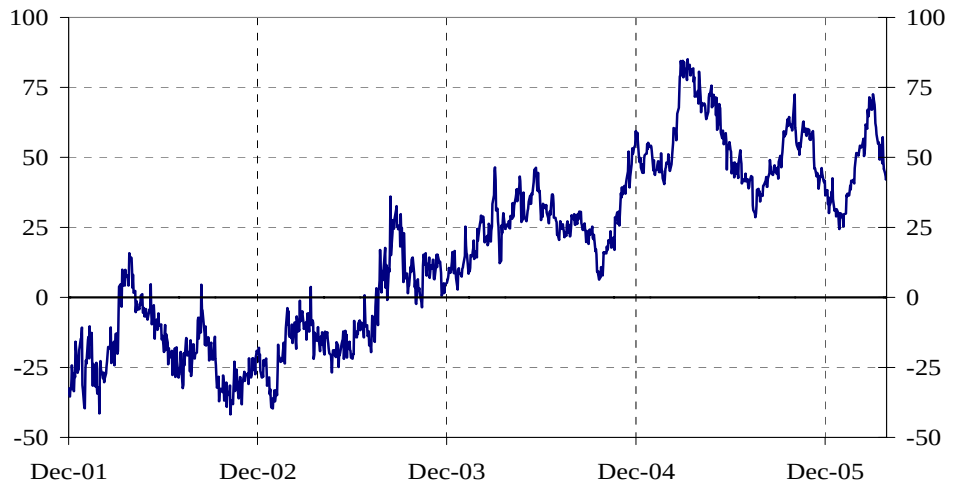
Chart 4 provides an overview of developments in BEIRs extracted from inflation-linked bonds of similar maturity in the euro area, the United States, the United Kingdom and France over the last few years.[28] These "spot" BEIRs provide information about the market participants' average inflation expectations over the residual maturities of the bonds.

28. Given the short sample available for the euro area inflation-linked bond, the 2009 French Treasury bond indexed to the French CPI excluding tobacco is also depicted in Chart 4.

Several features are noticeable from the chart. First, BEIRs have exhibited substantial volatility over the last few years in these four markets. This notwithstanding, a substantial degree of co-movement in the four markets is immediately apparent from the chart, which suggests that trends over time are determined by relatively global factors.[29] In this regard, it is worth noting the upward trend exhibited by the four BEIRs since mid-2003, which may reflect increasing concerns among market participants about the upsurge in commodity prices, mainly oil prices, and their impact on future inflation. Second, beyond a substantial co-movement, there seem to be some clear differences in the average level of the BEIRs. Indeed, the spreads between the BEIRs seem broadly consistent with the differences between the inflation objectives followed by the corresponding monetary authorities in the three economic areas over the medium term as perceived by market participants. The US case, however, seems to be somewhat extreme, as in the period 1997-2003 the BEIRs were abnormally low, probably reflecting some lack of development in the US linkers market. More recently, however, BEIRs in the United States have risen to levels more in line with other indicators of long-term inflation expectations.[30]

Changes in the BEIR spread between economic areas may also be a potentially useful way to detect the presence of idiosyncratic distortions in one specific market. For instance, the upsurge in oil prices pushed up BEIRs in all markets, including the euro area and the United States, from the first half of 2004 onwards, while at the same time, US BEIRs were gradually correcting from the extremely low levels in the earlier years. As a result, over 2004, the spread between the US and euro area BEIRs for a comparable maturity exhibited levels more in line with the differentials in survey measures of long-term inflation rates (see Chart 5).

Chart 5: Long-term break-even inflation rate spread between euro area and the United States *(daily data, basis points)*



Source: Reuters and authors' calculations.

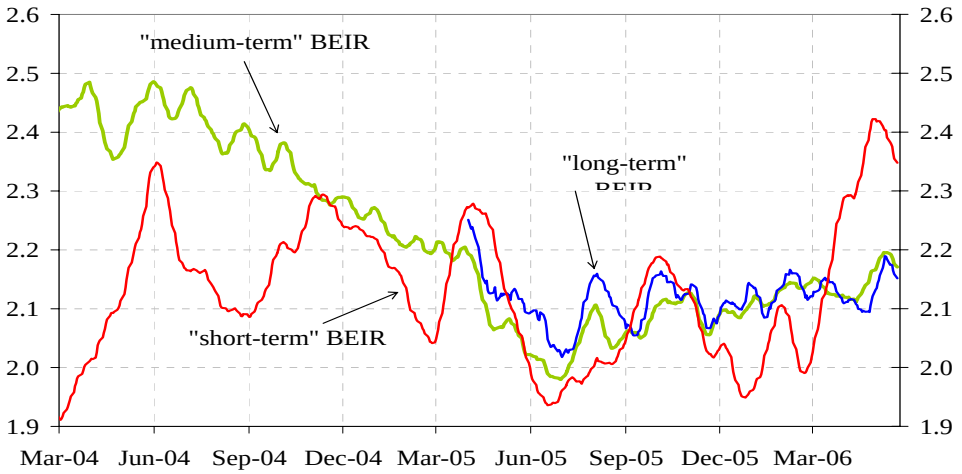
29. In the case of the UK market, recent developments may be affected by the change of index for the definition of the inflation target (see also Section 3.6).

30. This also appears to be supported by the US Federal Reserve's own assessment, which, despite the increase in break-even inflation rates over 2004, described long-term inflation expectations in the United States as "well-contained" in several of its Federal Open Market Committee statements.

The (spot) BEIRs (as shown in Chart 4) reflect the average inflation compensation required by investors over the whole residual maturity of the bonds. For example, biases aside, the BEIR extracted from the 2012 maturity bond reflects average inflation expectations up to that maturity date. These rates could therefore be influenced by shorter-term inflation expectations that may vary substantially with temporary price shocks beyond the control of the central bank. Implied forward BEIRs, calculated from a decomposition of "spot" BEIRs, can provide useful information to gauge the horizon at which average inflation expectations are changing. In the euro area, such a calculation can for example be conducted for the bonds maturing in 2008 and 2014 issued by the Italian Treasury and linked to the euro area HICP excluding tobacco. The implied forward BEIR should reflect investors' expectations for the average inflation rate between 2008 and 2014. In a similar vein, the recent issuance of the French OATei with maturity 2015 allows an implied forward BEIR to be calculated for 2012-15, which should better reflect longer-term inflation expectations. Therefore, by using the 2008 spot BEIR and the implied forward BEIRs for 2008-14 and 2012-15, one can gauge changes in BEIRs at short, medium and long-term horizons (see Chart 6).

Chart 6: Implied forward BEIRS in the euro area at different horizons

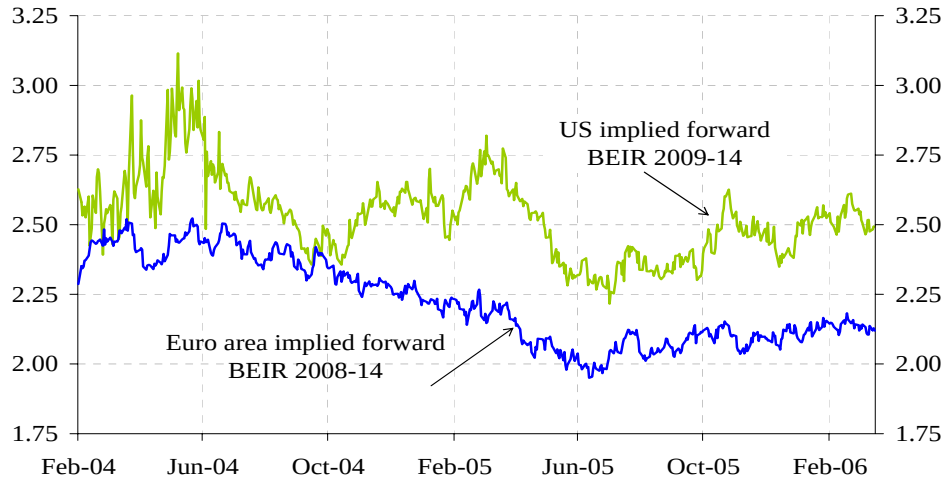
(daily data, ten-day moving average)



Source: Reuters and author's calculations. Note: Short-term inflation expectations are measured by the 2008 BEIR. The implied forward BEIRS for 2008-14 and 2012-15 measure medium and long-term expectations respectively.

Beyond monitoring movements in euro area BEIRs at different horizons, additional insights can be obtained from cross-checking developments in implied forward BEIRs across economic areas. Chart 7 depicts the above implied forward BEIRs in the United States and in the euro area since 2004.

Chart 7: Euro area and US implied forward long-term break-even inflation rates



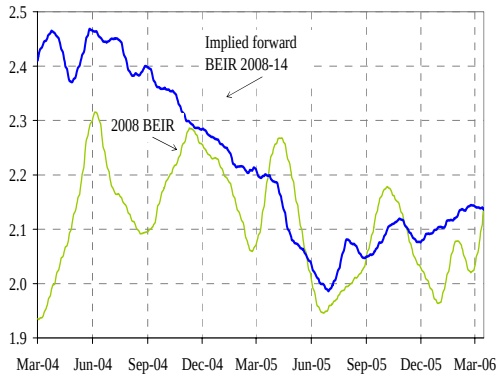
Source: Reuters and author's calculations.

On the basis of these market-based measures of inflation expectations, inflation expectations appear, at relatively long horizons, to be better anchored in the euro area than in the United States. First, in terms of levels, the US implied forward BEIR remained systematically above its euro area counterpart for the whole period under consideration. Second, long-term inflation expectations as measured by these indicators seem to have been more volatile in the United States than in the euro area since early 2004.

Although one has to bear in mind the short sample considered and the presence of idiosyncratic factors, not least the monetary policy stance in each economy, developments in BEIRs in both economic areas since early 2004 have been to a large extent influenced by inflationary pressures stemming from the upsurge in oil prices. The relatively different responses of long-term inflation expectations in the two economies to a relatively common shock can be interpreted as providing some support for the ability of a more explicit commitment to a quantitative definition of price stability, such as that formulated and published by the ECB, to anchor long-term inflation expectations.

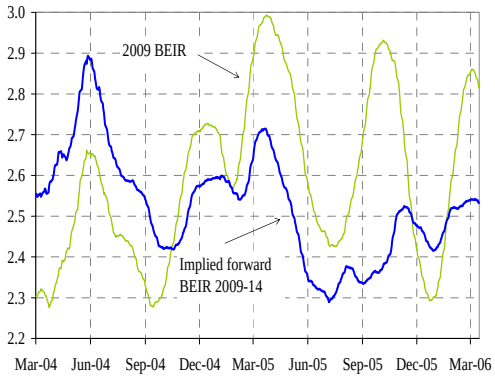
In this regard, it is also of interest to compare the co-movement between short-term and long-term inflation expectations in the two economic areas. In order to abstract from the day-to-day volatility, Charts 8a and 8b depict 20-day centred moving averages of the short-term and longer-term implied BEIRs in the euro area and the United States.

Chart 8a: Short-term and long-term BEIRs in the euro area *(daily data, 20-day moving averages)*



Note: The 2008 BEIR measures short-term inflation expectations, while longer-term expectations are measured by the implied forward BEIR 2008-14.

Chart 8b: Short-term and long-term BEIRs in the United States *(daily data, 20-day moving averages)*



Note: The 2009 BEIR measures short-term inflation expectations, while longer-term expectations are measured by the implied forward BEIR 2009-14.

These smoother series show that euro area long-term inflation expectations continued their downward trend between mid-2004 and mid-2005, without any significant reaction to the movements in shorter-term inflation expectations. By contrast, US long-term implied forward BEIRs appear to have partially reflected the rises in short-term inflation expectations in the period under consideration, suggesting that there may be a greater spill-over of short-term inflation expectations into long-term inflation expectations in the United States than in the euro area.[31]

Further insights into movements in medium-to-long term inflation expectations in the euro area can be obtained from the estimation of zero-coupon break-even inflation curves. Box 2 presents some additional indicators based on such an analysis and discusses some of the insights the estimation of zero-coupon BEIRs may offer.

Box 2. The estimation of term structures of zero-coupon inflation-linked bond yields and break-even inflation rates for the euro area

The estimation of a full term structure of zero coupon inflation-linked bond yields and corresponding BEIRs for the euro area offers two major advantages with respect to the measures discussed in the main text of this article. First, it allows the calculation of time series of real yields and BEIRs with *constant maturity* (for example a BEIR ten years ahead), which is particularly useful when assessing developments over a relatively long period of time. The maturity of observed yields and rates from existing bonds, by contrast, is not constant but declines over the existence of the bonds, which may complicate the interpretation of developments. Second, the calculation of zero-coupon rates allows potential distortions

31. For a more detailed discussion of the potential effects of the monetary policy strategy and central bank communication on break-even inflation rates, see Trichet (2005).

related to the different durations of the bonds used in the calculation of BEIRs to be avoided. Such distortions are related to the different cash-flow structures of inflation-linked and nominal bonds.[1]

However, the estimation of such term structures for the euro area at the current juncture requires the resolution of some technical problems related to the relatively low number of inflation-linked bonds, particularly at short maturities. Indeed, despite the significant development of the euro area inflation-linked bond market in recent years, it still has some important limitations in this respect.[2] For example, the euro area market has the unique feature that there are several sovereign issuers of inflation-linked bonds (France, Germany, Italy and Greece to date), which, although all bonds that have been issued are indexed to the euro area HICP excluding tobacco, are perceived by investors as carrying different credit risk (see Table 2 in Chapter 2), which may potentially distort the estimation.[3]

To estimate a real and a comparable nominal yield curve for the euro area, we employ a parametric approach proposed by Nelson and Siegel (1987).[4] This method assumes that the zero-coupon yield for a maturity of *m* years *(ym)* is specified by the following functional form:

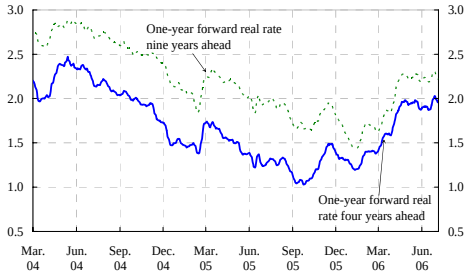
$$y_m = \beta_1 + (\beta_2 + \beta_3)\frac{\tau}{m}\left(1 - \exp\left(-\frac{m}{\tau}\right)\right) - \beta_3 \exp\left(-\frac{m}{\tau}\right)$$

The parameters β_1 β_2 β_3 and τ can be estimated by minimising the difference between the bond prices implied by the assumed functional form and the observed prices of inflation-linked bonds. The same methodology is applied to estimate the real yield curve and a comparable nominal yield curve, and constant-maturity BEIRs are calculated as the difference between those two curves.[5]

These alternative indicators offer two important insights. First, a comparison of the constant-maturity zero-coupon real yields and BEIRs with observed real yields and BEIRs —such as those discussed in the main text— of a comparable maturity suggests that, at least over the last two years or so, the latter measures seem to be relatively good approximations to the theoretically preferable zero coupon constant-maturity measures and are only slightly biased by potential distortions related to duration mismatching. Second, the estimation of the above-mentioned term structures of zero-coupon real rates and BEIRs offer the possibility to calculate implied forward rates at any horizon of interest, which is also constant over time. The lack of a sufficient number of inflation-linked bonds at short maturities in the euro area market calls for extreme caution when using such measures for horizons below three years, but reliable estimates of the real interest rate and inflation expectations at medium-term and long-term horizons can be constructed from available information. For example, one-year forward real rates and BEIRs four and nine years ahead (see Charts A and B) provide information on developments in market expectations for four and nine years ahead, which is very valuable for monetary policy-making.

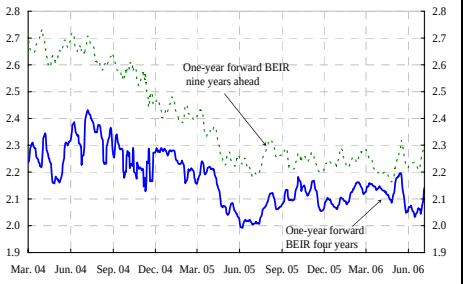
Chart B, for example, confirms the information from Charts 7 and 8 in the main text that euro area medium-to-long-term inflation expectations, as measured by the shown implied forward BEIRs, declined strongly in the course of 2004 and early 2005 and were relatively stable over the first half of 2006 despite the upward movements in short-term BEIRs and actual inflation.

Chart A: One-year implied forward real rates four and nine years ahead *(percentages; daily data; five-day moving averages)*



Sources: Reuters and ECB calculations.

Chart B: One-year implied forward BEIR four and nine years ahead *(percentages; daily data; five day moving averages)*



Sources: Reuters and ECB calculations

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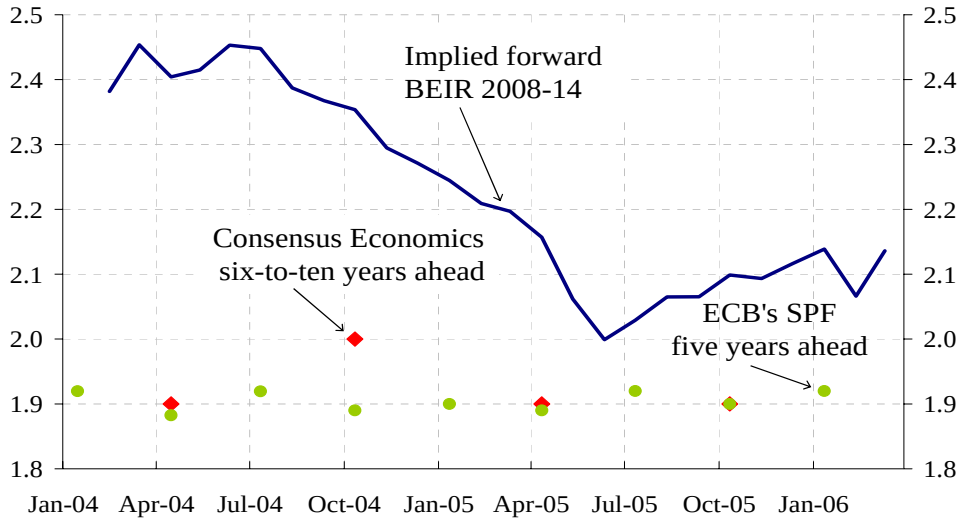
1. (Macaulay) duration is defined as the weighted average maturity of a bond's cash-flows, where the weights are the present values of each of the payments as a proportion of the total present value of all cash flows.
2. Constant-maturity zero-coupon BEIRs can be constructed by subtracting zero-coupon real rates from zero-coupon nominal rates of the same maturity. Hence, the problem of computing constant-maturity zero-coupon BEIRs is ultimately a matter of estimating real and comparable nominal zero-coupon yield curves.
3. Other differences in the characteristics of the bonds should also be borne in mind: for instance, the fact that the French and the Greek bonds have annual coupons while the Italian bonds have semi-annual coupons has important implications for the correct pricing of the bonds, but it is easily taken into account in the estimation.
4. See Nelson and Siegel (1987). The literature on yield-curve estimation proposes a variety of methods which can be roughly divided into parametric and non-parametric. In the case of parametric approaches, parsimoniously parameterised functional forms of the yield curve are assumed, and the parameters of these functions are chosen by maximising the fit of the observed bond prices. Non-parametric approaches are more flexible in fitting observed bond prices, but a good fit of observed bond prices entails the potential risk of over-fitting, which, in the case of the euro area real curve, may be especially important because there are relatively few inflation-linked bonds available. The Bank for International Settlements (BIS) recently showed that 10 out of 13 central banks use the same Nelson- Siegel method to estimate nominal yield curves (see BIS, 2005).
5. For a more comprehensive description of the methodology see Werner et al (2007), forthcoming in the ECB Working Paper Series.

Additional information can be obtained from a comparison of market-based measures of long-term inflation expectations extracted from financial instruments with survey measures of private sector inflation expectations (see Chart 9). In the case of the euro area, long-term inflation expectations are published bi-annually by Consensus Economics, which reports inflation expectations for six to ten years ahead, and at a quarterly frequency by the ECB from its Survey of Professional Forecasters (SPF), which reports inflation expectations for five years ahead.[32] The comparison between these two sources of information is not perfect, as they in principle reflect the opinion of different economic agents and come at a very different frequency. Overall, however, these differences do not prevent the comparison from being meaningful.

32. For a detailed description of the ECB's SPF, see Garcia (2003) in this Occasional Paper Series. The Euro Zone Barometer published by MJEconomics also provides survey measures of long-term inflation expectations in the euro area at a monthly frequency, although for a much shorter sample.

Chart 9: Indicators of private sector inflation expectations in the euro area



Sources: Reuters, Consensus Economics and author's calculations.

Two main differences between these indicators of long-term inflation expectations are evident from Chart 9. First, the implied BEIRs are more volatile than survey data (see also Chart 7). Second, they tend to hover around higher levels than survey measures of long-term inflation expectations, providing support for the existence of some inflation risk premium in their calculation.

The singular information offered to a central bank by the existence of inflation-linked bonds is evident from the chart. As indicators of inflation expectations, BEIRs allow changes in inflation expectations to be detected as they occur. For instance, in contrast to the rise in the BEIR in the second quarter of 2004 in the context of the rise in oil prices during that period, survey measures of long-term inflation expectations in the euro area appeared to have unchanged. However, the surveys were not conducted until much later (mid-July for the SPF and October 2004 for Consensus Economics), by which time inflationary concerns seem to have abated somewhat, as also indicated by lower spot and implied forward BEIRs.

The evidence presented in this section highlights the importance of BEIRs as a source of information on inflation expectations for a central bank, information that the ECB regularly publishes in its Monthly Bulletin in order to share it with the general public. The importance of BEIRs is likely to grow over time with the increase in available maturities and liquidity in the inflation-linked bond markets. In the meantime, some caution is advisable when monitoring movements in BEIRs for monetary policy purposes. In particular, it often seems useful to focus on changes rather than levels of BEIRs when interpreting them in terms of long-term inflation expectations. It also appears useful to cross-check their developments with those of other financial instruments, or with BEIRs of a similar maturity for other countries, as well as with survey measures of long-term inflation expectations.

4.2 Inflation-linked bond yields as measures of real interest rate and growth prospects

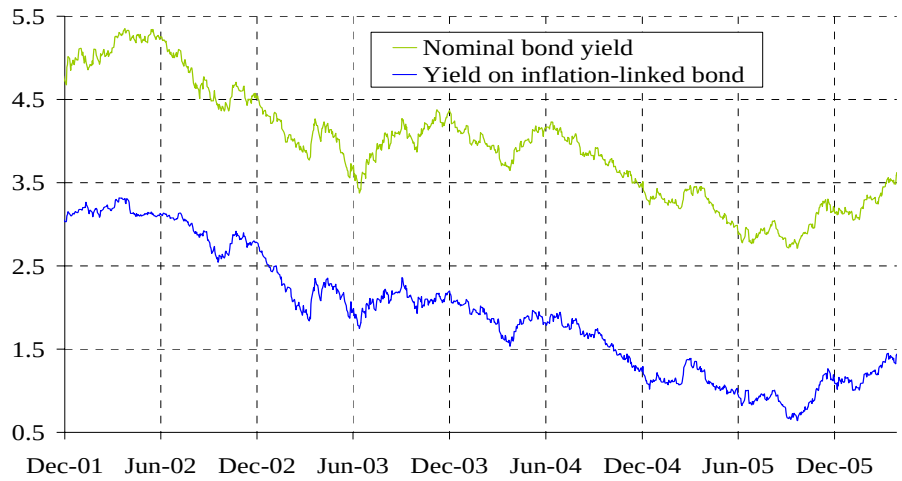
The yields on inflation-linked bonds, by providing direct information on the expected real return on a financial instrument, can also provide information about expected fluctuations in the rate of return on real investment as perceived by market participants at a certain

point in time. In this regard, inflation-linked bonds can provide information with which to decompose long-term nominal bond yields into the expected real interest rate, which is often regarded as being closely linked to expectations for economic activity, the expected long-term rate of inflation and various risk premia, as perceived by financial markets.

Academic literature has distinguished a great variety of factors determining real interest rates. First, important factors are those that determine the potential growth of the economy, i.e. the factors affecting the long-term equilibrium level of real interest rates at horizons stretching beyond the business cycle. This group includes demographic and productivity trends, as well as savers' time preferences and basic attitudes towards risk.[33] Long-term equilibrium real interest rates —also called the natural interest rates— are the rates that should prevail when output grows at its potential rate and when two further conditions are met. First, inflation should be stable around its steady state (see ECB, 2004a), and second, investors should correctly anticipate that economic growth will stay at its steady state level over the maturity of long-term bonds.[34] Assuming that these conditions are met, changes in real long-term interest rates may mirror changes in investors' (long-term) growth expectations. However, even on these assumptions, it has to be borne in mind that secular variations in investors' assessments of fundamental risks may change the equilibrium "wedge" between real interest rates and potential economic growth rates.

Abstracting from risk premia considerations, inflation-linked bonds make it possible to decompose long-term nominal bond yields into the real yield from the inflation-linked bond and the BEIR in order to assess whether it is growth prospects or inflation expectations that are driving developments in long-term nominal bond yields. Chart 10 provides such a decomposition using the 2012 maturity inflation-linked bond since its issuance by the French Treasury in November 2001.

Chart 10: Decomposition of long-term bond yields in the euro area



Sources: Reuters and authors' calculations. Note: This decomposition is based on yields on French bonds with maturity 2012.

33. For example, according to the "modified golden rule" in the Ramsey model, the equilibrium real interest rate equals the sum of consumers' rate of time preference and output growth (which in this model equals population growth with zero productivity growth). For a textbook exposition, see Blanchard and Fischer (1989). Furthermore, dynamic models in which Ricardian equivalence does not hold imply that fiscal policy can also have an impact on the steady state level of capital and thus on the equilibrium level of real interest rates.

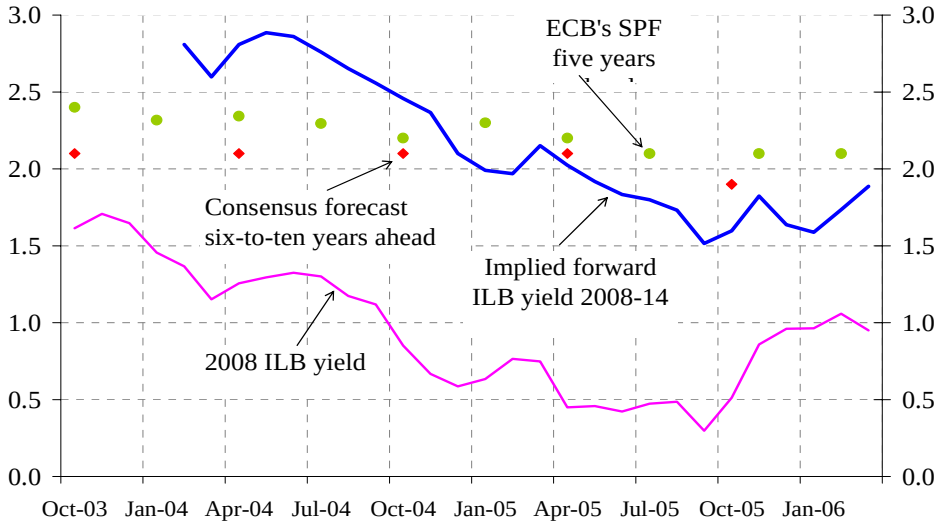
34. This condition implies that the pure expectations hypothesis of the term structure of interest rates, which neglects the existence of term premia, holds.

This decomposition shows that, although some fluctuations have been observable in the BEIR, long-term nominal and inflation-linked bond yields in the euro area have comoved substantially over the last few years. In particular, it is interesting to note the downward trend observable for most of the review period, particularly between mid-2004 and end-September 2005, which may point to somewhat more pessimistic views about economic activity in the euro area at that juncture. However, it has to be taken into account that the downward trend in real interest rates has been a global phenomenon that was also the subject of substantial interest and controversy among policy-makers and market participants in 2005.[35] Although both long-term real and nominal interest rates continue to be at relatively low levels by historical standards, the economic recovery that has become more clearly pronounced in the euro area since the first quarter of 2006 can be also observed in Chart 10.

Before drawing strong conclusions about growth prospects from this information, however, it may be helpful to look at a further decomposition of inflation-linked bond yields into implied forward yields, which, as with the indicator properties of BEIRs for inflation expectations, should be a more reliable indicator of market participants' long-term economic growth expectations. In addition, it is useful to compare them with survey data on long-term growth inflation expectations.

Chart 11 corroborates the impression of a decline in growth expectations for the euro area among market participants starting in mid-2004. In addition, it suggests that this downward revision was for both short and medium-to-long term horizons. Moreover, the apparent pessimism about long-term growth prospects that appears to be present in the implied forward yields on inflation-linked bonds seems to have been at least partly shared by participants in the surveys conducted in that period. For more recent periods, the information derived from inflation-linked bonds —both spot and implied yields— suggests improving economic growth prospects from the start of the third quarter of 2005 onwards.

Chart 11: Spot and implied forward inflation-linked bond (ILB) yields and survey measures of long-term real GDP growth expectations in the euro area



Source: Reuters, Consensus Economics and ECB.

35. See Greenspan (2005) for a brief and elegant exposition of the factors that may help to explain the low levels of real interest rates in global markets.

5 Concluding remarks

This Occasional Paper has reviewed the main arguments in favour of and against the issuance of inflation-linked debt in developed economies. It appears clear that the issuance of inflation-linked bonds and related inflation-linked derivatives offers important potential benefits to both sovereign issuers and private investors, for the further integration of European and global financial markets as well as for the development and management of pension assets and schemes in an era of ageing societies. All these factors may help to explain the significant growth experienced by this sector of the bond market in recent years.

From the perspective of an independent and credible central bank, the increasing issuance of inflation-linked bonds is on the one hand somewhat surprising, for the risks of high future inflation seem now to be lower than at any time in the past, so the need for an inflation hedge is debatable. Moreover, widespread indexation of economic and financial contracts is clearly neither necessary nor desirable. On the other hand, the issuance of inflation-linked bonds can be considered as a step conducive to the further broadening and deepening of financial markets, thus leading to additional efficiency gains in the provision of financial services in mature economies, both of which are positive developments from a central bank perspective. Fortunately, traditional concerns about the potential risks from the issuance of inflation-linked bonds for the implementation of monetary policy, i.e. that they may diminish public support for anti-inflationary policies or lead to widespread indexation, do not seem supported by evidence in countries with a relatively long tradition of indexed security issuance. It is likely that the increasing credibility of monetary policy has contributed decisively to such an outcome. As a matter of fact, the independence and credibility of central banks and the environment of low and stable inflation that they have established may have been among the most important reasons for the successful growth of the market for inflation-linked bonds in recent years.

Finally, it also has to be borne in mind that the issuance of inflation-linked bonds has explicit benefits for central banks. For example, it can provide specific information on changes in inflation and economic growth expectations among market participants, which is useful not only in the conduct of monetary policy but also in the communication of risks to price stability to the general public and market participants. Thus, the existence of inflation-linked bonds offers certain benefits to central banks, in addition to those for the issuers and investors.

Since the issuance of inflation-linked bonds began in the euro area, the ECB has regarded these instruments as a useful tool to obtain information on inflation expectations, and this information is assessed regularly in the context of the preparation and implementation of its monetary policy. The considerations behind this view have been explained in detail in this Occasional Paper, in particularly in Sections 3 and 4. They justify the efforts of the ECB to explain the information content of euro-denominated inflation-linked bonds to the public, either through regular references in its Monthly Bulletin and press conferences or in specific publications such as this Occasional Paper.

REFERENCES

ALONSO, F., R. BLANCO and A. DEL RÍO (2001). *Estimating inflation expectations using French government inflation-indexed bonds,* Banco de España, Working Paper Series No. 0111.

ALSTON, R. M., J. R. KEARL and M. B. VAUGHAN (1992). "Is there a consensus among economists in the 1990's?", *American Economic Review,* 82(2), *Papers and Proceedings,* pp. 203-209.

AMTE (EURO DEBT MARKET ASSOCIATION) (2005). "Inflation-linked products in the euro area: an AMTE working group to standardise, develop and promote the asset class", June.

ANDERSON, N., and J. SLEATH (2001). *New estimates of the UK real and nominal yield curves,* Bank of England, Working Paper Series No. 126.

ANG, A., G. BEKAERT and M. WEI (2006). *The term structure of real interest rates and expected inflation,* Columbia Business School, mimeo.

ARTUS, P. (2001). "Determinants of demand for inflation-indexed bonds", CDC IXIS Capital Markets, *Flash,* No. 2001-97.

BACH, G. L., and R. A. MUSGRAVE (1941). "A stable purchasing power bond", *American Economic Review,* 31(4), pp. 823-825.

BAGEHOT, W. (1875). "A new standard of value", *The Economist* (20 November), reprinted in *Economic Journal* (1892), 2(7), pp. 472-477.

BANK FOR INTERNATIONAL SETTLEMENTS (2005). *Zero-coupon yield curves: technical documentation,* BIS Paper No. 25.

BARCLAYS CAPITAL (2006). "Global inflation-linked products: a users' guide", January.

BARDONG, F., and T. LEHNERT (2004a). "European inflation-indexed government debt security markets: on efficiency", *Journal of Portfolio Management,* special issue, 30(4), pp. 226-238.

— (2004b). "TIPS, break-even inflation, and inflation forecasts", *Journal of Fixed Income,* December, pp. 15-35.

BARR, D. G., and J. Y. CAMPBELL (1997). "Inflation, real interest rates, and the bond market: a study of UK nominal and index-linked government bond prices", *Journal of Monetary Economics,* 39(3), pp. 361-383.

BARR, D. G., and B. PESARAN (1997). "An assessment of the relative importance of real interest rates, inflation, and term premiums in determining the prices of real and nominal U.K. bonds", *Review of Economics and Statistics,* 79(3), pp. 362-366.

BARRO, R. J. (1997). *Optimal management of indexed and nominal debt,* National Bureau of Economic Research, Working Paper Series No. 6197.

BERNANKE, B. (2004). "What policymakers can learn from asset prices", speech delivered before the Investment Analysts Society of Chicago, 15 April 2004.

BLANCHARD, O., and S. FISCHER (1989). *Lectures on macroeconomics,* Cambridge, Massachusetts: The MIT Press.

BNP PARIBAS (2005). "The global inflation market", BNP Paribas Fixed Income, London.

BODIE, Z. (1997). "Inflation-protected retirement plans", in De Cecco et al. (1997), pp.33-49.

BOGAERT, H., and P. MERCIER (1984). "Emprunts d'Etat indexés: instruments de gestion de la dette?", in *Rapport préparatoire du 6ème congrès des économistes belges de langue française,* Commission 2, Centre Interuniversitaire de Formation Permanente, pp.177-210.

BOHN, H. (1988). "Why do we have nominal government debt?", *Journal of Monetary Economics,* 21(1), pp. 127-140.

BOMHOFF, E. J. (1983). "Indexatie van de Staatsschuld", *Rotterdamse Monetaire Studies,* No. 12.

BREEDON, F. J. (1995). "Bond prices and market expectations of inflation", Bank of England, *Quarterly Bulletin,* May, pp. 160-165.

BREEDON, F. J., and J. S. CHADHA (1997). *The information content of the inflation term structure,* Bank of England, Working Paper Series No. 75.

BURASCHI, A., and A. JILTSOV (2005). "Inflation risk premia and the expectations hypothesis", *Journal of Financial Economics,* 75(2), pp. 429-490.

CAMPBELL, J. Y., and R. J. SHILLER (1996). *A scorecard for indexed government debt,* National Bureau of Economic Research, Working Paper Series No 5587.

CAMPBELL, J. Y., and L. M. VICEIRA (2001). "Who should buy long-term bonds?", *American Economic Review,* 91(1), pp. 99-127.

— (2002). *Strategic asset allocation: portfolio choice for long-term investors,* Clarendon Lectures in Economics, Oxford: Oxford University Press.

CAMPBELL, J. Y., Y. L. CHAN and L. M. VICEIRA (2003). "A multivariate model of strategic asset allocation", *Journal of Financial Economics,* 67(1), pp. 41-80.

CAPPIELLO, L., and S. GUÉNÉ (2005). *Measuring market and inflation risk premia in France and in Germany,* ECB, Working Paper Series No. 436.

CARLSTROM, C. T., and T. S. FUERST (2004). "Expected inflation and TIPS", Federal Reserve Bank of Cleveland, *Economic Commentary,* November.

CHRISTENSEN, I., F. DION and C. REID (2004). *Real returns, inflation expectations and the break-even inflation rate,* Bank of Canada, Working Paper Series No. 2004-43.

CREDIT (2005). "Inflation-linked bonds", July/August, pp. 37-41.

DE CECCO, M., L. PECCHI and G. PIGA (eds.) (1997). *Managing public debt: index-linked bonds in theory and practice,* Cheltenham: Edward Elgar.

DEACON, M., and P. ANDREWS (1996). "The use and value of index-linked bonds", *The Financier,* Vol.3(4 and 5), p. 13ff.

DEACON, M., and A. DERRY (1994). *Deriving estimates of inflation expectations from the prices of UK Government bonds,* Bank of England, Working Paper Series No. 23.
DEACON, M., A., DERRY and D. MIRFENDERESKI (2004). *Inflation-indexed securities: bonds, swaps and other derivatives,* New York: Wiley Finance, second edition.
DEUTSCHE BANK (2001). "Euroland inflation-indexed OATs: a new instrument for broader inflation protection".
— (2004a). "Inflation-linked bonds", Fixed Income Research Series.
— (2004b). "Inflation-indexed JGBs", Japan Relative Value Research.
DRESDNER KLEINWORT WASSERSTEIN (2004). "Supply strategist – March 2004: the birth of inflation-linked JGBs".
DRUDI, F., and R. GIORDANO (2000). "Wage indexation, employment and inflation", *Scandinavian Journal of Economics,* 102(4), pp. 645-668.
ECB (2004a). "The natural real interest rate in the euro area", Monthly Bulletin, May.
— (2004b). "Extracting information from financial asset prices", Monthly Bulletin, November.
EMMONS, W. R. (2000). "The information content of Treasury Inflation-Indexed Securities", Federal Reserve Bank of St Louis, *Review*, November/December, pp. 25-37.
EVANS, M. (1998). "Real rates, expected inflation and inflation risk premia", *Journal of Finance,* 53(1), pp. 187-218.
EVANS, M. D., and K. K. LEWIS (1995). "Do expected shifts in inflation affect estimates of the long-run Fisher relation?", *Journal of Finance,* 50(1), pp. 225-253.
FAVERO, C., A. MISSALE and G. PIGA (2000). *EMU and Public Debt Management: One Money, One Debt?,* Centre for Economic Policy Research, Policy Paper Series No. 3.
FINANZAGENTUR (2006). "Federal Republic of Germany inaugural eurozone inflation linked bond issue".
FISCHER, S. (1975). "The demand for index bonds", *Journal of Political Economy,* 83(3), pp. 509-534.
— (1983). "Indexing and inflation", *Journal of Monetary Economics,* 12(4), pp. 519-541.
FISCHER, S., and L. SUMMERS (1989). "Should governments learn to live with inflation?", *American Economic Review* 79(2), *Papers and Proceedings,* pp. 382-388.
FISHER, W. C. (1913). "The tabular standard in Massachusetts history", *Quarterly Journal of Economics,* 27(3), pp. 417-454.
GAPEN, M. T. (2003). "Seasonal indexation bias in US Treasury Inflation-indexed Securities", *Applied Financial Economics,* 13(7), pp. 509-516.
GARCIA, J. A. (2003). *An introduction to the ECB's Survey of Professional Forecasters,* ECB, Occasional Paper Series No. 8.
GONG, F. F., and E. M. REMOLONA (1996). *Inflation risk in the U.S. yield curve: the usefulness of indexed bonds,* Federal Reserve Bank of New York, Research Paper Series, No. 9637.
GOTO, S., and W. TOROUS (2003). *The conquest of U.S. inflation: its implications for the Fisher hypothesis and the term structure of nominal interest rates,* mimeograph.
GREENSPAN, A. (2005). "Intervention in the central bank panel discussion", International Monetary Conference, Beijing, People's Republic of China (via satellite), June 6.
GROUP OF TEN (2005). "Ageing and pension system reform: implications for financial markets and economic policies", report by an expert group chaired by I. Visco.
HETZEL, R. L. (1992). "Indexed bonds as an aid to monetary policy", Federal Reserve Bank of Richmond, *Economic Review*, January/February, pp. 13-23.
HSBC (2003). "UK index-linked gilts: A guide to the market".
HUMPHREY, T. M. (1974). "The concept of indexation in the history of economic thought", Federal Reserve Bank of Richmond, *Economic Review,* November/December, pp. 3-16.
HUNTER, D., and D. SIMON (2005). "Are TIPS the 'real' deal? A conditional assessment of their role in a nominal portfolio", *Journal of Banking and Finance,* 29(2), pp. 347-368.
IFR (2002). "Matching pension liabilities", *IFR Review,* July.
ISSING, O. (1973). *Indexklauseln und Inflation*, Vorträge und Aufsätze 40, Walter Eucken Institut, Tübingen: J.C.B. Mohr (Paul Siebeck).
KANDEL, S., A. OFER and O. SARIG (1996). "Real interest rates and inflation: an ex ante empirical analysis", *Journal of Finance,* 51(1), pp. 205-225.
KIM, D., and J. WRIGHT (2005). *An arbitrage-free three-factor term structure model and the recent behaviour of long-term yields and distant horizon forward rates,* Board of Governors of the Federal Reserve Board, Finance and Economics Discussion Series No. 33.
KITAMURA, Y. (1997). "Indexed bonds and monetary policy: the real interest rate and the expected rate of inflation", Bank of Japan, *Monetary and Economic Studies,* 15(1), pp.1-25.
— (2004). "Information content of inflation-indexed bond prices: evaluation of U.S. Treasury Inflation-Protection Securities", Bank of Japan, *Monetary and Economic Studies,* 22(3), pp. 115-143.
KOPCKE, R. W., and R. C. KIMBALL (1999). "Inflation-indexed bonds: the dog that didn't bark", *New England Economic Review,* January/February, pp. 3-24.
KOTHARI, S. P., and J. SHANKEN (2004). "Asset allocation with inflation-protected bonds", *Financial Analysts Journal*, January/February, pp. 54-70.
LAATSCH, F. E., and D. P. KLEIN (2003). "Nominal rates, real rates, and expected inflation: results from a study of U.S. Treasury Inflation-Protected Securities", *Quarterly Review of Economics and Finance,* 43(3), pp. 405-417.
LAHIRI, K., C. TEIGLAND and M. ZAPOROWSKI (1988). "Interest rates and the subjective probability distribution of inflation forecasts", *Journal of Money, Credit and Banking,* 20(2), pp. 233-248.
LAMM, R. M. (1998). "Asset allocation implications of inflation protection securities", *Journal of Portfolio Management,* 24(4), pp. 93-100.
LIVIATAN, N., and D. LEVHARI (1977). "Risk and the theory of indexed bonds", *American Economic Review,* 67(3), pp. 366-375.
LUCAS, G., and T. QUEK (1998). "A portfolio approach to TIPS", *Journal of Fixed Income,* December, pp. 75-84.

MAMUN, A., and N. VISALTANACHOTI (2005). *Diversification benefits of Treasury Inflation Protected Securities: an empirical puzzle,* mimeograph.
MCCULLOCH, J. H. (1980). "The ban on indexed bonds, 1933-77", *American Economic Review,* 70(5), pp. 1018-1021.
MCCULLOCH, J. H., and L. A. KOCHIN (2000). *The inflation premium implicit in the US real and nominal term structures of interest rates,* The Ohio State University, Working Paper No. 98-12, revised September 2000.
MERCIER, P. (1985). "Les emprunts d'Etat indexés", *Revue de la Banque,* Centres d'études financières, Brussels.
MISHKIN, F. S. (1992). "Is the Fisher effect for real? A re-examination of the relationship between inflation and interest rates", *Journal of Monetary Economics,* 30(2), pp. 195-215.
MIZUHO SECURITIES (2004). "Inflation-indexed JGBs".
MORGAN STANLEY (2002). "Inflation-linked bonds".
MUNNELL, A. H., and J. B. GROLNIC (1986). "Should the U.S. government issue index bonds?", *New England Economic Review,* September/October, pp. 3-21.
NATIONAL BANK OF NEW ZEALAND (1995). "Inflation-linked bonds: a New Zealand guide".
NELSON, C. R., and A. F. SIEGEL (1987). "Parsimonious modeling of yield curves for U.S. Treasury yields", *Journal of Business,* Vol. 60(4), pp. 473-489.
PECCHI, L., and G. PIGA (1997). "Who is afraid of index-linked bonds?", in De Cecco et al. (1997), pp. 173-194.
PERSSON, M. (1997). "Index-linked bonds: the Swedish experience", in De Cecco et al. (1997), pp. 18-32.
PRICE, R. (1997). *The rationale and design of inflation-linked bonds,* International Monetary Fund, Working Paper Series No. WP/97/12.
REMOLONA, E. M., M. WICKENS and F. F. GONG (1998). "What was the market's view of UK monetary policy? Estimating inflation risk and expected inflation with indexed bonds", Federal Reserve Bank of New York, Staff Reports No 57.
RESCHREITER, A. (2004). "Conditional funding costs of inflation-indexed and conventional government bonds", *Journal of Banking and Finance,* 28(6), pp. 1299-1318.
ROLL, R. (2004). "Empirical TIPS", *Financial Analysts Journal,* January/February, pp. 31-53.
SACK, B. (2000). *Deriving inflation expectations from nominal and inflation-indexed Treasury yields,* Board of Governors of the Federal Reserve System, Finance and Economics Discussion Series No. 2000-33.
— (2003). *A monetary policy rule based on nominal and inflation-indexed Treasury yields,* Board of Governors of the Federal Reserve System, Finance and Economics Discussion Series No. 2003-7.
SACK, B., and R. ELSASSER (2004). "Treasury inflation-indexed debt: a review of the U.S. experience", Federal Reserve Bank of New York, *Economic Policy Review,* May, pp. 47-63.
SAMUELSON, L. (1988). "On the effects of indexed bonds in developing countries", *Oxford Economic Papers,* 40(1), pp. 168-192.
SARNAT, M. (1973). "Purchasing power risk, portfolio analysis, and the case for index-linked bonds – a Comment by Marshall Sarnat", *Journal of Money, Credit, and Banking,* 5(3), pp. 836-845.
SCHOLTES, C. (2002). "On market-based measures of inflation expectations", Bank of England, *Quarterly Bulletin,* Spring, pp. 67-77.
SCOBIE, H. M., S. PERSAUD and C. CAGLIESI (1999). *Pension fund management within the EU,* London: Risk Books.
SHEN, P. (1995). "Benefits and limitations of inflation indexed Treasury bonds", Federal Reserve Bank of Kansas City, *Economic Review,* third quarter, pp. 41-56.
— (1998). "Features and risks of Treasury Inflation Protection Securities?", Federal Reserve Bank of Kansas City, *Economic Review,* first quarter, pp. 23-38.
SHEN, P., and J. CORNING (2001). "Can TIPS help identify long-term inflation expectations?", Federal Reserve Bank of Kansas City, *Economic Review,* fourth quarter, pp. 61-87.
SHILLER, R. J. (2003). *The invention of inflation-indexed bonds in early America,* National Bureau of Economic Research, Working Paper Series No. 10183.
SPIEGEL, M. M. (1998). Central bank independence and inflation expectations: evidence from British index-linked gilts", Federal Reserve Bank of San Francisco, *Review,* 1, pp. 3-14.
TAYLOR, N. (2000). "US inflation-linked bonds in the long run: a hypothetical view", *Applied Financial Economics*, 10(6), pp. 667-677.
TOBIN, J. (1963). "An Essay on principles of debt management", Cowles Foundation Paper 195, Reprinted from *Fiscal and Debt Management Policies,* Commission on Money and Credit.
TOWNEND, J. (1997). "Index-linked government securities: the UK experience and perspective", in De Cecco et al. (1997), pp. 1-17.
TRICHET, J.-C. (2005). "Credible alertness", intervention at the panel discussion "Monetary policy strategies: a central bank panel", at the symposium sponsored by the Federal Reserve Bank of Kansas City, Jackson Hole, Wyoming, 27 August 2005.
VIARD, A. D. (1993). "The welfare gain from the introduction of indexed bonds", *Journal of Money, Credit and Banking,* 25 (3), pp. 612-628.
WAGGONER, D. F. (1997). *Spline methods for extracting interest rate curves from coupon bond prices,* Federal Reserve Bank of Atlanta, Working Paper Series No. 97-10.
WERKGROEP REËLE BEGROTING (2005). "Indexleningen".
WERNER, T., J. EJSING and J. A. GARCIA (2007). *Estimating real and inflation term structures using euro area inflation-linked bond data,* ECB Working Paper series, forthcoming.
WILCOX, D. W. (1998). "The introduction of indexed government debt in the United States", *Journal of Economic Perspectives,* 12 (1), pp. 219-227.
WILLEN, P. (2005). "New financial markets: who gains and who loses", *Economic Theory,* 26 (1), pp. 141-166.
WOODWARD, T. G. (1990). "The real thing: a dynamic profile of the term structure of real interest rates and inflation expectations in the United Kingdom, 1982-89", *Journal of Business,* 63 (3), pp. 373-398.
WRASE, J. (1997). "Inflation-indexed bonds: how do they work?", *Business Review,* July/August, Federal Reserve Bank of Philadelphia, pp. 3-16.

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