CGFS Working Group on

Institutional Investors, Global Savings and Asset Allocation

What accounts for the low level of interest rates?[1]

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Executive Summary

In recent years, long-term yields in global bond markets remained at levels which can be regarded as very low both in absolute terms and relative to macroeconomic fundamentals such as economic growth and inflation. In particular, the fact that US long-term yields showed little response to the monetary policy tightening sequence conducted by the Federal Reserve has been recognized as unusual. The apparent lack of a consistent story explaining all aspects of unusual bond market behaviour in real time led former Fed Chairman Greenspan to dub the phenomenon of low bond yields a "conundrum".

This paper summarises the available evidence on the most commonly mentioned explanatory factors behind low long-term interest rates in some major global bond markets, namely those of the euro area, the United Kingdom and the United States. The analysis concludes that the low level of long-term interest rates observed over recent years has most probably been the result of a confluence of several factors:

- ***The observed pronounced decline in realised and expected inflation and in general the successful anchoring of long-term inflation can help explain the marked declined in nominal long-term rates since the 1980s, but less so over recent years.***
- ***There is little ground to support the view of a permanent reduction in the natural rate, related to expectations of growth or of demographics, at least in the United States, over the past couple of years.***

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- ***The decline of long-term real interest rates in 2004 and 2005, at a time of tightening of monetary policy and robust economic growth, remains particularly unusual. There is evidence from econometric term structure models suggesting that long-term rates, in particular long-term forward rates, declined to a large extent on account of lower risk premia. A contribution to the decrease of risk premia embedded in long-term real rates could have stemmed from improved credibility of central banks, which may have reduced the risk of observing big swings in real rates which may be needed to control inflation. In addition, there are indications that macroeconomic volatility may have also declined over time. However, it is difficult to establish whether the decline of risk premia on account of these factors could have played a significant role in 2004-2006.***

- ***Other factors may have therefore contributed to the decline in long-term interest rates and related risk premia. For the United States, the most often quoted factor has been the purchase of Treasury bonds related to inflows of capital into the United States of public entities (mainly central banks) and of private investors mainly from Asia and oil-exporting countries. The econometric evidence in this respect is very mixed. It cannot be ruled out that the additional demand of foreign investors may have contributed to the low level of real interest rates but that such effect has gradually vanished in the course of 2005. After the rebound observed in the last part of 2005 and in 2006, long-term real interest rates have reached levels more in line with long-term fundamentals.***

- ***In the United Kingdom, the extent of the possible portfolio reallocation related to regulatory changes seems to have significantly affected the level of long-term interest especially during the period 2004-2006.***

- ***Changes in accounting and pension regulations do not seem to have been the main driving force affecting the level of long-term interest rates in the United States. Such changes are not yet entirely defined and may imply in any case a portfolio reallocation which should be absorbed without major impact on bond yields.***

- ***In the euro area, there is less evidence that the level of long-term interest rates has been very low. Although flows of institutional investor into bonds has been sizeable for several years, major legislative changes have or are effecting the Netherlands only and this should have a limited impact on long-term nominal interest rates for the entire euro area.***

All in all, one can conclude from the analysis presented in this paper that although most of the explanatory factors are likely to have contributed to the observed declines in long-term interest rates in the major markets, it is extremely difficult to gauge the quantitative extent – or even the very existence - of each contribution.

1. Introduction

In recent years, the low level of long-term yields in global markets has puzzled market observers and policy makers. In particular, the fact that US long-term yields showed little response to the monetary policy tightening sequence conducted by the Federal Reserve has been recognized as unusual. In turn, long-term implied forward yields and also corresponding term premia estimated from term structure models have reached or remained at historically low levels, possibly related to increasing stability of both inflation expectations and real output growth.

The paper will review at first in Section 2 whether nominal yields declined on account of lower inflation expectations in some of the major markets (United States, United Kingdom and the euro area). The observed pronounced decline in realised and expected inflation and in general the successful anchoring of long-term inflation expectations provide a convincing explanation for the marked declined in nominal long-term rates since the 1980s, but less so over recent years.

The decline in real yields will be tackled next. First, a historical comparison will try to identify whether indeed real rates have remained at levels too low from a long-term viewpoint (Section 3). Subsequently, the paper will review the main potential factors explaining a decline in real rates. Several fundamental factors have been identified in this respect, mainly related to the expected equilibrium real interest rate. As a part of this analysis, increasing retirement savings related to demographic developments in industrial countries have also been mentioned as a factor contributing to an ongoing decline in equilibrium real yields. Besides expectation components, the decline in long-term rates has been linked to a compression of risk premia (Section 4), on account for example of lower macroeconomic variability (both nominal and real).

Finally, the paper will review other possible factors which may have contributed to the compression of risk premia in long-term real and nominal interest rates maybe below their long-term equilibrium levels (Section 5). In this respect a first prominent explanation is the accumulation of dollar reserves in the form of US bonds by foreign official institutions, in particular Asian central banks, as a result of continued foreign exchange intervention associated with the paradigm of export-led growth, and by oil-exporting countries. A variant of this argument is the famous ‘savings glut’ hypothesis of Federal Reserve Chairman Bernanke. A second potential source which may have driven yields below equilibrium are temporarily increased (net) corporate savings in industrial countries, associated with attempts

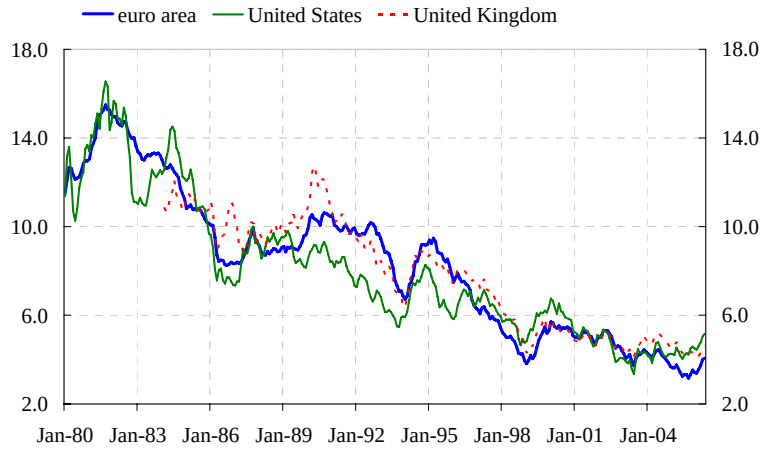
of corporate enterprises to strengthen their balance sheets. Finally, the paper will review as an additional factor the potential increase in bond demand by institutional investors, associated with changing regulations requiring a better matching of assets and liabilities, which may have contributed to drive down in particular the long-end of the yield curve.

Section 6 will conclude.

Section 2: The decline in nominal long-term interest rates and expected inflation

Nominal long-term interest rates have declined steadily over the past twenty years (Chart 1). This trend was set in motion in the early 1980s and continued during the 1990s and in the new century and characterised developments in the three areas which have been analysed (United States, euro area and United Kingdom) broadly in a similar way.

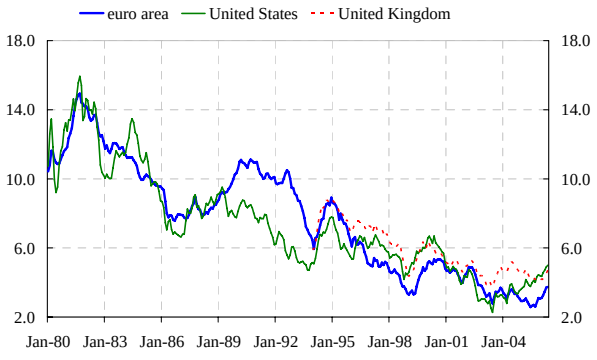
Chart 1: Long-term nominal interest rates (in %, monthly data, Jan. 1980 to May 2006)



Sources: BIS, Reuters and Bank of England.

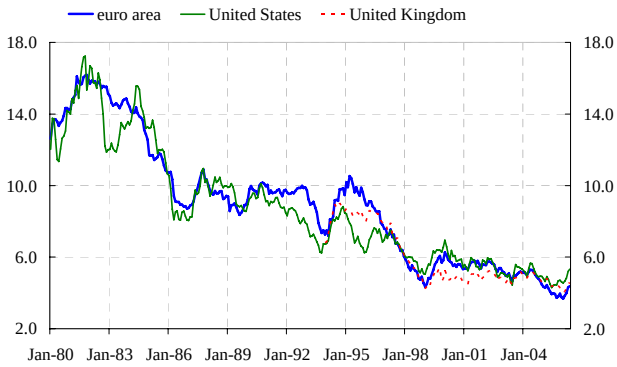
The decomposition of 10-year nominal interest rates into spot and forward interest rates suggests that financial markets gradually expected over time lower nominal interest rates in the long-run (measured by five-year forward interest rates five-year ahead) or at least required a significant lower compensation for bearing the nominal interest rate risk at long maturities (Charts 2 and 3).

Chart 2: Five year nominal interest rates (in %; monthly data, Jan 1980 to May 2006)



Sources: Reuters, Bank of England and BIS.

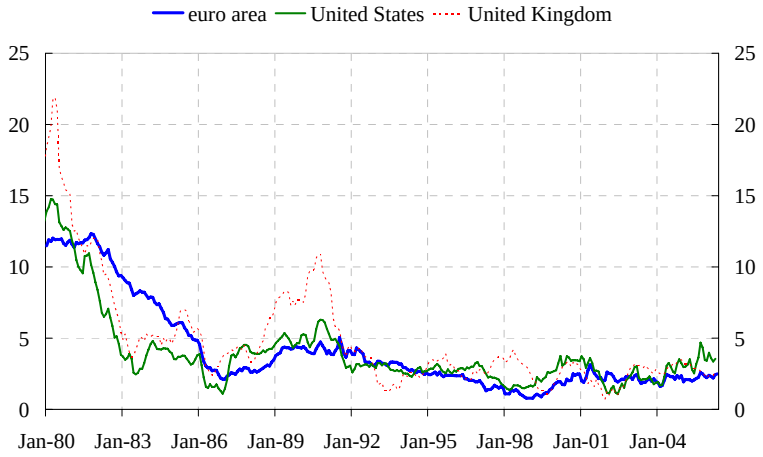
Chart 3: Five-year forward nominal interest rates five year ahead (in %; monthly data, Jan 1980 to May 2006)



Sources: Reuters, Bank of England, BIS, St. Louis Federal Reserve and ECB calculations.

The first 'candidate' to explain such a decline in nominal interest rates at all maturities is the decline in inflation and expected inflation. In fact, actual inflation (Chart 4) declined significantly especially in the 1980s, and further during the 1990s.

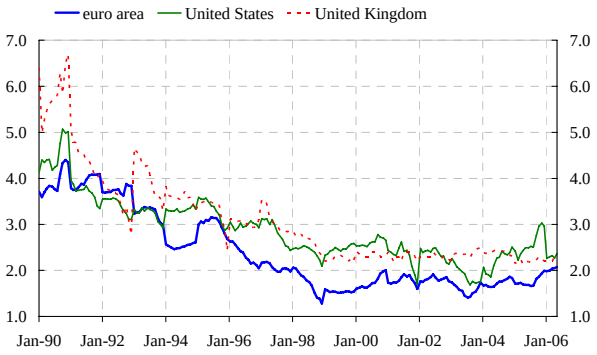
Chart 4: Inflation rates (in %, monthly data, Jan. 1980 to May 2006)



Sources: Eurostat, UK National Statistics office, St. Louis Federal Reserve.
Note: For the UK the RPI index is shown.

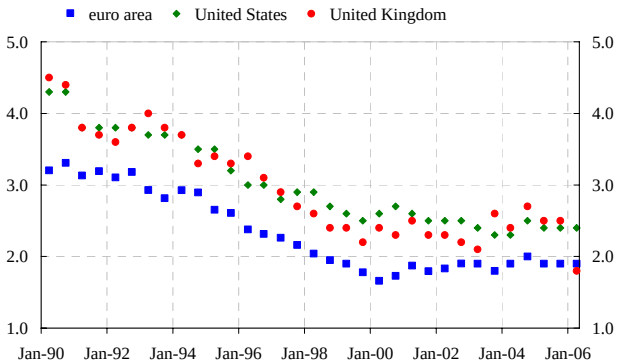
Measures of inflation expectations at short horizons and at longer horizons (see Charts 5 and 6), for which comparable data are available since the early 1990s, point to a significant decline during the past decade in the three areas.

Chart 5: One-year ahead survey based inflation expectations (in %; monthly data, Jan 1990 to May 2006)



Source: Consensus Economics.

Chart 6: Six to ten year ahead survey based inflation expectations (in %; monthly data, Jan 1990 to May 2006)



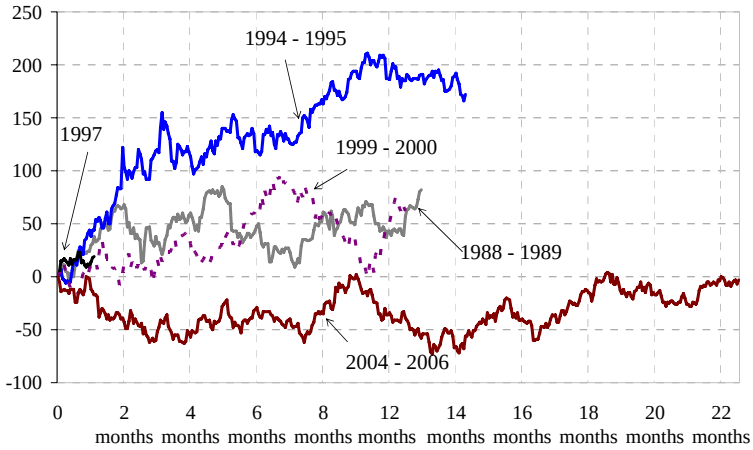
Source: Consensus Economics.

As it is evident from the above charts, a large part of the downward trend in nominal long-term interest rates was therefore associated with a decline in inflation and inflation expectations.

It is, however, remarkable that the decline in nominal yields has indeed continued over the past couple of years, until September 2005, in a period when inflation expectations stabilised and real economic growth was sustained or increasing. Furthermore, this has occurred in a period of tightening of monetary policy, which is a bit unusual. A comparison with past episodes of monetary tightening indicates that it is in fact normal for long-term rates to increase especially during the first period of a tightening cycle.

Chart 7 illustrates developments in 10-year rates over the most tightening periods of the Federal Reserve System. The current episode is quite different especially from the 1994-1995 tightening cycle, when long-term interest rates were possibly influenced by the so called 'inflation scare'. The difference is less striking with respect to the episode of 1988-1999 which was, however, followed quite soon by a period of low growth.

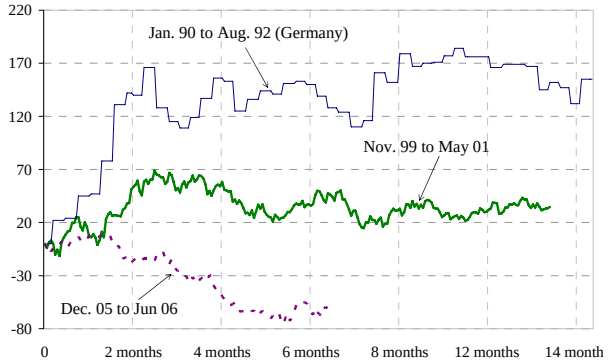
Chart 7: Reaction of ten-year bond yields to monetary policy tightening in the United States (in bp, daily data)



Sources: St. Louis Federal Reserve and ECB calculations.

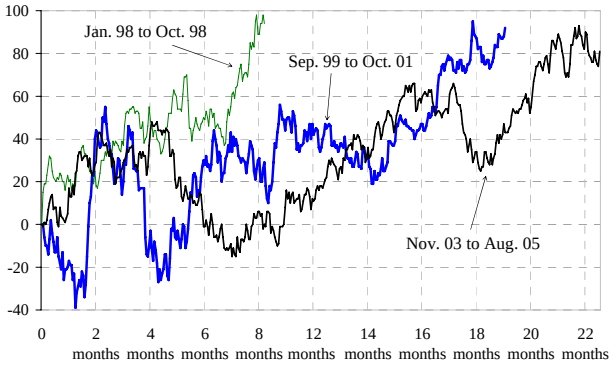
For what concerns the last tightening cycle of the Bundesbank (Chart 8) and subsequently the monetary actions undertaken by the ECB (after 1999), in the two previous tightening episodes (Jan. 90 to Aug. 92 and Nov. 99 to May 01) bond yields tended to move up at the start of the tightening cycle, although, especially in 1999-2001 the movement had been relatively muted.

Chart 8: Reaction of ten-year bond yields to monetary policy tightening in Germany and the euro area (in bp, daily data)



Sources: Bundesbank, Reuters and ECB calculations.

Chart 9: Reaction of ten-year bond yields to monetary policy tightening in the United Kingdom (in bp, daily data)



Sources: Bank of England and ECB calculations.

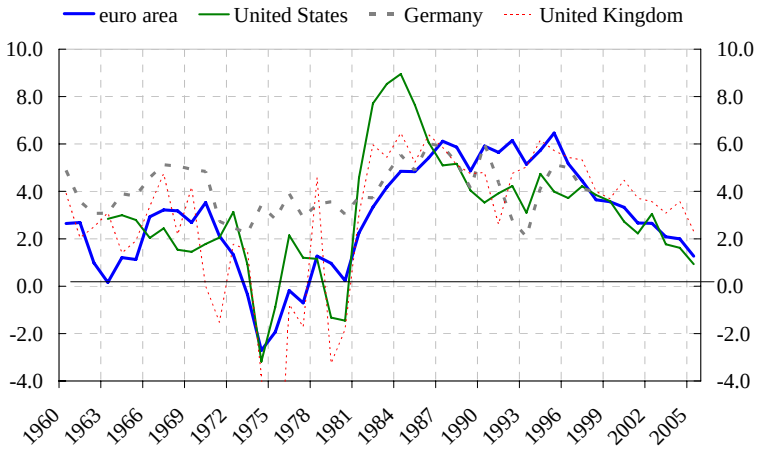
Overall, with the partial exception of the episode of 1999-2001 in the United Kingdom, the recent developments in bond yields, especially during the early stages of a tightening cycle, has been quite unusual, although a simple generalisation is hard to establish as macroeconomic conditions and monetary policy frameworks were different across countries and across time.

Section 3: The decline in real interest rates

Differently from nominal long-term interest rates, the decline in real long-term interest rates occurred mainly during the 1990s, especially in the second half of the decade, and continued over recent years, until the second half of 2005. This is true irrespective of the measure of real interest rates.

A first rough measure of long-term real interest rates, for which long-series are available, could be obtained by deflating nominal long-term interest rates by actual inflation (Chart 10). According to this measure, real interest rates declined almost continuously as from the mid-1990s and reached low levels in 2005, although not very far from levels realised in the 1960s, before the period of turmoil related to the collapse of the Bretton Woods system and the first oil shock.

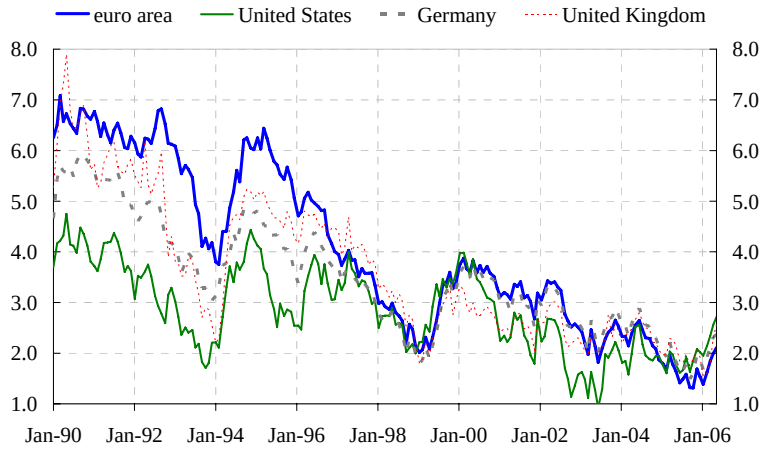
Chart 10: Long-term real interest rates (in %, annual data)



Sources: St. Louis Federal Reserve, UK National Statistics Office, Eurostat, Bundesbank, Global Financial Data and ECB calculations.

Ex-ante measures of the real interest rates (measured as nominal long-term interest rates deflated by inflation expectations at various maturities) provide a more precise, albeit similar, picture (Chart 11) and indicate that after the prolonged period of decline a significant pick-up started in the second half of 2005 and continued in 2006. Clearly, ex-ante real interest rates may be also distorted by premia on inflation affecting the level of the nominal interest rate used in the computation.

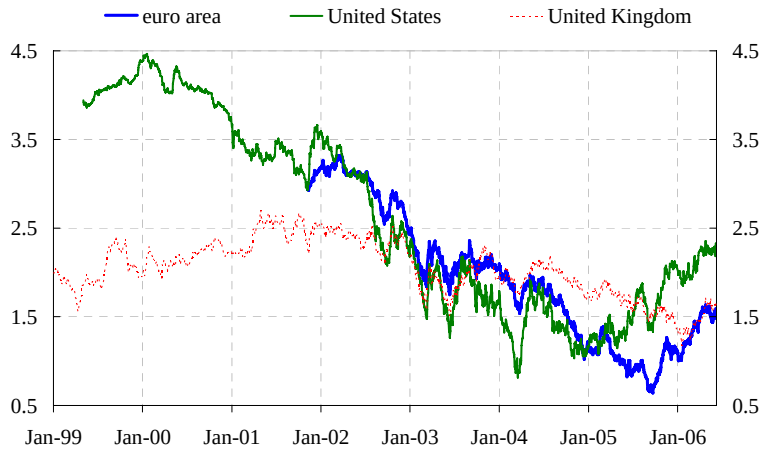
Chart 11: Long-term ex-ante real interest rates (in %, monthly data)



Sources: Reuters, Bank of England, Consensus Economics, Bundesbank and ECB calculations

Real yields on index–linked bonds avoid partly such distortion, as their level is in theory affected only by the expectation of the sequence of real rates over the relevant horizon and by risk premia related to the variability of real interest rates. At the same time, time-series of index-linked bonds are relatively short (with the exception of the United Kingdom) and, until few years ago, such yields may have been distorted by liquidity premia, especially in the United States and the euro area. These yields may provide an accurate gauge for developments in the period which is most central to the analysis, namely the phase of decline in real yields observed until late 2005 and the more recent period of rebound. Chart 12 illustrates in fact that spot yields on index-linked bonds with intermediate maturities declined to very low-levels in 2004 and 2005, to values which may be difficult to justify on the basis of the historical experience.

Chart 12: Inflation linked bond yields (in %, daily data)

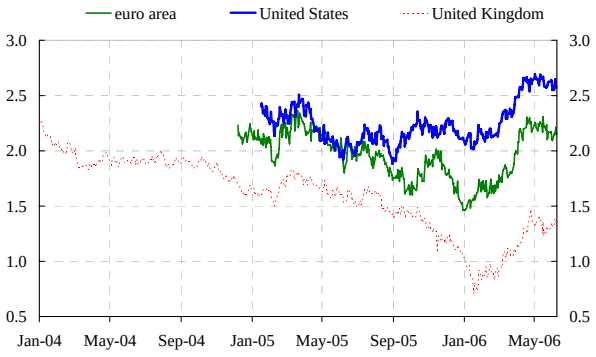


Source: Reuters.

Note: The inflation-linked bond yield with maturity 2012 is used for the euro area and for the United States the 2011 maturity is shown. For the United Kingdom the 2013 inflation-linked gilt is shown.

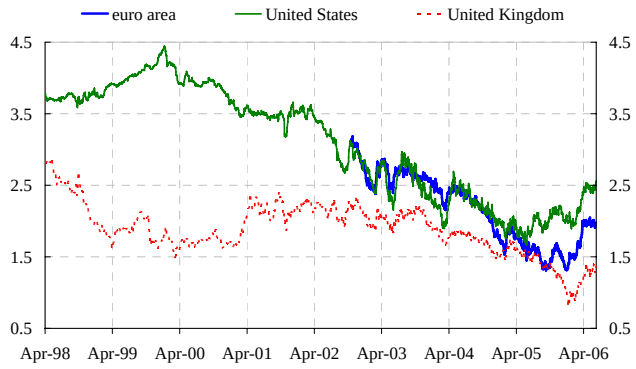
The computation of implied forward yields from inflation linked bonds (Charts 13) further indicates that a low level of real rates was expected to prevail for long-period of times. Yields on longer-dated securities (with maturities of around 2030) especially in the United Kingdom declined to even lower levels (Chart 14).

Chart 13: Implied forward inflation-linked bond yields (in %, daily data)



Sources: Reuters, Bank of England and ECB calculations.
Note: The inflation-linked bond yields with maturities 2012 and 2015 are used for the euro area and for the United States the 2011 and 2015 maturities. For the United Kingdom a ten year forward rate is shown.

Chart 14: Longer-term inflation linked bond yields (in %, daily data)



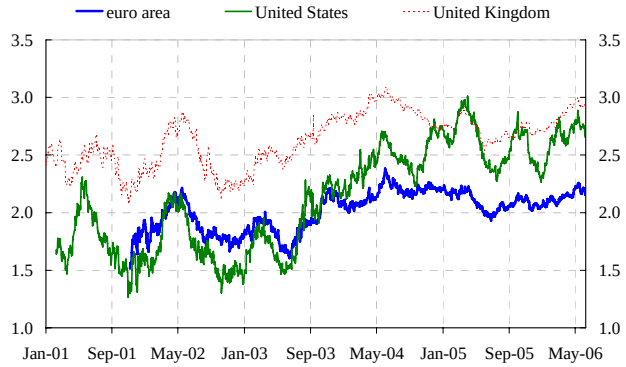
Source: Reuters.
Note: The inflation-linked bond yields with maturity 2032 is used for the euro area and for the United States the 2028 maturity. For the United Kingdom the 2030 is shown.

The question is therefore whether the decline in real rates around the world in 2004 and 2005 was too sharp and what may have accounted for it. In addition, was the level in mid-2006 still very low after the pick-up in late 2005 and in 2006? Was the decline in real rates too marked compared to that in nominal rates?

Some light on the first two questions could be shed by considering the concept and the implications of the of the natural rate, which will be analysed in section 3.1. Regarding the last questions, a simple way to assess the decline in real interest rate vis-à-vis that in nominal rate is to consider developments in break-even inflation rates (BEIRs), computed as the difference between yield on nominal and real bonds of comparable maturity. Developments in BEIRs (Charts 15 and 16) seem to indicate that the decline in real interest rates does not seem to have been excessive when compared to nominal rates, although some oscillations have been observed. In fact BEIRs remained at levels in line with long-term inflation expectations, obtained, for example, from surveys (see again Chart 6). Therefore, there is no *prima facie* evidence that a particular class of bonds has been affected in a particular way. So, when assessing, in section 5, the possible impact of special factors (including regulatory and

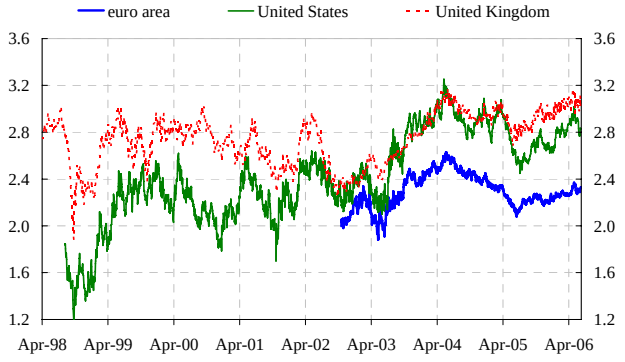
legislative changes) on the level of yields, it has to be taken into account that, if any, such changes seem to have affected nominal and real rates in a similar way, at least for maturities of up to ten years.

Chart 15: Break-even inflation rates (in %, daily data)



Sources: Reuters, and ECB calculations.
Note: The break-even inflation rates with maturities 2012 and 2015 are used for the euro area and for the United States the 2015 maturity. For the United Kingdom the 2013 Is shown.

Chart 16: Longer-term break-even inflation rates (in %, daily data)



Sources: Reuters and ECB calculations.
Note: The break-even inflation rates with maturity 2032 is used for the euro area and for the United States the 2028 maturity. For the United Kingdom the 2030 is shown.

3.1 The natural rate hypothesis

One of the most often quoted concept used to explain trend movements in real interest rates at long horizons is the so called ‘natural rate’. The concept of the natural rate has changed over time and recently there has been a growing attention paid to measures of the natural rate, also on account of the puzzling behaviour of real yields. According to one of the concepts, the natural rate is the steady state level of the real rate that has to prevail in a frictionless economy. Even this interpretation of the natural rate lends itself to various specifications, depending on the growth model which is underlying its computation. In general, however, models tend to relate this concept of the natural rate to the steady state rate of growth of the economy. Therefore, some light regarding the ‘movements’, if not on the ‘level’, of the natural rate implied in market expectations can be shed by looking at expectations of real growth in the long-term. A comparison could be then performed by plotting the level of long-term forward rates at comparable maturities.

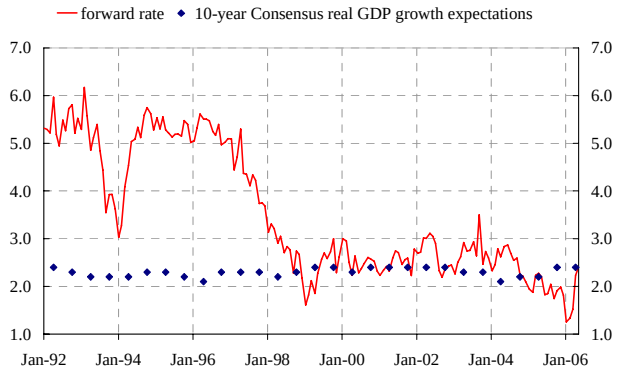
Such exercise indicate that, in the United States, the drop in forward real rates was not matched by a parallel decline in real growth expectations (Chart 17), which only marginally edged down in 2004 and 2005, at a time when long-term forward rates decline to very low levels.

Chart 17: Long-term real forward rates and growth expectations in the United States (in %, monthly data)

Source: Reuters, Consensus Economics and ECB calculations.

Note: Real forward rate measured by nominal five-year forward bond yield five years ahead less six to ten-year ahead Consensus inflation expectations. Growth expectations measured by six to ten-year ahead Consensus real GDP growth expectations.

Chart 18: Long-term real forward rates and growth expectations in the United Kingdom (in %, monthly data)



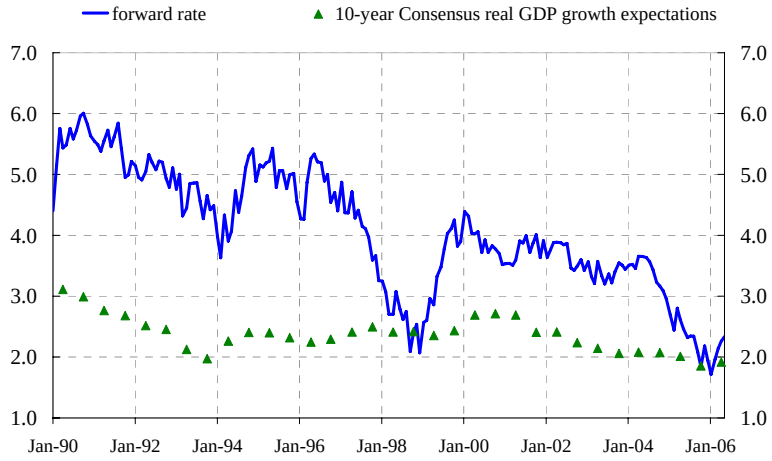
Source: Reuters, Consensus Economics and ECB calculations.

Note: Real forward rate measured by nominal five-year forward bond yield five years ahead less six to ten-year ahead Consensus inflation expectations. Growth expectations measured by six to ten-year ahead Consensus real GDP growth expectations.

A similar conclusion could be reached for the United Kingdom (Chart 18), where expected growth even increased in 2005. In addition, as it was mentioned, in the case of the United Kingdom the puzzle in real rates seems to be related even more to the very ultra-long real yields.

For what concerns the euro area (Chart 19), the downward movement in forward real rates at a time of little change in growth expectation is also puzzling, although the difference between the level of expected growth and of the real forward rate is quite modest. In all areas the upward movement in 2005 and 2006 led forward rates to a level closer to long-term growth expectations, although it has to be kept in mind that risk premia affect such comparison.

Chart 19: Long-term real forward rates and growth expectations in the euro area (in %, monthly data)



Source: Reuters, Consensus Economics and ECB calculations.

Note: Real forward rate measured by nominal five-year forward bond yield five years ahead less six to ten-year ahead Consensus inflation expectations. Growth expectations measured by six to ten-year ahead Consensus real GDP growth expectations.

A backward looking comparison indicates that, on average over the past 50 years, short-term real interest rates have been lower than the level of forward real yields prevailing in the United States in mid-2006 (Table 1). When performing such comparison it should be kept in mind, however, that over time the structure of the economy and of capital markets have changed, that premia may significantly affect the level of forward real yields and that trend growth has changed over time.

Table 1: Short-term real interest rates (in %, annual data)

	Germany/euro area	United States	United Kingdom
1960-1969	2.2	2.8	0.60
1970-1979	1.11	0.11	-3.90
1980-1989	2.64	4.35	5.40
1990-1998	2.59	2.17	4.38
1999-2006	1.00	0.89	2.89
1960-2006	1.91	2.06	1.87

Sources: Global Financial Data, Eurostat, Reuters and ECB calculations.

Note: Values for 2006 refer to latest available data. Before January 1999 Germany data is used and thereafter euro area data is shown. Short-term real rates are calculated as the difference between three-month deposit interbank rates minus year-on-year percentage changes of inflation

Other arguments have been proposed to explain a decline in the natural rate at present or in the future, which may or may not be captured by current growth expectations. Most

prominently, demographic trends have been identified as a possible source for such developments. Normally, such considerations seem to apply to virtually all industrialised countries, including the United States. At present, estimates for the euro area (where the demographic impact should be higher than in the United States) point to a decline in the range of only 30 to 80 basis points in the natural rate over 25 years (Kara and von Thadden 2006). In addition such estimates are conducted assuming a closed economy, which may lead to a too high estimate of the impact of demographic changes, taking into account convergence of real rates over sufficient long horizons at the global level. It is in any case unlikely that demographic trends may have suddenly affected suddenly long-term real rates in 2004 and 2005. All in all, explanations related to a "steady state" level of the real interest rate do not seem to explain the decline in real rate observed until late 2005, which may have been affected by some special factors.

Section 4: Bond market risk premia

Theory and evidence suggest that long-term interest rates do not only reflect market participants' expectations about the future developments in short-term interest rates - and thus about macroeconomic fundamentals such as growth and inflation -, but that long-term interest rates also contain risk premia. In general, such risk premia emerge from the fact that in an uncertain world, investors ask for a compensation to assume the specific risks implied by buying and holding a long-term bond relative to those implied by investing in alternative assets such as short-term interest rate instruments. However, bond market risk premia are not directly observable and thus need to be estimated. In this section, empirical evidence is first presented that indeed suggests that bond market risk premia have declined markedly to unusually low levels in major markets over recent years. Hence, this evidence suggests that an answer to the question as to why bond yields have become so low over recent years has to bear in mind factors that can help explain a decline in bond market risk premia. Several potential explanatory factors of declining term premia are therefore investigated in the subsequent sub-sections as well as in Section 5.

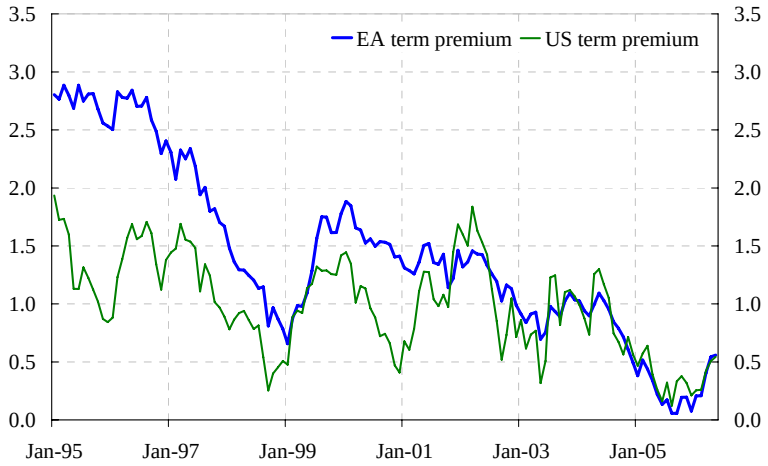
4.1 Risk premia in long-term bond yields have become very low

Bond market risk premia across the entire maturity spectrum can be consistently estimated on the basis of modern econometric models of the term structure of interest rates. Chart 20 displays time series of term premia embedded in ten-year zero-coupon interest rates in the euro area and the United States. In each case, the premium is estimated on the basis of a so-called affine term structure model which attempts to model term structure dynamics based on a few latent factors and no-arbitrage restrictions.[5] As can be seen from the chart, estimated term premia on ten-year yields markedly declined from around mid-2004 onwards both in the euro area and the United States to levels which can be regarded as very low in absolute terms and by historical standards. For example, from end-May 2004 to June 2005, the term premium declined by around 100 basis points in both markets, with the euro area premium becoming virtually zero as a result and the US term premium dropping to a level as low as 20 basis points at the end of that period. As a matter of fact, the decline in term premia is able to "explain" more or less entirely the concurrent decline in ten-year bond yields in both economies. Afterwards, term premia stabilised around such low levels until the end of 2005

[5] For the US case, see Kim, D.H. and J. H. Wright (2005). The model for the euro area, which contains two latent factors, is explained in Werner, T. (2006), "Term premia developments in the euro area: An affine term structure model estimated with survey data", mimeo.

and experienced a partial upward correction thus far in 2006 to stand at 60 basis points and 50 basis points by the end of May 2006 for the euro area and the United States, respectively. From a longer-term perspective, the evidence from Chart 20 suggests that a declining trend in term premia contributed to the observed trend in long-term interest rates more visibly in the euro area than in the United States over the last decade.

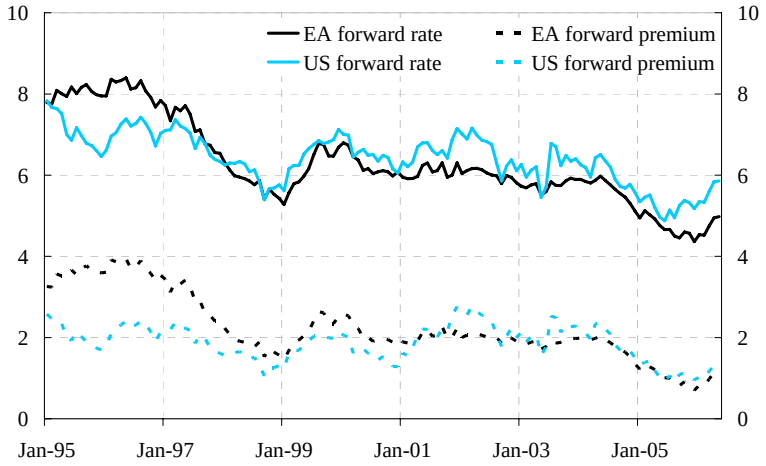
Chart 20: Term premia estimates for 10-year zero-coupon interest rates in the euro area and the U.S. (in % monthly data;)



Sources: Federal Reserve Board and ECB.

A further distinguishing feature of recent bond market developments has been the unusual decline in long-term forward rates. Indeed, the very pronounced drop in long-term forward rates in the US market constituted one of the main reasons why developments in the world bond markets were considered as a "conundrum" by the then Fed Chairman Greenspan in early 2005. Chart 21 shows long-term forward rates together with corresponding forward premia again for the euro area and the United States based on the same models as those underlying Chart 20. In the US case, for example, the strong fall in the ten-year-ahead instantaneous forward rate by 160 basis points between May 2004 and June 2005 was entirely driven by a lower risk premium which brought this forward rate to a new historical minimum. Similarly, in the euro area risk premia also declined most pronouncedly at the long-end of the yield curve.

Chart 21: Short-term forward rates 10 years ahead and corresponding forward premia in the euro area and the U.S. (in % monthly data)



Note: Euro area data refer to three-month forward rates, while US data refers to instantaneous forward rates.
Sources: Federal Reserve Board and ECB

However, the term premium estimates presented above rest on term structure models with latent factors only. Consequently, the developments in these premia and their presumed contribution to lower long-term bond yields remain silent about the ultimate driving factors in a structural economic sense. So-called macro-finance term structure models therefore may appear principally better suited for such purposes as they replace some latent factors driving yield curve developments by macroeconomic factors such as growth and inflation. Consequently, in this class of models term premia are linear function of the macroeconomic factors at hand which could facilitate interpreting variation of the premia over time. For example, Mönch (2005) obtains the result that term premia at the short end of the yield curve are more closely related to the business cycle whereas premia for longer yields seem to track inflation rather well. However, although term premia estimated on the basis of macro-finance models also showed some declines over recent years[6], they appear less able to explain the sharp drop in long-term bond yields by developments in term premia at least in the US case.[7] This typically gives rise to term premia estimates which are relatively high and thus either implied future interest rate expectations which appear rather, and maybe implausibly, low or relatively large model residuals. More generally, if one has a strong prior belief that various special factors not directly related to macroeconomic fundamentals had a strong bearing on bond yields, it is likely that such factors can be better captured by models with latent rather than macro factors as they impose less restrictions on the estimated term premia. Hence, in

[6] See, for example, Figure 5 in Mönch, E. (2005).

[7] See Rudebusch, G.D., Swanson, E.T. and T. Wu (2006).

what follows we try to provide in most cases indirect evidence on possible explanations behind the possible recent fall in bond market risk premia estimated on the basis of the above-mentioned latent-factor term structure models for the euro area and the United States. We therefore implicitly assume that the impact of these potential explanatory factors on the estimated term structure models show up mainly in the term premia estimates "as 'catch-all' measures that combine all of these effects".[8]

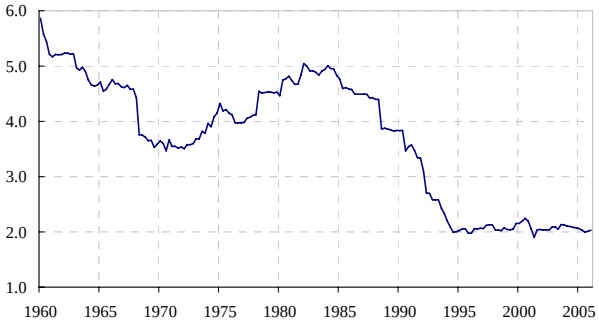
4.2 Lower macroeconomic volatility and stable inflation expectations

It has been argued that the longer-term trend decline in long-term interest rates is associated with the decline in volatility of macroeconomic variables. The intuitive logic of this argument runs as follows: Macroeconomic volatility affects the volatility of asset returns. Investors require compensation (risk or term premium) for the risks associated with the holding of assets such as long-term bonds, relative to investing in a revolving sequence of virtually risk-free short-term bonds. Thus, risk premia on long-term bonds, like risk premia on other assets, may be affected by the outlook on macroeconomic volatility. Under the presumption that the observed decline in macroeconomic volatility is persistent, the size of current risk premia may have fallen over time, and thus contributed to the decline in the yield of long-term bonds. At this aggregate level of discussion, the hypothesis that a decline in the volatility of macroeconomic variables may have reduced term premia of long-term bonds appears reasonably plausible.

During the past two decades, the volatility of US real GDP growth and other macroeconomic variables has declined considerably, compared to previous decades (see charts 22 and 23). While some observers explain this so-called "great moderation" by "good luck" (i.e., a sequence of smaller economic shocks), others refer to a greater success of economic and, in particular, monetary policies in stabilizing economic fluctuations.

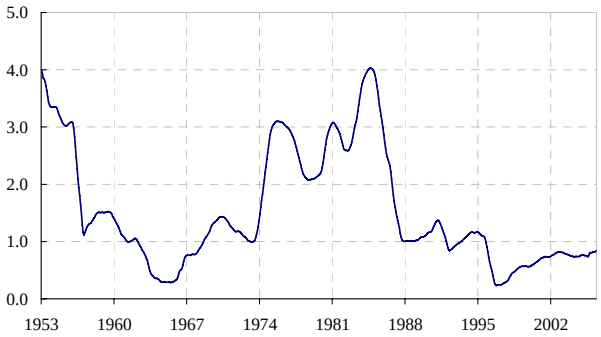
[8] D.H. Kim and J. H. Wright (2005), p. 5.

Chart 22: Standard deviation in real GDP annual growth rates (five year rolling window of quarterly data)



Sources: Bureau of Economic Analysis and ECB calculations.

Chart 23: Standard deviation in inflation annual growth rates (five year rolling window of monthly data)



Sources: Federal Reserve and ECB calculations.

Two main reasons seem to be mainly responsible for the decline in economic fluctuations. First, structural changes increased the flexibility of the economies of the industrialised countries in the presence of shocks. For example, more rigid economic structures and severe exogenous shocks in the 1970s and early 1980s were the main cause for high economic uncertainty during these decades. By contrast, the opening up to free trade and international capital flows during the 1980s allowed economies to adjust to exogenous shocks in a smoother manner and therefore macroeconomic flexibility and stability have increased.

Second, better monetary policy has been a major contributor to increased economic stability. The fight by central banks against inflation since the mid-1980s worked to halt the level of uncertainty faced by investors. So, monetary policy played an important role in stabilizing inflation and as such real growth developments. The fact that output volatility has declined in parallel with inflation volatility, suggests that monetary policy may have helped moderate the variability of output as well.

BOX: The "Great Moderation": A literature survey

Often, it has been cited that the low levels in macroeconomic volatility is purely a result of "good luck". This is reflected in the shocks that hit the economy that became smaller and more infrequent. According to Bernanke (2004) "if this hypothesis is true, it is entirely possible that the variability of output growth and inflation in the United States, at some point, return to the levels of the 1970s".

As it is shown in the charts volatility of real GDP growth in the United States has fallen by half since the early 80's. Inflation also stabilized around then, although only when compared with a shorter period of volatility in the 1970s. Several studies have examined the above

mentioned factors that have contributed to this reduction in output and inflation. Kahn et al. (2002), claim that changes in inventory behaviour stemming from improvements in information technology have played a prominent role in reducing real output volatility. According to their structure model, most of the reduction in aggregate volatility can be explained by a reduction in the variability of output in the durable goods sector. In addition, they show that monetary policy cannot be the primary source of increased stability since 1984, although it may have played a supporting role.

In contrast, Kim et al (2001), put forward a Bayesian framework for testing for structural breaks in real output. They investigate the stabilization on the trend and cyclical components of real GDP. They demonstrate that the volatility reduction in aggregate real GDP appears to be widespread, extending to both goods and structures production in broad categories and to both durable and non-durable production within the goods category. Lastly, they found that the persistence of inflation has also fallen while the persistence of movements in the Federal Funds rate has increased.

The hypothesis of "good luck" has also been examined by Ahmed et al. (2002). Their findings support the "good luck" hypothesis so that the aggregate output variability reduction for all of its broad demand-side and product-side components is evenly distributed to various frequencies. Better monetary policies have only played a minor role in explaining the decline in US output volatility while lower inflation is a result of "good luck" only. They conclude that this reduction in volatility cannot be a permanent feature of the US economy.

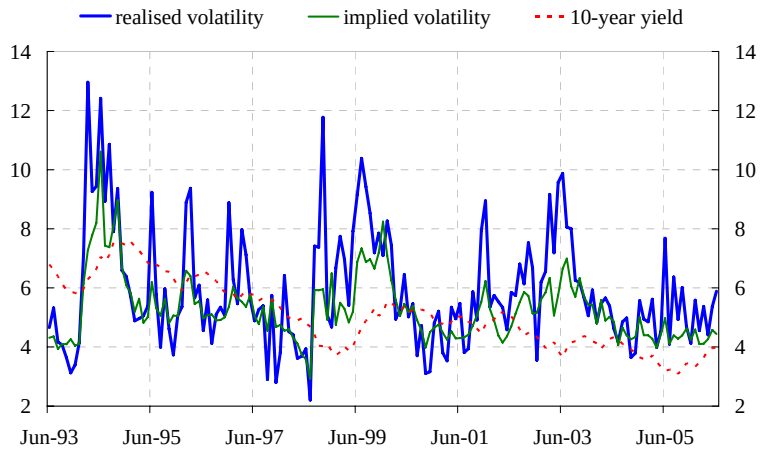
It is a well accepted stylised fact that lower inflation rates are associated with lower inflation variability and thus inflation uncertainty. Given that inflation expectations have proved to be increasingly well anchored over the past years (see Chart 5), there is little doubt that a fraction of the decline in term premia is due to a reduction in inflation uncertainty. This hypothesis receives empirical support from Kim and Wright (2005) who present results from an affine term structure model that provides a four-way decomposition of bond yields into expected future real rates, expected future inflation, a real term premium, and an inflation risk premium. These estimates suggest, for example, that the decline in the ten-year instantaneous forward rate by 149 basis points from a peak of 7.17% at the end of 2001 to 5.68% at the end of 2004 goes back to a decline in the expected real rate by 14 basis points, a decline in expected inflation by 19 basis points, a decline in the real term premium by 81 basis points

and a decline in the inflation risk premium by 35 basis points.[9] Hence, these results clearly argue in favour of the hypothesis that lower inflation variability contributed to lower bond yields through a lowering of the inflation risk premium. This notwithstanding, the bulk of declining term premia came through lower real premia which principally points towards the importance of special factors as discussed later in Section 5.

4.3 Did lower bond market volatility affect yields?

Lower macroeconomic volatility and more transparent monetary policy decision-making might have led to lower volatility in long-term bond yields which, in turn, would tend to make long-term bonds more attractive relative to other assets and drive term premia down, all else being equal. Indeed, Rudebusch, Swanson and Wu (2006) find significant explanatory power of implied volatility on longer-term US Treasuries for the bond yield residuals of two different macro-finance term structure models. In the euro area, however, realised and implied bond market volatility do not show an unambiguous downward trend over the past ten years which could explain the trend decline in term premia (see Chart 24).

Chart 24: Historical and implied volatility (percentages per annum, monthly data)



Source: Bloomberg and ECB calculation.

Notes: Realised volatility measured as the annualised monthly standard deviation of daily returns on German ten-year benchmark bonds. Implied volatility extracted from the end-of-month prices of the nearest at-the-money options on the German bund future contract.

Looking at shorter-term dynamics, although the decline in bond yields since mid-2004 took place in an environment of relatively low bond market volatility, volatility did not decline very much further over this period to justify by itself a decline in bond yields. As a similar

[9] See Table 1 in Kim and Wright (2005), p. 19.

pattern can be observed for the US market as well, we conclude that at least over the recent past, no mechanical relationship prevails between bond volatility and bond yields that could explain lower term premia on account of lower bond volatility.

All in all, the pattern of behaviour of estimated risk premia in major bond markets presented above provides support to those arguments which emphasize the prevalence of special demand and supply factors in long-term debt securities markets as a major reason why long-term interest rates have become so low.

Section 5: Other factors potentially affecting the demand for bonds

Official institutions, as well as academic observers and research departments of investment banks have made a number of research contributions which identify a relative imbalance of demand and supply of bonds as a main source for the low level of long-term yields, or term premia. Usually, these contributions offer a particular, or even multiple explanations for the seeming anomaly in the long-term interest rate. Most of the explanations refer to a relative increase in demand for bonds over supply, due to a combination of a 'global saving glut', the accumulation of foreign reserves by official institutions (as a result of continued foreign exchange intervention, in particular from Asian countries), high corporate savings, portfolio shifts from equity into bonds by pension funds and life insurances (corresponding to regulatory changes),[10] and/or excess liquidity in industrialized countries, following a period of accommodative monetary policy.

Due to the large number of explanations, empirical specifications of econometric models typically include only a small subset of the factors mentioned. Empirical work in this field is further complicated by methodological problems raised by the stationarity properties of the variables involved, and issues such as availability, incompleteness and limited coverage of data. As a natural consequence, empirical results differ quantitatively and qualitatively.

Table 6 summarise recent estimates of the impact of various factors on the level of US bond yields, based mainly on econometric evidence or on surveys. For example, Rudebusch, Swanson and Wu (2006) report the result of a survey conducted among market participants and which provides an assessment of the quantitative importance of various factors (Table 2).

Table 2: Survey Respondents' Assessments of Factors Holding Down the 10-Year Treasury Yield

Factor affecting yields	Effect in basis points
Demand by foreign central banks	21
Increased demand by pension funds	11
"Reaching for yield"	10
Minimal inflation risk	10
Greater transparency of the Fed	8
Excess global savings	8
Low economic growth volatility	7

Original Source: A survey of clients by Macroeconomic Advisers as reported in the newsletter "Monetary Policy Insight's Survey on Long-Term Interest Rates", March 8, 2005, cited from Rudebusch et al. (2006).

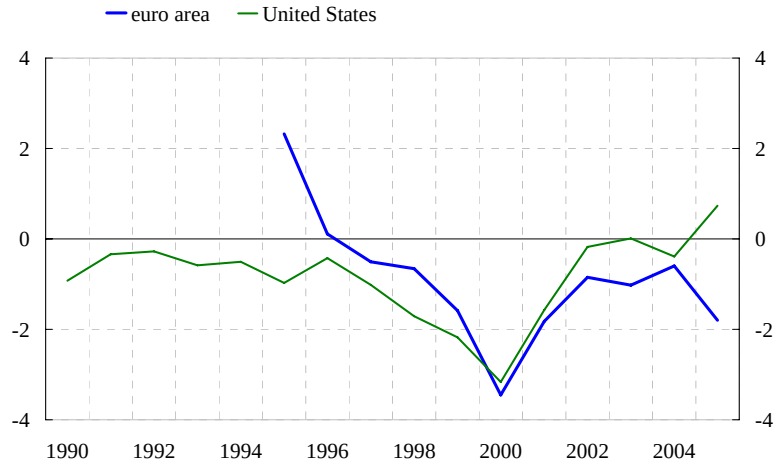
[10] There may be even an increased demand by households for retirement savings, corresponding to an increasing awareness by savers in industrialized countries of demographic changes. Increasing retirement savings would at least partly be channelled through life insurances and pension funds. However, this effect may depend on policy reforms and be of comparatively small scale over the short run.

It is interesting to note that the assessment of the overall impact is only of around 75 basis points, and that, in the meantime, nominal long-term interest rates have rebounded significantly. Rudebusch et al. (2006), in their paper, come to estimates of the possible unexplained part of the decline in nominal interest rates of a similar magnitude, while the rest is accounted by a decline in term premia in line with the factors used in their specifications.

5.1 Corporate savings

As documented by the IMF[11], corporate saving has increased around the world. In particular, over the past few years, the US non-financial corporate sector has developed from a strong net borrower to a net lender, a development which may appear even more pronounced when including the financial sector (Chart 25).

Chart 25: Corporate financing gap in the euro area and in the United States (annual data; percentage of GDP, 1990 to 2005)



Sources: ECB, Eurostat, US Federal Reserve Board Flow of Funds Accounts.

Note: Estimated for 2005 for the euro area. The financing gap is defined as the net lending (+) / net borrowing (-) of the sector in relation to GDP.

According to JP Morgan (2005)-estimations[12] of a single-equation reduced form regression model, the increase in corporate saving accounts for approximately 70 basis points of the

[11] IMF Global Financial Stability Report, September 2005, Chapter II.

[12] Loeys, Jan, David Meckie, Paul Meggyesi, and Nikolaos Panigirtzoglu (2005): Corporates are driving the global saving glut. JP Morgan Research, June 24, 2005. The JP Morgan approach explains the US real ten-year yield by a short term real rate, the corporate financing gap, government deficit, inflation variability, and emerging market current account.

decline in real ten-year US yields (relative to long-term average levels), as corporate enterprises have used rising company profits in order to strengthen their balance sheets instead of making new investments. In turn, demand for corporate bonds has been comparatively high, relative to supply, consistent with comparatively low risk premia on corporate bonds. However, Warnock and Warnock (2005) find in their regressions an insignificant impact of the increase in corporate savings, as they control for inflows into US bonds from official and private sources.

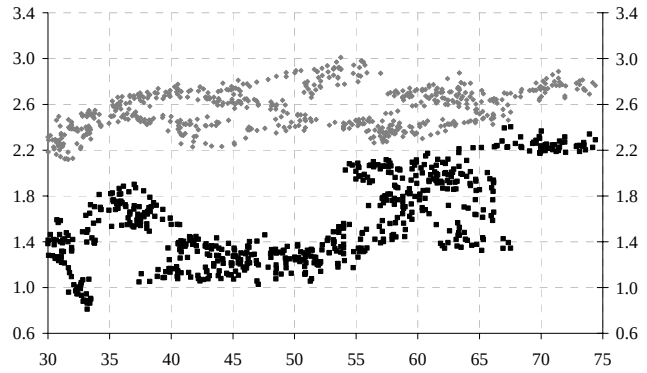
5.3 'Global saving glut', current account imbalances and official interventions

At an aggregate level, estimates by JP Morgan (2005) suggest, that the current account of emerging market countries accounts for approximately 35 basis points of the decline in real ten-year US bond yields, relative to long-term average levels, at the end of 2005. Warnock and Warnock (2005) find a substantial part of the decline in yields to be related to total inflows into US bonds (up to 150 basis points), in an extension of a domestic model by measures of foreign inflows.

More recently, the recycling of oil surpluses may have led to an additional demand on US Treasuries. Part of the observed negative correlation between real rates and oil prices could be explained on the basis of the oil revenues hypothesis (see Chart 26). However, it has turned out to be difficult to isolate in regression analyses the impact of oil revenues on yields, possibly due to collinearity problems.[13] More recently the negative relationship between oil prices and real rates seems to have disappeared.

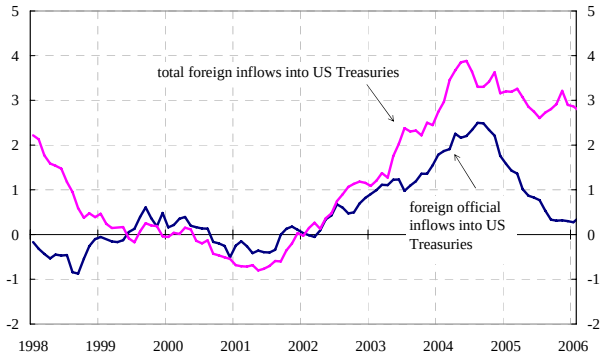
[13] See IMF World Economic Outlook April 2006, pages 89-91.

Chart 26: Brent oil prices (horizontal scale in US $) **and US long-term real bond yields** (black dots, in%, vertical scale) **and break-even inflation rates** (grey dots, in%, vertical scale), January 2004 to June 2006) (in %, daily data)



Sources: Reuters and ECB calculations.

Chart 27: Foreign inflows into US Treasuries, (12-month average as % of GDP Jan 1986 – Feb 2006)



Source: Federal Reserve Bank of New York, TICS, Thomson Financial Datastream. Methodology borrowed from Warnock and Warnock (2005)..

After 2002, Asian policymakers intervened in the foreign exchange markets in order to prevent the appreciation of their currencies against the US dollar. These measures have been viewed as a part of an export-led growth strategy that relies on generating export surpluses. As a result, a number of countries have accumulated substantial amounts of foreign reserves (see Table 3), of which a substantial fraction is held in the form of US Treasury bonds.[14] Hence, many observers have emphasized the role foreign official inflows into US Treasuries play in explaining the 'conundrum' (see chart 27 and Table 6).

[14] Many central banks do not report details of their reserve holdings in terms of currency of denomination and maturity structure. Nevertheless, it is generally perceived that central banks preferably hold their reserves in short- to medium-term high quality bonds, mostly denominated in US dollars. In this context, some observers have noted that US fiscal authorities have been able to reduce the average maturity of outstanding debt, in spite of increasing levels of public debt, which has been related to the demand of foreign central banks in recent years. Thus, the demand from foreign official investors may have indirectly helped to drive down yields at the long end of the curve.

Table 3: Foreign exchange reserve holdings in selected countries (USD Billions, end of period, percentage changes)

	Stocks					% change			
	Dec. 2002	Dec. 2003	Dec. 2004	Dec. 2005	Apr. 2006	2002 vs 2003	2003 vs 2004	2004 vs 2005	2005 vs 2006 ytd.
Japan	451	653	824	829	839	45%	26%	1%	1%
China	286	403	610	819	875 [1)]	41%	51%	34%	7%
Korea	121	155	198	210	223	28%	28%	6%	6%
India	67	98	125	131	154	46%	28%	5%	17%
Hongkong	112	118	124	124	126 [1)]	6%	4%	1%	1%
Singapore	81	95	111	115	126	17%	17%	3%	9%
Malaysia	33	43	65	70	75	31%	50%	7%	8%
Thailand	38	41	48	51	55	8%	18%	4%	10%
Indonesia	31	35	35	33	40	13%	0%	-6%	23%
Philippines	13	14	13	16	18 [2)]	2%	-4%	22%	12%
Sub Total	**1234**	**1654**	**2154**	**2397**	**2531**	**34%**	**30%**	**11%**	**6%**
Russia	44	73	121	176	218	66%	65%	45%	24%
Mexiko	50	58	63	73	77	16%	9%	16%	6%
Brasil	37	49	53	54	56	31%	7%	2%	5%
Argentina	10	13	18	23	21	26%	37%	26%	-8%
Sub Total	**142**	**193**	**254**	**325**	**373**	**36%**	**32%**	**28%**	**15%**

Notes: [1)] March 2006 [2)] February 2006.

Source: IMF

Such official interventions could be seen, partly, as a counterpart of the *global savings glut* hypothesis, which contemplates the role that an excess of saving over investment in emerging market countries played for the level of bond yields over the recent period. As Chart 27 illustrates, foreign inflows into US Treasury bonds have been considerable.

There is broad agreement that continued foreign exchange interventions by official institutions have considerably increased the demand for US bonds in general and US Treasuries, in particular. Although foreign official inflows into US Treasuries account only for a part of total foreign inflows into US Treasuries, it has been argued that market participants react sensitively to buying activities of official buyers. According to this logic, a 1 billion USD purchase of US Treasuries in the course of a foreign exchange intervention affects prices more than the purchase of the same amount by a private agent. This hypothesis is plausible in so far as foreign exchange interventions are rather meant to affect prices in foreign exchange markets than to take advantage of favourable bond market conditions when optimizing a portfolio under risk and return considerations.

According to estimates by Warnock and Warnock (2005), the impact of inflows into US bonds from foreign official institutions may amount to roughly 100 (50) basis points in 2004 (2005). In line with these numbers, Deutsche Bank (2005)[15] gives an estimate of 60 basis points for the impact of inflows from official institutions. In an error correction approach, Frey and Moëc (2005) see 125 basis points as an upper bound to the decline in nominal

[15] Deutsche Bank Global Markets Research: The bond puzzle. March 2005.

yields, caused by intervention in 2004. In a higher frequency study, Bernanke, Reinhart and Sack (2004) regress the change in US Treasury yields on US dollar denominated Japanese interventions over the period January 2000 – March 2004 and find that interventions worth 1 billion USD would lead, on average, to a 0.66 basis point decline in both 5 and 10-year yields. This estimate, however, applies to the very short-run and allows no conclusion about the persistence of the impact. Bernanke, in a speech delivered in March 2006[16] explicitly expressed doubts about the role played by official purchases. In particular, he argues that the low level of spreads between corporate bonds and government bonds indicates that the impact of official purchases has been modest, as he considers unlikely that foreign central banks and institutions purchased significant amount of corporate bonds.

In the following, we use the study by Warnock and Warnock (2005) in order to provide a crude approximation of the impact of a representative 1 billion USD US Treasury bond purchase of long-term yields. One of the explanatory variables in this study is the 12-month average of foreign official inflows, relative to GDP. When taking literally the point estimate and considering a representative level of foreign official inflows of 2% of GDP for the year 2004, it may be concluded that a 1 billion USD foreign central bank purchase of US Treasuries would have driven down ten-year yields by less than 0.4 basis points within the year after the purchase.

Possibly, this estimate could be affected by an omitted-variable problem, as private inflows should matter as well. If we therefore use instead the corresponding estimate from Warnock and Warnock for the impact of total inflows into US Treasury bonds on ten-year yields, and consider a representative level of inflows of 3% of GDP for the year 2004, then a 1 billion USD purchase of US Treasuries by foreign investors would have driven ten-year yields down by roughly 0.2 basis points. In a sense, these results fit well the insights gained by Bernanke et al., because the short-run impact of bond purchases on yields should be much larger than the medium-term impact. In the long-run, the impact of any single act of purchase on yield should vanish.

The above considerations may nevertheless still over-estimate the impact of demand from foreign official institutions on long-term yields. If even broader categories of inflows into US bonds (for example including corporate and agency bonds) were included into the analysis, then the impact of foreign demand for US Treasuries might appear even smaller in empirical estimates. All in all, we may nevertheless conclude that the foreign exchange policies pursued

[16] "Reflections on the Yield Curve and Monetary Policy", March 20, 2006, before the Economic Club of New York.

by the central banks of countries such as Japan, China, Korea and Thailand may have contributed, at least temporarily, to raise the price of US long-term government bonds, in particular over the period from 2003 to 2005, thereby holding the US long-term yields down although the recent results of Rudebusch et al. (2006) challenge this view.

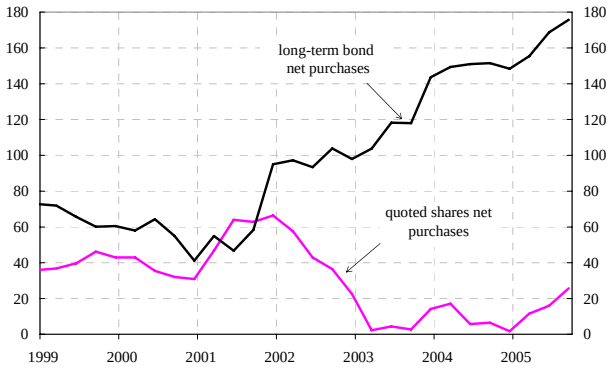
5.6 The role of institutional investors

Demand from pension funds and insurance companies for European and US bonds

Many observers[17] have claimed that the recent low levels of long-maturity bond yields and distant implied forward yields may have been due to higher demand from pension funds and life insurance companies, induced by changes in pension fund regulation and pension-related accounting standards throughout many industrialized countries. Also according to Deutsche Bank (2005), the expectation that (US) institutional investors (such as pension funds and life insurances) will reallocate portfolio shares from equity to longer term fixed income securities in response to regulatory changes, may have contributed to lower yields. The IMF Global Financial Stability Report of September 2005 comes to similar conclusions. Other than the reserve accumulation by central banks, the impact of institutional investors' demand on bond yields has received comparatively little attention by quantitative empirical research.

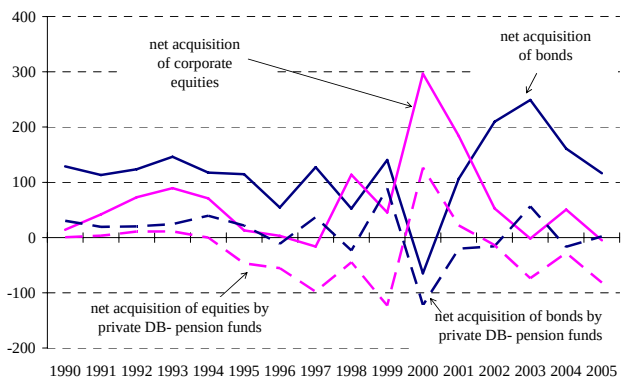
We first review some data evidence for factual changes in portfolio allocations, before considering the potential impact of regulatory developments in the following subsection. Concerning past developments, in charts 28 and 29, we depict the net acquisition of bonds and equity by institutional investors in the United States and the euro area. While in the euro area, annual net acquisitions of bonds by institutional investors have more than doubled during the past five years, net acquisitions of bonds have fallen slightly in the United States. In the euro area it seems likely that the purchases of bonds were related mainly to portfolio choices which, over time, followed developments in the stock market.

Chart 28: Purchases of long-term bonds and quoted shares by euro area insurance corporations and pension funds (1999 – 2005, 4-quarter average data, bn. €)



Source: ECB

Chart 29: Net acquisition of bonds and corporate equity by US life insurance corporations and pension funds (1998 – 2005, annual data, bn. USD)



Source: Federal Reserve Board Flow of Funds Accounts.

[17] Prominently among them US Federal Reserve Chairman Ben Bernanke in his above mentioned speech on "Reflections on the Yield Curve and Monetary Policy", March 20, 2006.

When compared to the purchases of US Treasuries by foreign official institutions, net bond acquisitions by US life insurance corporations and pension funds are almost of comparable size in 2004 and 2005. However, when related to foreign inflows into US bonds including corporate and agency bonds, the level of demand from US pension funds and life insurance corporations appears comparatively moderate to date. In particular, net bond purchasing activities of US private defined benefit pension funds remain at comparatively very moderate levels, although DB pension funds are the group of institutional investors which is thought to be most affected by possible future regulation changes. Nevertheless, more considerable portfolio reallocations may occur as future US pension regulation becomes more concrete (see below).

Possible role of regulations

Over the past couple of years, changes in accounting standards and other regulations may have encouraged pension funds to better match assets and liabilities, and to improve and reduce the volatility of their funded status. These developments have concerned, or continue to concern a number of industrial countries, such as Denmark, the UK, and the Netherlands. Similar regulations are currently debated in the US. The intended and already implemented regulatory developments may be classified into (a) a change in accounting principles, (b) minimum funding (solvency) requirements, and (c) other regulations, such as risk management and monitoring requirements in the Netherlands (solvency test). The combination of these developments may imply motives for pension fund managers to shift considerable fractions of their portfolios from equity into bonds of very long maturity, as they envisage to better match assets and liabilities.[18]

In the following, we provide a rough approximation of the possible volume of the portfolio shifts on an aggregate level. In particular, we do not only contemplate shifts in portfolio allocations that can factually be observed, but also those changes which may be and have been presumed to occur over a longer time horizon, as already the anticipation of changes in pension fund portfolio allocation may have triggered speculative demand.

Table 3 relates estimates of future changes in portfolio allocations from equity into bonds by defined benefit pension funds to amounts outstanding of total bonds (government bonds) of maturity of more than 1 year. However, the volume of bonds outstanding with a maturity

[18] In principle, the liabilities of pension funds consist of long series of consecutive annuity payments to retirees, and thus may have a very long average maturity. To the extent that pension fund liabilities are inflation index-linked, index-linked bonds and even inflation swaps may be potential target assets of pension funds in the wake of regulation changes.

suitable for purposes matching the duration of pension liabilities is much smaller.[19] The estimates of portfolio changes are from different sources and may exhibit a diversity of reliability and accuracy, and should be viewed as affected with a high degree of uncertainty.

Table 4: Possible portfolio reallocation from equity to bonds by defined benefit pension funds, due to regulation, versus bond market size.

	Debt securities outstanding, in tn. USD, mat. >1 yr. (thereof gov. bonds)	**Possible portfolio reallocation in bn. USD**	**Reallocation as % of outstanding debt sec.** (as % of gov. bonds)
USA	**15.7** (4.3)	**290** [3)]	**2%** (7%)
UK	**0.6** (0.6)	**250** [2)]	**40%** (42%)
Netherlands	**6.8** (4.0) [1)]	**120**	**2%** (3%)

Notes: [1)] Euro Area, [2)] 100-150 bn. GBP, translated at 2 USD/GBP [3)] refers to private sector DB-pension plans

Sources: BIS Security Statistics, Goldman Sachs (2005), Vlaar (2005), Popat et al. (2004)[20].

Pension funds in OECD countries held assets totalling 19 USD trillion as of 2004, according to the OECD.[21] The United States, the United Kingdom and the Netherlands are among the countries which have been, or may be in the future, affected by regulation changes. Jointly, these countries make up for two thirds of OECD pension fund assets (United States: 11 trillion USD (including 4 trillion USD referring to the public sector), United Kingdom: 1.4 trillion USD, and Netherlands: 0.6 trillion USD).[22]

It seems important to distinguish between defined benefit- and defined contribution pension plans, as defined contribution plans are less affected by regulation than defined benefit plans. A main reason for this distinction is that changes in the funded status of defined benefit pension plans typically will entail consequences for the balance sheets of plan sponsors. For the UK, a shortage of suitable pension fund assets (in particular, long-term and index-linked bonds) has received even the attention of a greater public, as real long-term bond yields dropped even below 1% earlier this year. Observers noted a strong interrelation of these market developments with concerns that demand from pension funds for suitable bonds would not be matched by available supply. In the UK, defined benefit plans still account for up to

[19] Schich, S. and Weth, M. relate durations of pension liabilities to maturities of outstanding government bonds in order to construct a measure of scarcity for bonds, and find relatively more scarcity for long and very long maturities.

[20] Goldman Sachs (2005): Pension reform – Implications for plan sponsors and the capital markets. The portfolio reallocation estimate for the Netherlands should be viewed as an upper bound. According to Vlaar (2005), the portfolio reallocation may be 5-20% of pension fund assets, depending on model assumptions in an elaborate simulation study. We have chosen the upper bound of this change, which refers also to the Danish experience reported below.

[21] Figures are derived from "Pension markets in Focus", OECD, December 2005.

[22] Figures are again derived from "Pension markets in Focus", OECD, December 2005.

90% of pension fund assets, however with a strong tendency of defined benefit schemes to be replaced by defined contribution plans in the coming years.[23]

In the United States, the situation is less clear. Private sector defined benefit pension plans account for a pension fund asset volume of 1.8 trillion USD [24], a much smaller fraction than in the UK. Furthermore, the fraction of active defined benefit insurers as a percentage of private sector workers has been steadily decreasing over the past two decades. Similarly, the number of firms sponsoring defined benefit pension plans has been decreasing for a long time.[25] In order to assess the possible impact of effective and anticipated demand, it may be helpful to approximately quantify the volume of pension fund assets to be re-allocated to long-term bonds.[26] Available estimates referring to the presumed reallocation of private sector defined benefit pension assets are in the range of 180 to 290 billion USD (Deutsche Bank (2005) and Goldman Sachs (2005)). The latter figure has been determined based on a survey of the Committee on the Investment of Employee Benefit Assets (CIEBA) among their members. Based on the survey response, Goldman Sachs (2005) estimates the likely reallocation from equity to bonds to be 16 percentage points of total private defined benefit pension assets, or 290 billion USD. This estimate may be considered as an upper bound to the reallocation, as the survey was based on the assumption that a complete set of contemplated pension reforms would be put into force at once.[27] Treasury assistant Secretary Warshawsky, argued, also on the basis of the CIEBA survey, that the reallocation could be in the order of 360 billions, with an impact on bond yields in the range of 10 to 15 basis points. Such assessment of the impact was based on previous estimates of the Treasury on the impact of the announcement of the discontinuation of the issuance of 30 years bonds, arguing that the impact of events that changes net demand may be similar.[28]

When relating these projected portfolio changes the US to the sizes of the respective bond markets, and the volume of foreign exchange interventions that could been observed over the past few years, then the impact of (anticipated) regulation changes on US yields may well be of a magnitude smaller than in the UK. Similar arguments as for the US may apply to the

[23] Popat et al. (2004).

[24] Goldman Sachs Global Strategy Research: "Portfolio Research United States. Pension reform: Implications for plan sponsors and the capital markets.", April 6, 2005.

[25] Goldman Sachs (2005).

[26] According to anecdotal reports, similar regulation changes in Denmark (becoming effective in 2001) induced an almost 20%-point increase of the share of bonds in pension fund portfolios (Credit: "Fund Managers back France's 50-year bond", 1 March 2005). In the same context, Baring Asset Management (2006) terms a presumed corresponding increase of 10%-points in the US as 'moderate'.

[27] Deutsche Bank (2005), and Goldman Sachs (2005) based on a survey. A more alarmist position is taken by Toby Nangle of Baring Asset Management (2006): Prospective Pension Regime Change: A Systemic Shock to the U.S. Financial System.

[28] Palumbo et al. (2006).

Netherlands, as the Netherlands have access to the comparatively larger euro area bond market.

6. Conclusions

The low level of long-term interest rates which was observed over recent years has been the result of a confluence of several factors:

- The reduction in inflation expectations in most of advanced economies led to significant reduction in the level of long-term nominal interest rates which has been observed as from the 1980s.
- When assessing real interest rates, the decline of long-term real interest rates in 2004 and 2005, at a time of tightening of monetary policy and robust growth, remains puzzling. A contribution to the decrease of long-term rates could have stemmed from the compression of risk premia on account of the improved credibility of central banks, which may reduce the risk of observing big swings in real rates which may be needed to control inflation expectations. In addition, there are indications that macroeconomic volatility may have also declined over time. It is difficult to establish whether the decline of risk premia on account of these factors could have played a significant role over the past couple of years.
- There is little ground to support the view of a permanent reduction in the natural rate, related to expectations of growth or of demographics, at east in the United States, over the past couple of years.
- Other factors may have therefore contributed to the decline in long-term interest rates. For the United States, the most often quoted factor has been the purchase of Treasury bonds related to inflows of capital in the United States of public entities (mainly central banks) and of private investors. The econometric evidence in this respect is very mixed. It cannot be ruled out that the additional demand of foreign investors may have contributed to the low level of real interest rates but that such effect has gradually vanished in the course of 2005. After the rebound observed in the last part of 2005 and in 2006, long-term real interest rates have reached level more in line with long-term fundamentals.
- In the United Kingdom, the extent of the possible portfolio reallocation related to regulatory changes seems to have significantly affected the level of long-term interest especially during the period 2004-2006.

- Changes in accounting and pension regulations does not seem to have been the main driving force affecting the level of long-term interest rates in the United States. Such changes are not yet entirely defined and may imply in any case a portfolio reallocation which should be absorbed without major impact on bond yields.
- In the euro area, there is less evidence that the level of long-term interest rates has been very low. Although flows of institutional investor into bonds has been sizeable for several years, major legislative changes have or are effecting the Netherlands only and this should have a limited impact on long-term nominal interest rates for the entire euro area.
- In general, it appears that the impact on bond yields has been similar on nominal and index-linked bonds, as evidenced by the substantial stability of break-even inflation rates. This indicates that the impact of regulation, if any, has had similar effects on the demand for index-lined and nominal bonds.

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Table 5: Evolution of Pension regulation and accounting rules in the Netherlands, United Kingdom, and United States

Netherlands		United Kingdom		United States: replace this with possible FASB change in regulation)	
1999	Prudential supervisory authorities set up a project for a new "Financial Assessment Framework" (FTK)	*1995*	UK Pension Act: Indexation of pensions in payment to up to 5% inflation. Minimum Funding Requirements (MFR) determine time schedule for return of under-funded plans to fully funded level.	*Since 1974*	Employee Retirement Income Security Act (ERISA): DB pension funds are legally separated and tax-exempt, and have to follow minimum standards with respect to plan design, and reporting and disclosure practice. Pension Benefit Guarantee Corporation (PBGC) insures employee pensions against employer failure. Valuation rules allow smoothing of asset valuation, sluggish response to situations of under-funding, and factually favour equity over bonds.
2000 to 2004	Development, discussion and revision of the main components of FTK: 1) Realistic (market-based) valuation of pension assets and liabilities 2) Solvency test: Does the insurer have sufficient capital to withstand some 1-year risk scenarios with highprobability? 3) Institutional requirements for monitoring and control.	*2000*	FRS 17 published: Main features were the market-based valuation of pension assets and liabilities, and the recognition of pension scheme surpluses/deficits in financial statements. Introduction was deferred and became effective in the beginning of 2005.		
		2004	Pensions Act introduced to replace MFR. Pension Protection Fund (PPF) to insure employee pensions against employer failure, similar to PBGC in the US. Became effective in 2005.	*1985*	FAS 87 provides a definition of pension cost to be used in income statements, but still allows for delayed recognition of valuation changes. Disclosure of more market-based asset- and liability valuation in footnotes of financial statements.
2007	FTK will become effective.			*2001/ 2002*	Minimum funding rules for DB-plan sponsors relaxed
Future	Adoption of future IAS/			*Future*	Tendency to move information on

	IFRS- rules.				funded status of pension plans onto balance sheets. At a later stage, inclusion in income statements, and coordination with IAS-rules. Pension regulation may envisage accelerated amortization of funding deficits and market-based valuation of liabilities.
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Table 6: Summary of explanations for lower long-term bond yields (United States)

Explanation for lower US bond yields (contribution to decline in bp)	***Low short-term real interest rate; excess liquidity; search for yields; monetary policy accommodation***	***Global saving / corporate saving***	***Inflows from Asian/emerging market countries: foreign official bond purchases***	***Inflows from Asian/emerging market countries: bond purchases by private agents***	***decline in volatility measures***	***Pension fund demand***	**Memorandum: current model residual**
Model based studies (time horizon)							
JP Morgan (2005)[1] (2003-2005)	60 bp (short-term real rate)	70 bp (corporate financing gap)	35 bp (emerging market current account)		25 bp (inflation variability)		**13 bp**
Warnock/Warnock (2005) (2004-2005)		up to 150 bp	up to 50–100 bp	up to 50–100 bp	?		
Rudebusch, Swanson and Wu (2006)			1.6–6 bp		8–32 bp (various volatility measures)		**32–86 bp**
Moec and Frey (2005)			up to ~ 125 bp				
Bernanke, Reinhart and Sack (2004) (2003-2004)			0.66 bp per USD bn., short-term impact of interventions				**50–100 bp**
Guesses/surveys							
Deutsche Bank (2005)			60 bp				
Macroeconomic Advisors (2005): Average survey response	10 bp (search for yields)	8 bp (excessive global savings)	21 bp		7 bp (growth) 10 bp (inflation) 8 bp (Fed transparency)	11 bp	**(sum: 75 bp)**
Treasury Assistant Secretary Warshawsky, cited by Palumbo ea. (2006) [2]						10-15 bp	

Notes: n.i.= not included; [1] 2003-2005 deviations from 1960-2005 average decomposition of 10 yr. real rate. Fiscal expansion worked in the opposite direction (40 bp).
[2] Palumbo, Michael, Julio A. Santanella, and George Zanjani: Accounting and Regulation of Private Defined Benefit Pension Plans and Other Institutional Investors in the United States and México, June 2006.