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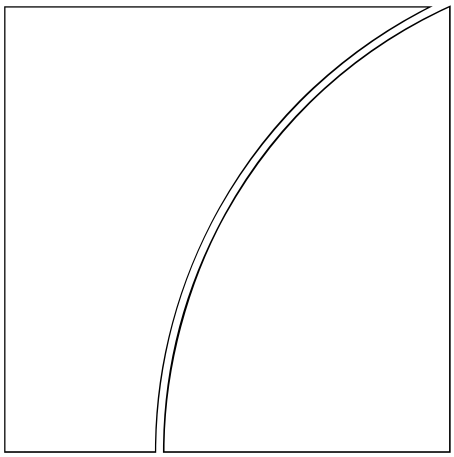

BIS Papers

No 5

The changing shape of fixed income markets: a collection of studies by central bank economists

Monetary and Economic Department

October 2001

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This publication is available on the BIS website (www.bis.org).

ISSN 1609-0381

ISBN 92-9131-625-3

Foreword

The papers in this volume analyse recent changes in the world's major fixed income markets. The introduction of the euro, structural changes in governments' fiscal positions, traumatic events such as the global financial market crisis of 1998, and advances in the technology of trading platforms are reshaping fixed income markets in Europe, Japan and the United States. The first paper provides a broad overview of the changes under way, and the following four papers elaborate on some of the issues that emerge. These papers complement a report published by the Committee on the Global Financial System in March 2001 on the use of collateral in wholesale financial markets.

Taken together, the papers in this volume highlight the growing importance of private sector debt instruments. Falling supply and shifts in the mix of investors holding government securities are draining liquidity from some government securities markets, in particular the US Treasury and UK gilt markets. In contrast, non-government markets have seen issuance volumes soar, a greater diversity of instruments made available, and liquidity conditions improve at least for the largest bond issues. The paper by Mastroeni describes the development of one of the fastest growing segments of non-government securities market: Pfandbrief-style products in the euro market.

Investors have accommodated changes in the relative borrowing patterns of the government and non-government sectors by moving towards more diversified portfolios. A key challenge faced by portfolio managers is pricing and managing the credit risk that they thereby take on. The paper by Hattori, Koyama and Yonetani examines the pricing of credit risk in the yen corporate bond market. They find that default risk, the stability of the financial system and the level of new corporate bond issuance relative to government bond issuance are the most important determinants of credit spreads in Japan.

Demand for fixed income instruments in recent years has also been affected by changes in hedging and arbitrage activity. The 1998 crisis led to a reassessment of risk management practices, one outcome of which was a switch away from the exclusive use of government bonds as hedging vehicles in favour of a wider array of instruments. Other traumatic events, such as squeezes in German government bond futures contracts, reinforced this search for alternative hedging vehicles. Schulte and Violi examine interactions between cash and derivatives markets in the euro area, and assess ways to alleviate the risk of a shortage in the cheapest bond to deliver into a futures contract.

Each market participant who switches to using non-government instruments as hedges subtracts liquidity from the government market and adds it to other markets, in the process raising the incentive for other market participants to follow suit. As non-government instruments gain liquidity, they are increasingly being used to price and hedge other securities and perform other functions for which government securities tended to be used in the past. The paper by Cooper and Scholtes concludes that declining supplies of government paper have helped to depress US Treasury and UK gilt yields below risk-free interest rates and so diminished their usefulness as benchmarks. They then demonstrate that interest rate swaps appear to have become the de facto benchmark for pricing high-quality bonds.

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The changing shape of fixed income markets

Study group on fixed income markets[1]

Abstract

The world's major fixed income markets have in recent years seen a marked increase in the relative importance of private sector debt instruments. Outside Japan, non-government securities have overtaken government securities as the larger segment of the cash market. Similarly, in derivatives markets, trading in instruments based on private sector obligations, in particular interest rate and default swaps, is increasing whereas turnover in many government bond futures contracts has declined. Some investors have been slower to adjust their portfolios to the new issuance patterns, and this differential response has hastened the decline in trading activity and liquidity in the UK gilt and US Treasury markets. At the same time, the introduction of the euro and development of electronic trading platforms have contributed to an improvement in liquidity in euro markets. While government securities remain among the most liquid assets available to investors, as non-government instruments gain liquidity they are increasingly being used to price and hedge other securities and perform other functions for which government securities tended to be used in the past. This process appears to be furthest advanced in the euro market, where the interest rate swaps curve is emerging as the benchmark yield curve.

1. Introduction

A remarkable process of change is under way in the world's major fixed income markets. Relative supplies of government and non-government bonds have shifted rapidly in recent years as governments in the United States and several other countries began paying down their debt, the Japanese government issued record amounts of debt, and bond issuance by corporations and other non-government borrowers surged. Liquidity conditions are deteriorating in what used to be the world's most liquid securities market – the US Treasury market – but improving in other fixed income markets, particularly the euro-denominated market in the wake of the introduction of the single currency. Market participants are increasingly turning to derivative products to construct yield curves and gauge market expectations. And investors are diversifying into credit products and other higher-risk assets in search of higher returns.

Many of the developments in fixed income markets are encapsulated in the emergence of new benchmarks for pricing other securities and alternative vehicles for hedging selected risk exposures. In the past few decades, government securities were widely recognised as the pre-eminent benchmark and hedging instrument in financial markets. In industrial countries, price discovery about macroeconomic prospects occurred mainly in government securities markets. Bonds issued by corporations, financial institutions and other non-government borrowers tended to be priced against government yield curves. And government securities and related derivatives contracts were commonly used to hedge holdings of other types of securities. In recent years, however, government securities have begun to lose their pre-eminence. Owing to shifts in supply and recent episodes of market stress, market participants are exploring the suitability of other instruments as benchmarks and hedging vehicles. A process of adjustment is under way in which a range of non-government debt instruments are emerging to perform the functions conventionally fulfilled by a single instrument: government securities.

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[1] The study group benefited from contributions by Pierre Cousseran and François Haas of the Bank of France. Anna Cobau of the Bank for International Settlements provided invaluable research assistance. Philip Wooldridge held the pen for much of the paper.

This search for alternative benchmark and hedging instruments is both a key determinant and an outcome of the changing shape of fixed income markets. Competition for benchmark status has led some borrowers in the United States and Europe to mimic government issuance programmes by regularly issuing large amounts of debt. While investors as a group are shifting their portfolios to match changing supplies of debt securities, some investors, including central banks, are moving away from their original mix of assets more slowly than others. Such changes in supply and demand are contributing to a shift of liquidity towards non-government securities, especially top-rated debt such as US agency securities and Pfandbriefe. Price discovery is migrating to derivatives markets and even corporate bond and equity markets. Market participants increasingly see advantages to using interest rate swaps as a means of positioning along the yield curve and hedging interest rate risk, particularly in the US dollar and euro markets but also in the yen market. Likewise, some double-A and single-A rated borrowers are establishing themselves as benchmarks for pricing similarly rated debt. The use of credit products as benchmarks for pricing has been fostered in part by their growing use as hedging instruments. Market disturbances in recent years have raised awareness among dealers and end-investors of the need to take both market risk and credit risk into account when constructing a hedge, and a variety of instruments have emerged to address either or both of these risks.

The following sections of this paper, together with the accompanying papers in the study, document and analyse the changes under way in fixed income markets in Europe, Japan and the United States. Section 2 identifies the forces driving change. Section 3 considers shifts in the supply of debt securities, and Section 4 shifts in demand. Section 5 examines the ebb and flow of liquidity in recent years. The study finishes with some conclusions about new benchmarks for price discovery.

2. Forces for change

Competition among issuers, portfolio adjustments by investors, innovations by providers of financial services and improvements in risk management practices are continuously reshaping fixed income markets, and financial markets in general. The interactions among these factors contribute to the endogenous dynamism of financial markets. Recent years have been unusual because of the importance of several factors exogenous to the normal functioning of these markets. Foremost among these were structural changes in governments' fiscal positions, the introduction of the euro, traumatic events such as the global financial market crisis of 1998, and advances in the technology of trading platforms.

2.1 Evolution of public finances

Since the mid-1990s, most industrial countries, with the exception of Japan, have made substantial progress towards fiscal balance (Graph 1). The US federal government posted its first budget surplus in nearly three decades in 1998, and even with the recent tax cuts, surpluses seem likely over the near term. The Australian, Canadian, Swedish and UK governments also moved into surplus in the late 1990s. Public finances in the euro area have gradually strengthened, supported by euro area governments' commitment to the Maastricht Treaty and the Stability and Growth Pact.[2] Thanks to windfall revenues from auctions of third-generation (3G) mobile telephone licences, the euro area posted a small surplus in 2000, and its fiscal position is expected to remain broadly in balance over the near term. In contrast to Europe and the United States, Japan has posted large fiscal deficits in recent years. These arose mainly from the government's efforts to stimulate the economy and strengthen the banking system in the wake of the 1997-98 financial crisis.

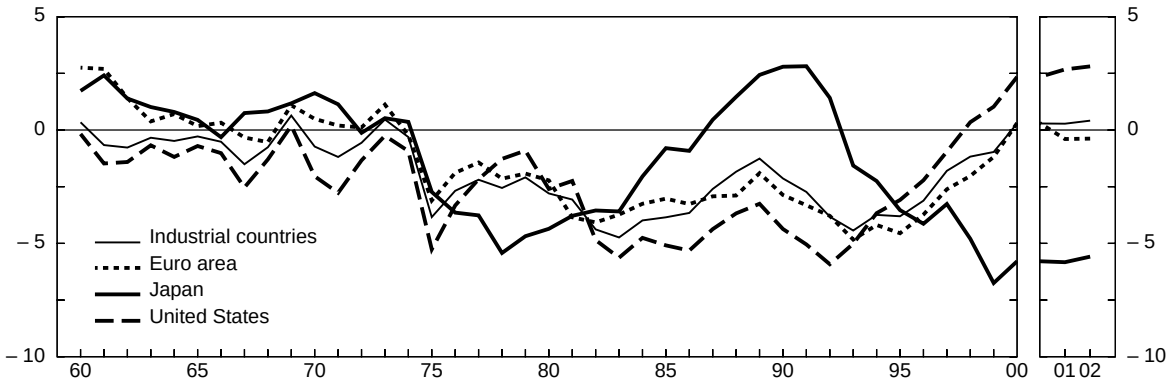
While the fiscal trends evident in the late 1990s appear likely to continue over the near term, the medium- and long-term outlook is more uncertain. Governments in the industrial countries are committed to keeping their deficits low, but the ageing of populations is expected to put pressure on

[2] The Maastricht Treaty, signed in 1991, commits prospective members of the euro area to reducing government debt levels to 60% of GDP. The Stability and Growth Pact, signed in 1998, commits members of the euro area to limiting their fiscal deficits to 3% of GDP.

Graph 1

General government borrowing requirements[1]

As a percentage of nominal GDP



[1] OECD forecasts for 2001 and 2002.

Sources: European Commission; OECD.

public finances in many industrial countries in coming decades. As the baby boom generation passes into retirement, dependency ratios in Europe, Japan and the United States will steadily increase, peaking sometime after 2030.[3] Such demographic changes are likely to boost public spending on pensions and healthcare as well as reduce the tax base. Governments have introduced reforms designed to stabilise public pension accounts over the long term. However, numerous studies suggest that in most industrial countries these measures will not be sufficient to prevent fiscal balances from deteriorating beyond 2010.[4] In a major study of the effects of ageing, the OECD (1998, p32) concludes: "The fact that all the various approaches [to forecasting the fiscal impact of ageing] give very similar results implies that it is very likely that, despite recent reforms in many countries, there will be important strains building up on public finances in 10-15 years' time."

Notwithstanding the possibility that the current improvement in public finances could prove to be temporary, fiscal consolidation has focused attention on the positive externalities provided by government securities markets. Beyond their role as a source of financing for the government, these markets have come to perform a range of other functions for the broader financial markets, the benefits of which are not entirely reflected in the yields government securities command. Government securities and associated derivative products often serve as benchmarks for pricing and quoting yields on other securities. They are frequently used as vehicles for taking positions on the general level of interest rates, as well as hedging against movements in interest rates. Government paper is the most common form of collateral in financial markets, including in central bank operations. Government securities are often considered substitutes for cash, and thus are universally seen as "safe havens" into which investors can escape during periods of heightened risk. The infrastructure supporting government securities markets – the legal and regulatory framework, trade execution arrangements, clearing and settlement systems, repo and derivatives markets, and risk management procedures – enhances the development of non-government securities markets.

For all of these reasons, some market participants question whether financial markets as currently configured can function efficiently without government securities.[5] Indeed, several governments with a

[3] The dependency ratio equals the number of people who are not of working age (ie, under the age of 15 and over the age of 64) divided by the number of people of working age (ie, aged 15 to 64). The dependency ratio in Japan is already rising, and the United Nations (1996) projects that it will nearly double by 2050, to 86%. The dependency ratio in Europe is projected to increase from 49% in 2010 to 78% by 2050. The dependency ratio in the United States is projected to increase from 48% in 2010 to 65% by 2030.

[4] See Chand and Jaeger (1996), European Commission (2000), Group of Ten (1998) and OECD (1998).

[5] For an example of this view, see Wojnilower (2000).

history of fiscal surpluses, including those of Hong Kong SAR, Norway and Singapore, have resorted to overfunding by issuing debt even when the funds are not needed. The policy authorities in such cases apparently deem the social benefits of government securities markets to be more than sufficient to offset the costs of issuing unneeded debt. For other governments facing fiscal surpluses, the question is whether financial markets will produce private instruments that can perform the social functions that government securities have been performing.

One concern is the repercussions of a declining stock of government securities for investors' and dealers' willingness to take on risk. The absence of a riskless asset into which investors could move during periods of extreme price movements might reduce their willingness to incur risk during normal times (see Section 4). Also, the amount of capital dedicated to making markets in non-government securities may depend on the returns available from trading government paper. The government securities business provides a more or less assured earnings base for many securities dealers at relatively low risk. As this business declines, the risk-reward structure of market-making will change, and some dealers may decide that the rewards for making markets in non-government securities no longer compensate for the risks (Wojnilower (2000)). A decline in government securities trading could thus lead dealers to withdraw from other markets, with adverse consequences for the provision of liquidity (see Section 5).

A scarcity of low-risk, liquid collateral could also adversely affect the functioning of non-government securities markets. Collateral mitigates default risk, thereby lowering the cost of financial transactions and facilitating the participation of a broad range of counterparties in financial markets. The use of collateral has increased tremendously in recent years, and government securities have traditionally been the preferred form of collateral. Issues arising from the possible scarcity of collateral with inherently low credit and liquidity risks were examined by the Committee on the Global Financial System (CGFS). In its report, the Committee concluded that any scarcity "is likely to elicit a wide variety of market responses that taken together substantially allay the concern about a general shortage" (CGFS (2001, p 6)).

Rather than impeding the development of non-government securities markets, it is also conceivable that a declining stock of government debt might boost financial market activity. Many economists and policymakers are of the view that by increasing the demand for loanable funds, government deficits put upward pressure on real interest rates and so reduce investment by private agents. In other words, government debt potentially "crowds out" borrowing by other agents.[6] Reductions in government borrowing, therefore, could stimulate an increase in private investment. If an increase in investment materialises and is financed with private sector debt obligations, it is not clear a priori whether such instruments would provide the broader benefits that government debt has offered (see Section 3).

2.2 Introduction of the euro

The replacement of 11 European currencies with a single currency in January 1999 was a landmark event in the development of euro-denominated financial markets. While the integration of securities markets across the euro area had begun well before the launch of the single currency, the actual introduction of the euro accelerated the process. Efforts to harmonise market practices intensified. For example, euro area governments now publish indicative calendars of issuance, and common trading platforms have emerged to ease cross-border trading. Competition in the market for investment banking services increased. One indication of this is the rapid convergence of underwriting fees in the euro-denominated segment of the international bond market towards US dollar levels in the wake of monetary union (Galati and Tsatsaronis (2001)).

Nevertheless, the process of integration is evidently far from complete. In particular, the euro area still lacks a unified market infrastructure. Barriers to cross-border activity include the lack of legal harmonisation and, in some cases, incompatible clearing and settlement systems. Consider the euro

[6] Another view of government debt is that deficit financing stimulates an increase in desired private saving that offsets the decrease in public saving, and so government debt does not have any important effects on real economic activity (Barro (1974)). This view is known as the Ricardian equivalence theorem. Although many economists doubt that Ricardian equivalence holds, this theorem has had an extraordinarily important influence on the academic debate about government debt.

government securities market. In contrast to the Japanese government securities (JGS) market or US Treasury markets, 12 different issuers participate in the euro government securities market. The single largest borrower, the Italian Treasury, accounts for no more than 30% of the outstanding stock of euro-denominated government securities. Competition among issuers can be a positive force for integration. However, differences in governments' credit ratings, issuance techniques and instruments remain an obstacle to the fungibility of euro area government securities.

Despite the continued fragmentation of euro-denominated financial markets, many investors now take a euro area-wide perspective rather than a national one when deciding their portfolio allocations.[7] Prior to the introduction of the euro, regulations and prudential policies restricting currency mismatches on the balance sheets of many financial institutions and institutional investors had led to a strong national bias in portfolio allocations. The single currency effectively relaxed such restrictions and enabled investors to achieve a greater degree of diversification by investing across the euro area. While this broadened the investor base, it also reduced the number of captive investors who previously had purchased securities issued domestically for lack of alternative investments. In effect, the single currency intensified competition among issuers for funds.

The launch of the euro also triggered a search for a euro-denominated benchmark to replace benchmarks in the legacy currencies. Monetary union greatly expanded the universe of instruments that could be used as benchmarks and thereby made obsolete many of the benchmarks in the legacy currencies. McCauley and White (1997) suggested that for a yield curve benchmark, a private one would emerge, specifically the interest rate swaps curve (see Section 6).

2.3 Traumatic events

The late 1990s also witnessed a number of credit events that left a lasting imprint on fixed income markets. The near collapse of Long-Term Capital Management (LTCM) in September 1998 was especially notable. In a report on the events of 1998, the CGFS (1999c) notes that the LTCM crisis exposed the shortcomings of certain financing, trading and hedging techniques common in markets at that time. In particular, relative value "arbitrage" trades, which use leverage to exploit small pricing anomalies, were shown to be anything but riskless.[8] Inadequate risk management practices led investors engaged in such trades to underestimate the risks to which they were exposed and the extent to which these risks were correlated.

The 1998 crisis also highlighted the risks inherent in the use of government bonds and related derivatives to hedge positions in non-government securities – a routine strategy among dealers up until that time. The features that make government securities so unique may at times cause their prices to move out of synch with changes in the prices of credit products. This is especially likely to be the case during periods of financial turmoil, when losses on riskier assets often provoke a flight to quality and liquidity, which historically meant a flight to government securities. The resulting imbalance in the supply of and demand for government securities can cause the (normally stable) relationship between government and non-government bond yields to break down. Episodes of this sort had earlier forced market participants to re-examine their use of US Treasury bill rates as a proxy for private rates in the dollar money market, eventually leading participants to reference the eurodollar rate instead (McCauley (2001)). The events of August-October 1998, during which banks and dealers incurred losses on their short positions in Treasury securities that more than offset any gains on their long positions in dollar-denominated private securities, triggered a similar process in bond markets.

Unexpected changes in the supply of government securities also at times caused a sudden widening of the spread between government and private yields. Such shocks then further strengthened the incentive to switch to alternative hedging vehicles, ie agency securities, corporate bonds, interest rate swaps, and other non-government instruments (see Section 4). In the late 1980s, a reduced supply of US Treasury bills had accelerated the substitution of a private for a government instrument in money markets (McCauley (2001)). In the late 1990s, this process was repeated in bond markets. As early as

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[7] For a discussion of the shift in the relative weight of country and sector factors in pricing euro area equities, see Tsatsaronis (2001).

[8] Arbitrage refers to the opportunity to earn a riskless profit with no investment.

1998, supply factors had weighed on UK gilt yields. In February 2000, the US Treasury's announcement that it would auction fewer 30-year bonds and concentrate buybacks at the long end of the curve seemed to catch market participants by surprise, leading to a sharp decline in long-term Treasury yields.

Another watershed event in the late 1990s was the first ever defaults on Japanese corporate bonds. Yaohan, a large retailer, defaulted on its publicly traded bonds in September 1997, and several Japanese banks followed in subsequent months. As discussed in the accompanying paper by Hattori, Koyama and Yonetani, these defaults called into question the guarantees that trustees had implicitly provided in the past. Consequently, investors began to pay greater attention to the credit quality of issuers. As investors build up expertise to evaluate credit risk, this should over time result in credit spreads that more accurately reflect information about such risk.

2.4 Technology

In the second half of the 1990s, digital and telecommunications technologies began to alter the way fixed income markets functioned. The electronic revolution is affecting fixed income markets in two fundamental ways. First, it is sharply reducing the costs of trading and of distributing information. Second, it is altering the relationships among dealers and end investors. While this trend began on the US markets, it has been to a large extent more impressive and visible on the European markets, where this development has been contemporaneous with other changes triggered by the advent of the euro. The new technologies tended to be focused on the government bond markets, since these have been the most active fixed income markets. The innovations have evidently now begun to spread to other sectors. The other markets that have seen the benefits of new technology include the repo market, the interbank loan and deposit market and the swap markets.

Derivatives exchanges were among the first to demonstrate the cost advantages of digital technology. In 1986, two exchanges – the Stockholm Options Exchange (OM) and the Swiss Options and Financial Futures Exchange (SOFFEX) – introduced the electronic trading of derivatives. Twelve years later, the advantages of this mode of trading proved decisive. In 1998, the trading of derivatives on Eurex, an electronic exchange formed by the merger of Deutsche Terminbörse (DTB) and SOFFEX, surpassed that on the London International Financial Futures and Options Exchange (LIFFE), which then still relied on trading by open outcry. The shift in liquidity from one exchange to the other took place in large part in the bund futures contract, which was traded on both exchanges. In the same year, the Marché à Terme International de France (MATIF) switched from open outcry to electronic trading.

In the cash markets, the new technologies offer significant trading cost advantages for market participants. Dealers can monitor quotes continuously, transactions can be executed quickly, and automatic matching allows instant verification. The whole transaction process is being transformed. By allowing a wide and immediate dissemination of price information, electronic systems enhance transparency in the price discovery process and help establish best prices. Some systems even go beyond single quote information by disclosing the order book, thus providing information about demand or supply schedules. Some platforms offer direct links with the futures markets, allowing for automatic hedging and arbitrage. In the inter-dealer market, electronic trading and matching platforms are replacing the telephone as a means of communication. At the back office, the new technologies make it possible to completely automate the various steps up to the delivery and settlement stage. At the time of settlement, the platforms can provide a common connection with a central counterparty, which can reduce settlement risk significantly.

The new systems are also altering the relationships among dealers and investors by blurring the demarcation between the inter-dealer market and the dealer-customer market. In the inter-dealer market, the MTS system in Europe has found success with the traditional market-maker model, which limits participation to dealers. These dealers are required to fulfil market-making obligations designed to foster liquidity. In the United States, the open model seems to be taking over. Following this model, platforms such as e-Speed and BrokerTec are open to all market participants subject only to minimal eligibility requirements and without imposing any market-making obligations. These open systems have cannibalised the US Treasury market. Moreover, it is not a big step from these systems to dealer-customer systems. TradeWeb, in particular, is a multi-dealer system that is beginning to dominate dealer-customer transactions in US Treasury securities. Such a system seems to be giving customers increased access to a centralised market for price discovery, a market that had traditionally been limited to dealers.

While open dealer systems and multi-dealer customer systems may begin to converge, they remain separated by a difference in technical architectures. Among dealers, the emphasis on safety and speed has translated into the use of secured devoted telephone lines. Between dealers and end investors, the importance of minimising costs in reaching the widest possible range of customers has so far led to an emphasis on internet technology.

If open dealer systems and multi-dealer customer systems combine to take over fixed income markets, the issue that arises is whether such systems will be able to provide liquidity in times of stress. In the traditional market-maker systems, dealers were obliged to provide such liquidity in exchange for their privileged access to a centralised market for price discovery. In systems where no participant has a market-making obligation, the availability of liquidity will have to depend on whether well informed and well capitalised investors can be expected to take the other side of a market that is becoming one-sided.

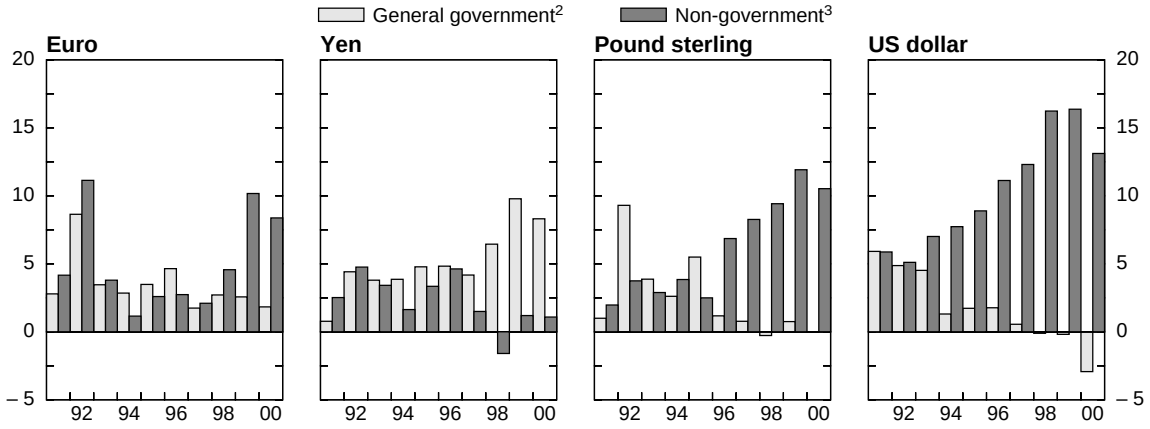
3. New patterns of issuance

The impact of the various forces for change has been easiest to measure on the volume of issuance. Outside Japan, government issuance slowed substantially in the late 1990s, and at the same time issuance by corporations, financial institutions and other non-government borrowers soared (Graph 2). As a result of these shifts in the volume of issuance, between 1995 and 2000 the outstanding stock of debt securities issued by industrial country governments fell to 35% of debt securities issued worldwide from 45% (Graph 3). The types of instruments issued have also changed. In particular, big European, US and supranational borrowers have competed to provide liquid instruments that could fulfil the benchmark and hedging roles traditionally performed by government securities.

Graph 2

Net issuance of debt securities[1]

As a percentage of nominal GDP

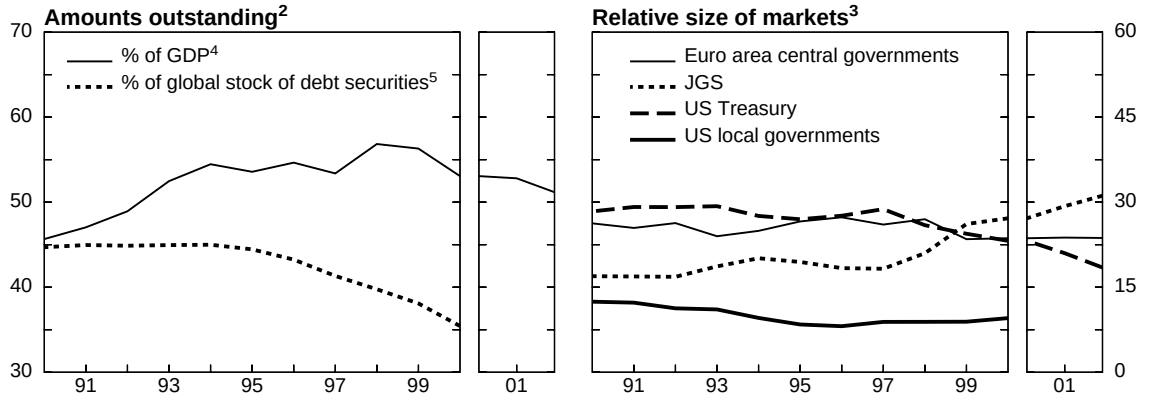


[1] Net issuance of money market instruments and bonds in domestic and international markets. [2] Central governments, local governments and central banks. Data exclude issues by foreign governments. [2] Non-financial corporations, financial institutions, government-sponsored enterprises and supranational institutions.

Sources: Bank of England; Dealogic Capital Data; Euroclear; International Securities Market Association (ISMA); Thomson Financial Securities Data; national data; BIS calculations.

Graph 3

Government securities markets[1]



[1] Projections for 2001 and 2002 are based on OECD forecasts of general government borrowing requirements (see Graph 1). [2] Outstanding stock of debt securities issued by general government borrowers in industrial countries. [3] As a percentage of the outstanding stock of debt securities issued by general government borrowers in industrial countries. [4] As a percentage of industrial countries' GDP. [5] As a percentage of the outstanding stock of debt securities issued worldwide by government and non-government borrowers.

Sources: Bank of England; Dealogic Capital Data; Euroclear; ISMA; OECD; Thomson Financial Securities Data; national data; BIS calculations.

3.1 Government securities markets

Beginning in the 1970s, government securities markets in many industrial countries experienced a long period of expansion. Fiscal deficits led to the large-scale issuance of treasury bills and bonds, and government debt managers and market participants alike grew accustomed to ever increasing supplies of government debt. The fiscal consolidation of recent years has broken this general trend. In 2000, net issuance of government securities fell to its lowest level in decades, and the outstanding stock of debt securities issued by industrial country governments declined to 53% of GDP from a peak of 57% in 1998 (Graph 3).

Government securities markets are shrinking fastest in the United Kingdom, the United States and other industrial countries with fiscal surpluses. Between 1998 and 2000, the US Treasury market contracted by 11%, to $3 trillion, and it is projected to contract by at least a further 10% by 2002.[9] The local government securities market in the United States – which at $1.2 trillion is one of the largest debt markets in the world – continues to grow, but not by enough to offset the decline in the US Treasury market. Government securities markets in the euro area have maintained their size in recent years and are set to surpass the US Treasury market in terms of amounts outstanding.

At the other end of the spectrum, the size of the Japanese government securities market increased by 27% between 1998 and 2000, to ¥400 trillion. It is projected to expand by upwards of 15% by 2002.[10] The JGS market replaced the US Treasury market as the world's largest government securities market in 1999, and on present trends JGS will account for over 30% of outstanding securities issued by industrial country governments within a few years.

Governments have responded to changes in their financing requirements, and in the euro area to greater competition among issuers following the introduction of the single currency, by modifying their debt management operations (see Annex 1). Many of these modifications are intended to improve the

[9] The US Office of Management and Budget (2001) forecasts that debt held by the public will decline by approximately $230 billion in each of fiscal years 2001 and 2002.

[10] The Japanese Ministry of Finance (2001) forecasts that government bonds outstanding will increase by approximately ¥30 trillion in fiscal year 2001, excluding FILP bonds (see Section 3).

liquidity of government securities and manage the profile of maturing debt. Governments typically attach high importance to the maintenance of a liquid market for their securities because it lowers borrowing costs and, by enhancing the attractiveness of government securities as benchmark instruments, supports the efficient functioning of markets. The maturity profile of outstanding debt is also important because it influences governments' exposure to interest rate risk and can affect the demand for, and consequently liquidity of, outstanding issues. Larger governments in the euro area have been particularly active in adapting their maturity profiles to demand, in an effort to establish their securities as benchmark instruments at different points along the yield curve.

In general, the larger the trading supply and substitutability of a financial instrument, the higher is its liquidity (CGFS (1999b); McCauley and Remolona (2000)). To improve the liquidity of their securities – or in those countries retiring debt, to forestall any deterioration in liquidity – a number of governments began in the late 1990s to concentrate their borrowing in fewer, sometimes larger bond offerings. In the United Kingdom and the United States, the number of original maturities and the frequency of auctions were reduced. In the euro area, several governments increased the size of offerings and took steps to regularise their issuance programmes, especially their issuance of treasury bills. One way in which some euro area treasuries have regularised their operations is by cutting back on their issuance of inflation-linked bonds and other unconventional securities. The French, UK and US governments, however, remain committed to issuing indexed securities.

Reopenings enable issues with the same coupon and maturity to be built up over time. France and the United Kingdom have made regular use of reopenings since at least the early 1990s, and in recent years the US Treasury and other euro area governments have followed suit. A number of governments in the euro area have also explored the use of alternative distribution channels to boost the size of their initial offerings. For example, syndication has enabled some treasuries to issue a larger bond than they would normally be able to sell through an auction. Joint issuance programmes have been mooted as a means of raising issue sizes, especially for smaller governments in the euro area (European Commission (2000)).

Another important way in which governments have concentrated their borrowing is through the introduction of exchange and buyback programmes. The United Kingdom has regularly conducted "switch" auctions since 1999, allowing bondholders to convert their holdings of less liquid bond issues into more liquid ones. Several euro area governments have established comparable programmes. In 2000, European and US governments began buying back outstanding debt through reverse auctions. Debt buyback programmes help to concentrate liquidity in the remaining bond issues and, moreover, enable issuers to better manage the maturity profile of their debt. The UK and US governments repurchased £2.7 billion and $30 billion (face value) worth of bonds, respectively, during 2000, equivalent to approximately 1% of their outstanding debt. France, Italy and several other countries in the euro area conducted similar operations, with some governments using the revenues raised through 3G auctions to repurchase their securities.

Table 1

Maturity profile of central government debt

Average remaining years to maturity

End of period	1995	1996	1997	1998	1999	2000
Euro area[1]	...	...	...	...	6y	...
Japan[2]	...	...	...	...	5y 6m	5y 2m
United Kingdom[3]	10y 5m	10y 1m	10y 1m	10y 2m	10y	9y 11m
United States[4]	5y 3m	5y 3m	5y 5m	5y 6m	5y 6m	5y 10m

[1] Domestic government debt. [2] Japanese government securities, excluding financing bills. [3] Debt held by the public, calculated using the latest possible redemption date. Data are as of end-March. [4] Marketable debt held by the public, excluding inflation-indexed bonds.

Sources: Bailey (2000); ECB; Japanese Ministry of Finance; US Treasury.

Although in an entirely different fiscal situation, Japan has also taken steps in recent years to promote the liquidity of its government securities market. In addition to boosting issue sizes, the Japanese government has increased the number of original maturities. For example, in 1999, it began issuing one-year Treasury bills and five- and 30-year bonds. Greater availability of debt across the maturity spectrum both promotes the development of a meaningful yield curve and increases the appeal of JGS to investors with different maturity needs.

To date, the changes that governments have made in their debt management strategies have enabled them to forestall significant shifts in the average maturity of their debt. The average remaining years to maturity for JGS, gilts and US Treasuries remained more or less unchanged in the period 1999-2000 (Table 1). However, owing in part to changes in demand, the results of governments' efforts to maintain a liquid market for their securities have been more mixed (see Section 5).

3.2 Non-government bond markets

One of the most significant developments in fixed income markets has been the surge in net issuance of debt securities by corporations, financial institutions and other non-government borrowers. The US dollar market nearly doubled in size between 1995 and 2000, to $13.2 trillion (Table 2). Euro-denominated issuance by non-government entities rose noticeably following the introduction of the euro. Even the outstanding stock of yen-denominated non-government securities expanded modestly in the late 1990s. However, at $4 trillion and $2.6 trillion respectively, the euro and yen non-government securities markets remain less than one third the size of the US dollar market.[11]

3.2.1 US dollar market

The US dollar market has long been the largest and most heterogeneous non-government securities market in the world. Many different types of issuers and investors have historically been active in the dollar market, and a wide variety of instruments have been made available. Despite already being well developed, in the late 1990s the US dollar market remained a dynamic environment. New issuers tapped the market, including many lower-rated borrowers, such as developing country residents and dotcom firms. New products gained broader acceptance: for example, asset-backed commercial paper, home equity loan-backed securities, and credit-linked notes. And above all, non-government issuance soared. From 7% of GDP in the first half of the 1990s, net issuance rose to 15% in the 1998-2000 period.

The growth of the non-government segment of the US dollar market at a time when government issuance declined raises questions about the extent to which the latter contributed to the former. Under the crowding-out hypothesis, reductions in government borrowing should stimulate an increase in private investment. Recent macroeconomic developments are consistent with this hypothesis. During the 1990s, long-term interest rates, and consequently firms' cost of capital, fell significantly in the United States, and private investment increased to levels not seen in decades. Notably, much of the increase in investment was financed by issuing bonds, not equities; net issuance of equities actually turned negative in the latter half of the 1990s. Therefore, to the extent that fiscal consolidation brought about the rise in private investment, then it would also have been a key factor behind the recent growth of the US dollar bond market. However, it is difficult to identify the direction of causation. The rise in private investment could have arisen from an exogenous shock, such as technology-related improvements in productivity. Likewise, the propensity for established firms to increase their leverage through debt-financed repurchases of equity – in an effort to enhance their return on equity – may have had a larger impact on bond issuance in the late 1990s than changes in government supply.

[11] The outstanding stock of debt securities issued by non-government borrowers worldwide totalled $22.2 trillion at the end of 2000. The euro, yen and US dollar markets together account for a little less than 90% of this amount. The sterling market is the fourth largest market, and accounts for 4% of the global stock of non-government securities.

Table 2

Non-government securities markets

Percentage of outstanding non-government securities

End of period	Euro		Yen		Sterling		US dollar	
	1995	2000	1995	2000	1995	2000	1995	2000
Corporations	8.2	17.7	27.4	34.0	28.0	32.4	28.5	24.8
Financial institutions	57.0	53.6	42.8	39.8	65.6	59.4	18.9	20.8
Commercial banks	49.6	44.7	42.1	37.0	41.8	39.6	11.1	12.4
Other fin. institutions	7.4	8.9	0.7	2.7	23.8	19.8	7.8	8.5
Collateralised debt	...	...	...	...	...	...	39.6	39.2
ABS[1]	...	...	0.0	0.0	...	...	6.1	12.2
MBS/Pfandbriefe[2]	18.6	19.6	...	...	...	...	33.5	27.0
of which: Agency[3]	1.2	8.8	...	...	...	...	22.4	18.8
GSEs[4]	11.8	5.8	26.7	24.1	0.7	0.2	11.5	13.7
Supranationals[5]	4.5	3.4	3.1	2.2	5.7	8.0	1.6	1.5
Memo: International[6]	18.5	43.1	13.3	16.7	47.5	50.4	11.3	21.6
Total (trn US$)[7]	3.4	4.0	2.5	2.6	0.4	0.9	7.0	13.2

[1] Asset-backed securities. [2] For the euro area, Pfandbriefe; for the United States, mortgage-backed securities (MBS) and collateralised mortgage obligations. [3] For the euro area, Jumbo Pfandbriefe; for the United States, MBS and collateralised mortgage obligations issued by Fannie Mae, Freddie Mac and the Government National Mortgage Association. [4] Government-sponsored enterprises, excluding debt securities issued by non-resident GSEs. [5] Supranational institutions, including debt securities issued by GSEs resident abroad. [6] International segment of the non-government securities market, ie debt securities issued in a foreign currency or sold in whole or in part to investors outside the issuer's domestic market. [7] Outstanding stock of non-government debt securities, converted into US dollars at end-of-period exchange rates.

Sources: Bank of England; Deutsche Bundesbank; Bond Market Association; Dealogic Capital Data; Euroclear; ISMA; Japan Securities Dealer Association (JSDA); Thomson Financial Securities Data; national data; BIS calculations.

Empirical studies of government debt fail to offer convincing evidence either for or against the crowding-out hypothesis.[12] Nevertheless, recent issuance patterns provide anecdotal support. If changes in government supply induce changes in non-government borrowing, then non-government entities might be expected to step up their issuance in those segments of fixed income markets that governments are vacating, ie to step up their issuance of securities with risk characteristics similar to those of government bonds. This appears to be occurring. Triple-A rated borrowers have become much more active in the US dollar market in recent years, accounting for over 50% of announced international issues in 2000 compared to approximately 25% a few years earlier (Graph 4). Issuance by US government-sponsored enterprises (GSEs), in particular Fannie Mae and Freddie Mac, grew especially rapidly in the late 1990s – indeed all through the 1990s. Mortgage-backed securities (MBS) remain the largest component of GSE debt, but GSE issuance of straight bonds has outstripped their issuance of MBS in recent years: whereas the outstanding stock of agency MBS increased by approximately 60% to $2.5 trillion between 1995 and 2000, the stock of GSE securities more than doubled to $1.8 trillion (Table 2).

There are also clear signs of greater competition among non-government issuers to offer a highly liquid instrument. The average size of US dollar-denominated issues increased noticeably in the late 1990s (Graph 5). Even more telling was the increase in the number of very large bond issues – offerings greater than $1 billion. Efforts by large borrowers to improve the liquidity of their debt instruments typically involved revamping debt management programmes to mimic the US Treasury's issuance strategy. In early 1998, Fannie Mae introduced its so-called "benchmark" programme, and Freddie Mac its "reference" programme. These programmes emphasise the provision of maturities across the yield curve, provide calendars of regular non-callable issuance, follow transparent pricing procedures, and allow the stripping of interest and principal components of each issue. Freddie Mac

[12] For a survey of the literature on the macroeconomic effects of government debt, see Elmendorf and Mankiw (1999).

went so far as to replace the traditional underwriting syndicate for distributing non-government bonds with an auction system similar to that used to sell Treasuries. Both issuers offer dealers strong incentives to make markets in issues covered by the programmes, and actively encourage the development of repo and derivatives markets. Futures contracts on Fannie Mae and Freddie Mac securities were introduced in early 2000.

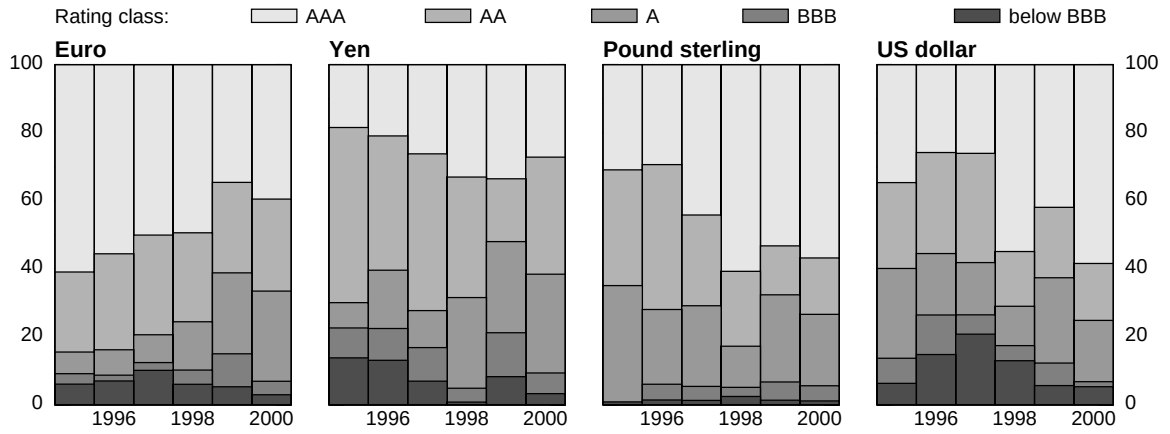
Even some issuers with less than a triple-A credit rating have established Treasury-like issuance programmes, in the hope of benefiting from the lower liquidity premium potentially offered by such programmes. For example, in mid-1999, Ford Motor Company – which is rated single-A – and its finance company subsidiary, Ford Motor Credit, launched their Global Landmark Securities (GlobLS) programme, patterned after the Fannie Mae and Freddie Mac programmes. However, the inflexibility of such programmes and the high underwriting fees often associated with them make them uneconomical for all but the largest borrowers.

In addition to stepping up their issuance of debt securities with similar credit and liquidity risk characteristics to government bonds, non-government issuers might be expected to gravitate to those segments of the yield curve where government issuance declined the most. The existence of regulatory or self-imposed constraints on the maturity structure of investors' balance sheets could reduce the price elasticity of demand, and so strengthen the incentive for non-government entities to step up their issuance in those maturities most affected by declines in government supply. There is little evidence of such a relationship, however. Over the 1999-2000 period, non-government borrowers tended to issue where the US Treasury issued. In particular, in the international segment of the US dollar market, issuance of short maturities increased proportionately more than that of longer maturities, echoing the concentration of new Treasury issues at the short end (Graph 6). It appears that other factors, including the shape of the yield curve and borrowers' investment horizons, had a more important influence on the maturity distribution of new non-government issues than shifts in government supply.

Graph 4

Credit ratings of new non-government bond issues

Percentage of announced rated international issues[1]



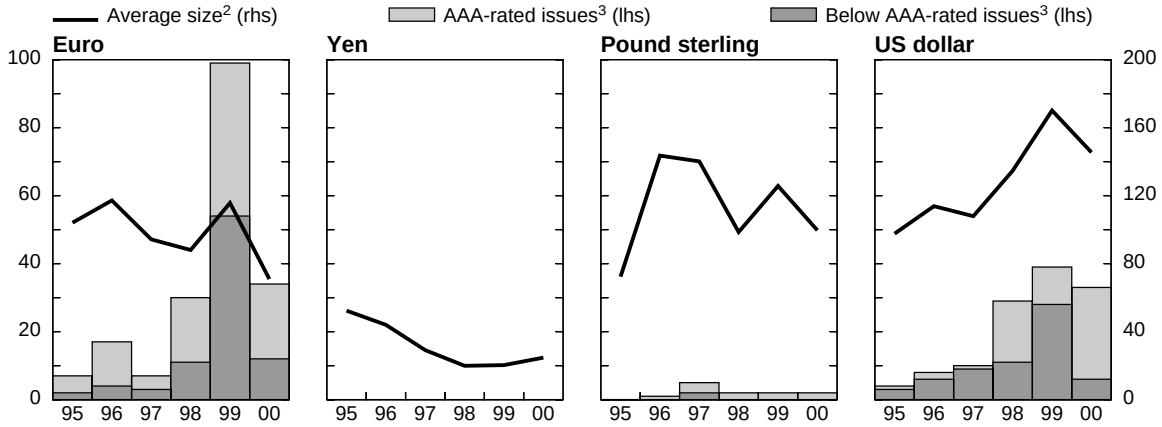
[1] International issues refer to bonds issued in a foreign currency or sold in whole or in part to investors outside the issuer's domestic market. Data exclude money market instruments.

Source: Dealogic Capital Data.

Graph 5

Size of new non-government bond issues

Announced international issues[1]



[1] International issues refer to bonds issued in a foreign currency or sold in whole or in part to investors outside the issuer's domestic market. Data exclude money market instruments. [2] In millions of US dollars. [3] Number of announced international bond issues larger than $1 billion.

Sources: Dealogic Capital Data; BIS calculations.

3.2.2 Sterling market

Many of the trends evident in the US dollar market in recent years were also present in the sterling market. The non-government segment of the sterling market actually grew more rapidly than the non-government segment of the dollar market, albeit from a much smaller base: between 1995 and 2000, the outstanding stock of sterling-denominated debt securities issued by non-government entities increased nearly threefold, to £635 billion. As in the dollar market, triple-A rated borrowers aggressively stepped in to provide substitutes for declining supplies of government securities (Graph 4). UK government enterprises borrow directly from the government rather than in the capital markets, and so GSE issuance in the sterling market is minimal. But supranational institutions such as the European Bank for Reconstruction and Development (EBRD) and European Investment Bank (EIB) became more active in the sterling market. From negligible amounts in the mid-1990s, net issuance by supranational institutions increased to 1% of UK GDP in the 1998-2000 period.

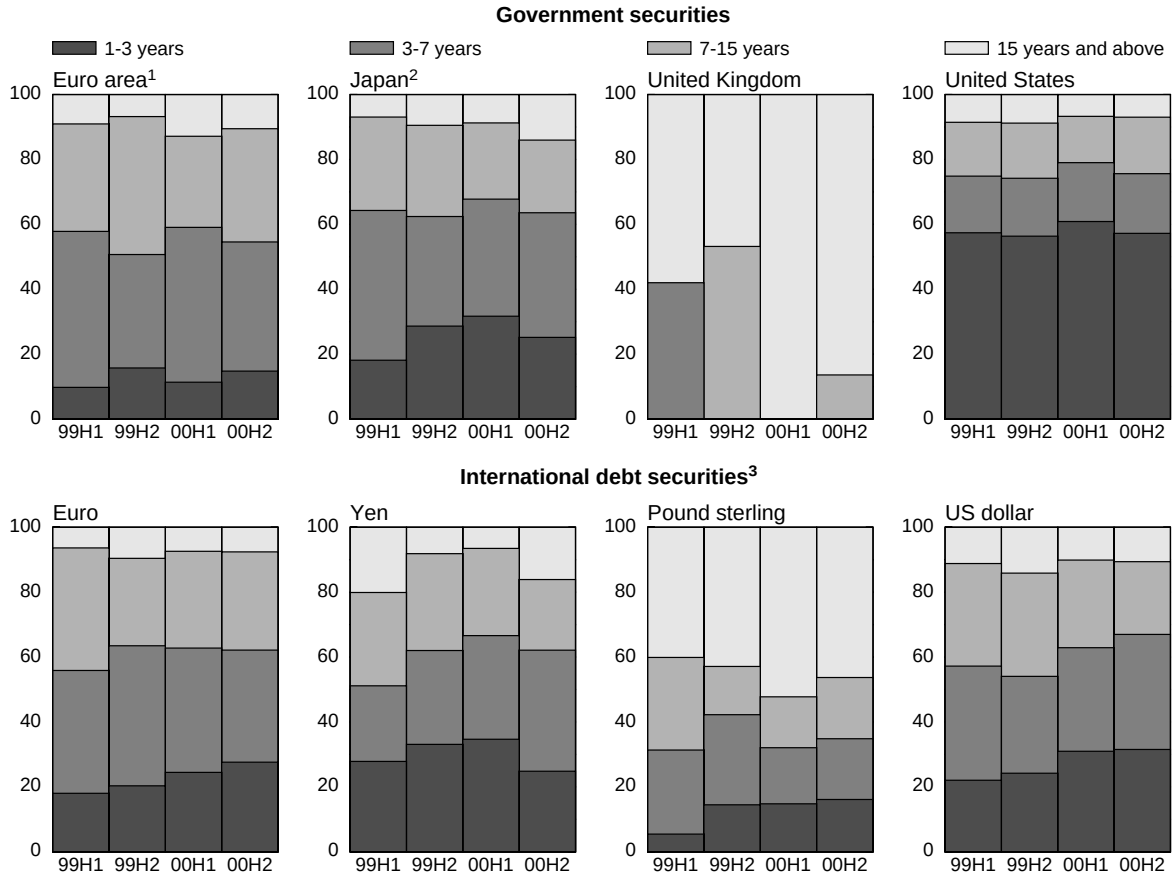
Sterling-based borrowers do not appear to have gone to the same lengths as dollar-based borrowers to improve the liquidity of their securities. In particular, there was no noticeable increase in the size of sterling-denominated issues in the late 1990s (Graph 5). The EBRD experimented with a programme of large, regular bond offerings. However, it decided that any savings arising from a reduction in the liquidity premium were more than offset by the costs associated with a pre-commitment to tap markets regardless of financing conditions.

Among government and non-government issuers alike, long-dated bonds accounted for the bulk of announced issues in recent years (Graph 6). This maturity distribution was driven principally by the inversion of the sterling yield curve. Regulatory requirements are widely thought to have contributed to strong and relatively price-inelastic demand from pension funds and life assurance companies for long-dated sterling bonds. As a result, entities looking to borrow at long maturities found it attractive to issue in the sterling market.

Graph 6

Maturity of new bond issues

Percentage of announced issues



[1] Sum of issuance by France, Germany and Italy. [2] Data for 1999 H1 refer only to the second quarter. [3] International issues refer to bonds issued in a foreign currency or sold in whole or in part to investors outside the issuer's domestic market.

Sources: France Trésor; German Ministry of Finance; Italian Ministry of Finance; Japanese Ministry of Finance; UK Debt Management Office; US Treasury; BIS calculations.

3.2.3 Euro market

The introduction of the euro in January 1999 had a profound impact on the development of the euro private securities market. At one stroke, monetary union unified eleven relatively small and underdeveloped debt securities markets into the second largest non-government market in the world. Differences in national legal systems made the use of cross-border collateral difficult, and so the repo market was slow to break out of the segmentation that characterised it prior to the introduction of the single currency. Ironically, it was the riskier unsecured money market that became integrated first. An integrated bond market also emerged within a few weeks of the launch of the euro. Whereas the euro market had grown at a steady but unremarkable pace for much of the 1990s, net issuance doubled to 9% of euro area GDP in the two years following the introduction of the euro. Higher volumes were accompanied by a noticeable increase in the diversity of issuers, investors and instruments active in euro money and bond markets.

Financial institutions, especially German banks, have traditionally dominated non-government activity in the euro market. Financial institutions remained the largest issuers following the lauch of the single currency, but the corporate segment exhibited the greatest dynamism. Note and bond issuance by non-financial corporations rose to 3.6% of GDP in the 1999-2000 period from 0.6% in the two years before monetary union and, as a result, corporations' share of the outstanding stock of non-government securities denominated in euros doubled between 1998 and 2000, to 16.8% (Table 2).

Telecommunications companies were partly responsible for the increase in corporate activity, issuing large amounts of debt in 1999 and 2000 to finance mergers, acquisitions and purchases of 3G licences. Corporations are typically rated less than triple-A and so, in contrast to the dollar and sterling markets, in the euro market issuance by lower-rated credits increased proportionately faster than that by triple-A rated credits in 1999 and 2000 (Graph 4).

Non-resident issuers were especially active in euro money and bond markets following monetary union. By the end of 2000, non-residents accounted for 15.8% of the outstanding stock of euro-denominated non-government debt securities, compared to less than 10% a few years earlier. UK-based borrowers were the largest non-resident issuers, followed by US borrowers. That euro area residents lagged non-residents in tapping the euro market is not altogether surprising given that relatively few firms in the euro area have credit ratings. For example, in the United States, over 3,000 firms are rated by at least one of the major rating agencies, compared to approximately 500 firms in the euro area (Estrella et al (2000, p37)).

As a result of the broadening in the range of issuers who tapped the euro market following the launch of the single currency, no consistent trend in the average size of new issues is evident (Graph 5). Nevertheless, the number of very large bond issues denominated in euros surged in 1999, as large borrowers competed to concentrate liquidity in their securities. Even before monetary union, Jumbo Pfandbriefe had established themselves as among the most liquid instruments available in the euro market.[13] Created in 1995 by the Association of German Mortgage Banks, Jumbo Pfandbrief have a minimum size of €500 million, a straight bond structure, and the support of at least three market-makers. Since its inception, the Jumbo market has been one of the fastest growing segments of the euro market, with issues outstanding totalling €370 billion at the end of 2000.[14] In his paper in this volume, Mastroeni discusses how the success of the Jumbo Pfandbrief market has spawned imitators in other European countries, such as Obligations Foncières in France and Cédulas Hipotecarias in Spain. At present, none of these other markets comes close to matching the size and liquidity of the Pfandbrief market.

Following the example set in the dollar market, several large borrowers have established programmes of large, regular bond offerings in the euro market. The EIB was the first, launching its Euro Area Reference Notes in early 1999. Freddie Mac followed in late 2000 and Kreditanstalt für Wiederaufbau in 2001. The advent of electronic bond trading platforms strengthened the incentive to consolidate issuance in "benchmark" programmes. In particular, to be eligible to be listed on EuroCreditMTS – a platform launched in May 2000 to trade Pfandbriefe and other non-government bonds – bonds must have a minimum issue size of €3 billion, the outstanding amount of similar bonds must be at least €10 billion, and borrowers must publish a calendar of issuance.

3.2.4 Yen market

Of the major non-government securities markets, the yen market was the only one not to have experienced a period of rapid growth in recent years. Yen issuance picked up in the mid-1990s, peaking at 4.5% of Japan's GDP in 1996, but subsequently fell back. The slowdown in non-government issuance coincided with the rise in JGS issuance. However, in their accompanying study on Japan's corporate bond market, Hattori, Koyama and Yonetani find no evidence that government borrowing crowded out borrowing by non-financial corporations. Instead, the subdued level of non-government issuance is better explained by Japanese firms' low funding needs and banks' financial difficulties.

Notwithstanding its lacklustre growth, the yen market underwent a process of transformation in the latter half of the 1990s. The primary market for corporate bonds was fully liberalised in 1996, thus encouraging firms used to borrowing from banks to turn to capital markets. The fragility of the Japanese banking system in the 1997-98 period strengthened firms' incentive to tap bond markets, and yen-denominated issuance by non-financial corporations rose to record levels in 1998. Owing to the weakness of the economy, corporate issuance subsequently slowed. Yet, it still remained much

[13] Pfandbriefe are bonds issued by German mortgage banks and collateralised by either loans to the public sector (Öffentliche Pfandbriefe) or mortgages (Hypotheken-Pfandbriefe).

[14] The vast majority of outstanding Jumbos are collateralised by loans to the public sector.

stronger than issuance by financial institutions. Net issuance by banks turned negative during the 1998-2000 period. This was partially offset by the growing activity of non-bank financial institutions, including securitisation vehicles. In particular, ABS and MBS markets began to develop in Japan in the late 1990s.

The GSE market in Japan is also being remade. The outstanding stock of bonds issued by Japanese GSEs, such as the Government Housing Loan Corporation and the Japan Bank for International Cooperation, totalled ¥71 trillion at the end of 2000, equivalent to approximately one quarter of the outstanding stock of yen-denominated non-government securities. However, this figure overstates the size of the market for publicly traded GSE debt. In the past, most bonds issued by Japanese GSEs were placed with government institutions, in particular the Ministry of Finance's Trust Fund Bureau and the postal life insurance system. The stock of publicly issued, government-guaranteed bonds totalled only ¥25 trillion at the end of 2000. The reform of the Fiscal Investment and Loan Program (FILP) could eventually lead to the large-scale issuance of marketable GSE bonds; FILP agency bonds, which do not carry a government guarantee, were introduced in April 2001. However, in the near term, few GSEs are expected to be able to issue FILP agency bonds at a reasonable cost, and so the Japanese government will continue to issue bonds on behalf of its agencies.[15]

Owing in part to shifts in issuance, the yen market is gradually becoming more heterogeneous. Triple-A and especially double-A rated borrowers have historically dominated the non-government segment of the yen market. Although such borrowers continue to account for over half of new issuance, single-A rated entities have become relatively more active. Also, whereas in the past issuance tended to be concentrated in medium-term maturities, non-government issuance of longer-dated bonds is picking up. Notably, in contrast to the dollar and euro markets, there appears to be little competition among non-government borrowers in the yen market to offer potentially liquid securities. The average size of new international issues is much smaller in the yen market than in the other major markets, and there are few instances of very large offerings by non-government borrowers.

4. The response of investors

While investors as a group must necessarily shift their portfolios to match the new supplies of debt securities, fixed income markets will be shaped in part by the smoothness with which this shift takes place; supply-demand imbalances can seriously disrupt the normal functioning of markets. Overall, investors appear to have willingly modified their investment strategies to accommodate changing borrowing patterns. At the same time, traumatic events and other exogenous changes in fixed income markets led investors to re-assess their arbitrage and hedging activities.

4.1 Composition of portfolios

The limited data that are available on the composition of portfolios suggest that most classes of investors have adjusted their investment strategies to at least some degree to accommodate recent shifts in supply. The large number of performance indices introduced by the major investment banks over the past few years bears witness to institutional investors' willingness to move towards more diversified portfolios. Nevertheless, some investors adapted more readily than others. This resulted in important changes in the mix of investors holding government securities in particular.

[15] Under the reform of the FILP, effective 1 April 2001, funds accumulated by the postal savings system, postal life insurance system and government pension plans will no longer be deposited with the Trust Fund Bureau and instead will be invested in financial markets. FILP agencies will finance their activities by issuing FILP agency bonds, government-guaranteed bonds or FILP bonds. FILP bonds differ from government-guaranteed bonds in that they are issued directly by the government. FILP bonds are equivalent to Japanese government bonds.

Table 3

Holdings of financial assets

Percentage of total financial assets

End of period	Euro area		Japan		United Kingdom		United States	
	1997[1]	2000[1]	1995[2]	2000[2]	1995	2000	1995	2000
	Households[3]							
Currency and deposits	42.5	34.7	51.2	54.1	24.2	22.2	13.2	10.6
Debt securities	15.3	12.5	3.6	3.1	1.6	1.3	11.0	9.4
Government	...	...	1.2	1.6	0.8	0.8	5.5	2.5
Non-government	...	...	2.4	1.6	0.8	0.5	5.5	6.9
Shares and other equity[6]	...	...	15.6	11.3	19.5	23.2	45.2	48.1
of which: Listed shares[7]	13.2	19.6	6.4	4.5	8.7	8.9	19.2	21.0
Mutual funds[8]	8.5	11.9	2.5	2.6	3.8	5.9	5.3	9.2
Insurance reserves[9]	20.6	21.4	25.5	27.1	51.0	50.3	28.7	29.6
Other financial assets	...	...	4.1	4.3	3.7	3.0	1.9	2.3
Memo: Total (trn US$)[10]	12.8	13.1	12.0	11.5	3.0	4.3	21.7	33.4
	Insurance companies and pension funds[4]							
Currency and deposits	5.3	4.2	5.9	3.7	4.6	3.8	2.1	1.6
Debt securities	29.9	42.9	27.8	37.7	23.8	27.7	42.3	34.3
Government	...	...	16.6	22.9	15.0	12.4	9.7	5.8
Non-government	...	...	11.2	14.8	8.9	15.3	32.6	30.2
Shares and other equity[6]	...	...	33.9	32.2	67.9	64.6	36.6	46.7
of which: Listed shares[7]	63.8	51.5	22.3	17.8	45.3	42.2	30.4	36.4
Mutual funds[8]	...	...	0.6	0.7	6.7	8.1	6.2	10.3
Other financial assets	1.1	1.4	32.5	26.4	3.7	3.9	19.0	14.7
Memo: Total (trn US$)[10]	...	1.8	2.6	2.5	1.5	2.4	5.7	8.6
	Banks[5]							
Currency and deposits	...	...	13.0	12.6	36.4	34.9	1.5	1.0
Debt securities	17.1	16.1	10.2	16.7	15.5	16.3	21.3	20.0
Government	9.1	6.9	5.9	12.2	2.1	0.3	8.3	4.6
Non-government	8.0	9.2	4.3	4.5	13.4	16.0	13.0	15.4
Shares and other equity[6]	...	...	8.8	6.9	2.1	2.9	0.2	0.4
of which: Listed shares[7]	2.9	5.2	5.3	3.2	0.2	0.3	0.1	0.2
Loans	73.2	71.7	63.9	59.2	45.6	45.7	58.8	59.7
Other financial assets	6.9	7.0	4.2	4.6	0.3	0.1	18.3	19.0
Memo: Total (trn US$)[10]	12.7	13.5	10.7	9.5	3.1	4.8	4.5	6.5
	Rest of the world							
Currency and deposits	...	...	10.4	3.1	50.5	39.6	7.0	5.5
Debt securities	...	...	15.8	15.7	14.9	11.7	40.4	39.3
Government	...	...	5.5	11.4	3.9	2.0	24.1	16.2
Non-government	...	...	10.3	4.4	11.0	9.8	16.3	23.0
Shares and other equity[6]	...	...	20.6	31.0	16.8	29.2	34.6	43.6
of which: Listed shares[7]	...	...	20.0	29.4	9.1	19.7	15.1	23.7
Other financial assets	...	...	53.1	50.2	17.8	19.4	18.1	11.6
Memo: Total (trn US$)[10]	...	...	2.0	1.8	2.5	4.8	3.5	7.2

[1] For pension funds, 1997 refers to February 1998. For households, 2000 refers to September 2000. [2] Fiscal year, eg 2000 refers to March 2001. [3] Households and non-profit institutions serving households. For the euro area, data refer to the non-financial sector, ie households, non-financial corporations and general government. [4] For the euro area, pension funds only, based on Merrill Lynch's *Fund Manager Survey*. For Japan, data exclude the postal life insurance system and public sector pension funds. [5] Banks refer to: in the euro area and the United Kingdom, monetary financial institutions; in Japan, depository corporations excluding the postal savings system and collectively managed trusts; in the United States, commercial banks. For the euro area, data exclude external assets. [6] Comprises equity securities, unlisted shares, mutual funds and personal trusts. For Japan, data include foreign debt securities. [7] Shares issued by residents and either listed on an exchange or registered in an over-the-counter market. [8] For the euro area and the United States, money market mutual funds are included with non-government debt securities. [9] Net equity position in life insurance and pension fund reserves, and premium prepayments. [10] Total financial assets, converted into US dollars at end-of-period exchange rates.

Sources: Bank of Japan; ECB; Federal Reserve System; Merrill Lynch; UK Office for National Statistics (ONS); BIS calculations.

4.1.1 Sterling and US dollar-based investors

UK and US investors have long held broadly diversified portfolios, with a heavy concentration in equities and a relatively small proportion of their assets held in safe, liquid instruments such as government securities and bank deposits (Table 3). Their holdings of higher-risk assets rose gradually through most of the 1990s, driven by the long bull market in equities as well as incremental portfolio adjustments. Beginning in the mid-1990s, banks, securities firms, insurance companies and households in the United States reduced their holdings of US Treasuries and, at the same time, stepped up their purchases of GSE securities. In the United Kingdom, banks and securities firms have been net sellers of gilts since 1997, and insurance firms since 1998, purchasing instead debt securities issued by UK and foreign residents. Other classes of investors were slower to reduce their holdings of government securities. For example, US pension funds continued to purchase Treasury securities, and UK pension funds to purchase gilts, through 2000. Nevertheless, there is little indication that the declining stock of government securities made investors any less willing to hold riskier assets.

Changes made by central banks in the composition of their portfolios suggest that investors are finding other near-riskless assets to substitute for government securities. So as to maintain a liquid, low-risk portfolio and guard their neutrality towards market participants, central banks have historically invested the bulk of their reserves in government securities. Consequently, central banks have been among the slowest investors to adjust to the diminished supply of gilts and Treasuries. Yet even they have begun to diversify. US Treasuries remain the most popular investment among foreign central banks, comprising over half of US dollar-denominated reserves. But since 1998, foreign central banks have gradually shifted their dollar purchases towards GSE securities. As a result, between 1998 and 2000, the share of central banks' (identified) dollar reserves invested in GSE securities rose to approximately 5% from 3%, whereas the share invested in US Treasuries fell to 59% from 62% (see Annex 2).

Likewise, while the Federal Reserve System still holds most of its portfolio in Treasury securities, it is taking steps to diversify into credit products. In 1999, the Fed expanded the pool of collateral eligible for use in open market operations to include agency MBS. Other central banks accept a wider range of collateral than the Fed. For example, the Eurosystem accepts high-quality debt and equity securities, and even some non-marketable debt instruments. If the experience of these central banks is any guide, central banks' portfolios need not consist entirely of highly liquid securities for them to implement monetary policy effectively. Indeed, one advantage of using repurchase agreements to conduct open market operations is precisely that they do not require a liquid underlying market (Borio (1997)). In a study of the implications of the declining US Treasury market, Schinasi et al (2001) suggest that investors might come to regard any assets that are eligible to be used as collateral in transactions with central banks as safe haven assets.

As a result of the different paces at which investors are adjusting their portfolios, an increasing proportion of UK gilts and US Treasury securities is held by investors following relatively passive asset management strategies (Table 4).[16] Pension funds, life insurance companies, mutual funds and government bodies, including central banks, together held 72% of UK gilts and 65% of US Treasuries in 2000, up from 66% and 57% respectively in 1995. Pension funds were responsible for most of the increase in passive investors' holdings of gilts, and central banks – the Fed as well as foreign central banks – for the increase in passive investors' holdings of US Treasuries.

4.1.2 Euro-based investors

Aggregate data on the portfolio allocations of euro area residents are not readily available, but anecdotal evidence suggests that in the latter half of the 1990s especially, euro area investors adopted more aggressive investment strategies. Net purchases of equities by euro area households and corporations jumped to nearly 6% of GDP in the 1998-99 period from less than 2% a few years earlier. At the same time, deposit flows, traditionally the savings vehicle of choice in the euro area, halved to 2%. Euro area residents began in the mid-1990s to reduce their holdings of debt issued by

[16] Pension funds, life insurance companies, mutual funds and government bodies tend to have longer investment horizons than other investors, and so trade their positions less often. In particular, pension funds and life insurance companies typically buy securities with the intention of holding them until maturity. Most mutual funds concentrate their purchases in a predefined asset class and are restricted from diversifying into other assets.

Table 4

Ownership of government securities

Percentage of outstanding government debt

End of period	Euro area[1]		Japan[2]		United Kingdom[3]		United States[4]	
	1995	2000	1995[5]	1999[5]	1995[5]	1999[5]	1995	2000
Passive investors	...	...	66.4	60.6	73.8	77.2	57.2	67.4
Public sector	...	...	52.4	48.0	14.8	14.2	37.1	46.2
Central bank	...	...	16.7	12.0	6.2	5.0	11.7	17.7
Foreign cen. banks[6]	...	...	...	...	5.4	5.4	14.0	18.9
Other public sector[7]	...	...	35.7	36.0	3.2	3.8	11.4	9.6
Insurance companies[8]	14.7	19.5	9.1	9.0	36.5	35.5	7.2	4.0
Pension funds	...	...	4.9	3.6	21.2	26.1	4.3	6.0
Mutual funds	...	...	...	...	1.2	1.4	8.6	11.2
Active investors	...	...	33.6	39.4	26.2	22.8	42.8	32.6
Banks	41.1	33.8	18.8	22.9	4.1	-2.1	9.5	6.6
Households	...	...	4.6	4.5	4.1	9.4	15.5	4.0
Other residents	23.0	13.6	6.0	6.3	9.4	1.0	8.0	1.9
Other non-residents[9]	21.0	33.0	4.2	5.7	8.6	14.5	9.8	20.1
Memo: Total (trn US$)[10]	5.2	4.2	2.6	3.9	0.4	0.5	3.3	3.0
Non-marketable[11]	...	...	...	...	...	...	1.7	2.7

[1] General government gross consolidated debt, including coins, loans and debt securities. [2] Japanese government securities, including financing bills. [3] UK government securities. [4] Marketable US Treasury securities. [5] Fiscal year, eg 1999 refers to March 2000. [6] For Japan, foreign central banks are included with other non-residents. [7] For Japan, other public sector includes the Trust Fund Bureau and the postal system. For the United States, other public sector includes state and local pension funds. [8] For the euro area, insurance companies refer to non-bank financial institutions. [9] For the euro area, other non-residents include residents of the euro area outside the country whose government issued the debt. [10] Outstanding stock of government securities, converted into US dollars at end-of-period exchange rates. [11] Outstanding stock of non-marketable government debt, in trillions of US dollars.

Sources: Bank of England; Bank of Japan; ECB; Federal Reserve System; ONS; US Treasury; BIS calculations.

their own government and to diversify into other assets. By contrast, non-residents, including euro area residents outside the country where the issuer is located, were net buyers of euro area government securities throughout the 1990s, and especially in the 1998-99 period. As a result, non-residents' holdings of euro area government debt rose to 30% of the outstanding stock in 1999 from 21% in 1995.

Recent innovations in fixed income indices confirm that euro area investors shifted away from conservative investments and into credit products and other higher-risk instruments. Whereas a plethora of indices for US fixed income markets have existed since at least the mid-1980s, indices for euro markets had previously tended to focus on government securities. That changed in the run-up to monetary union. Beginning in the mid-1990s, indices were introduced for a wide range of euro-denominated debt instruments, from Jumbo Pfandbriefe to high-yield bonds. These sectoral indices were often combined to form "broad" or "aggregate" indices covering the universe of euro-denominated bonds. Portfolio managers are increasingly considering derivatives alongside notes and bonds when constructing a portfolio of credit products, and this has been reflected in the creation of indices covering interest rate swaps in various currencies and default swaps on large corporations.

Privatisation and the favourable performance of European equity markets were important factors behind the move towards more diversified portfolios, and the rise in equity holdings in particular, in the late 1990s. The institutionalisation of savings – for example, as retail investors placed more of their financial assets with professional fund managers – also supported a growing appetite for risk. Finally, the single currency and the consequent convergence of interest rates across the euro area prompted investors used to achieving higher returns through currency diversification to turn to equities and credit instruments to pick up extra yield.

4.1.3 Yen-based investors

Japanese investors have traditionally preferred low-risk investments, but structural changes in the domestic bond market in the late 1990s laid the foundations for an eventual move towards more diversified portfolios. As discussed in the accompanying paper by Hattori, Koyama and Yonetani (2001), investors had historically considered corporate bonds issued in Japan to be implicitly guaranteed by the trustee. Consequently, credit risk analysis was not well developed. This changed in 1997, when a series of corporate bond defaults prompted investors to pay greater attention to the credit quality of issuers. Furthermore, index providers introduced the first broad indices for the Japanese market in 2000, suggesting that investors' appetite for yen-denominated credit products is growing.

These structural changes notwithstanding, Japanese investors remained conservative in their portfolio choices in recent years. Currency and bank deposits continued to account for over 50% of households' total financial assets. Among pension funds, private insurance companies and commercial banks, purchases of non-government debt securities and equities did not keep pace with purchases of government securities, and so by 2000 their portfolios were less diversified than in 1995. Commercial banks in particular invested heavily in short-term financing bills in 1999 and 2000, resulting in a near doubling of their JGS holdings.

Banks' purchases helped to boost the proportion of JGS held by investors who turn over their portfolios relatively frequently. Commercial banks, securities firms and other private lending institutions now hold 34% of the outstanding stock of JGS, up from 29% in 1995. But the public sector, including the Trust Fund Bureau, the postal system and the Bank of Japan, continues to hold the largest share of outstanding JGS: 44% in 2000.

Foreign purchases of JGS have picked up in recent years, such that non-residents now hold 6% of the outstanding stock, up from 4% in 1995. However, owing to concerns about the impact of increasing debt levels on JGS prices, most international investors are uncomfortable holding large positions in the JGS market. This is apparent in the construction of fixed income indices. In response to investor demands, some investment banks have altered their indices' eligibility criteria in a way that effectively reduces the weight of Japan. For example, for inclusion in Salomon Smith Barney's World Government Bond Index, minimum issue sizes for JGS are significantly higher than for other government securities: ¥500 billion (approximately $4 billion), compared to $1 billion for US Treasuries and €1 billion for euro area government securities.

Investors' discomfort with the rising share of JGS in the global securities market was also a factor behind the recent advent of global indices offering broad market coverage. Prior to 1999, the only multicurrency indices available to investors with international portfolios were composed exclusively of government bonds. Since 1999, several investment banks have launched international indices that include, in addition to government securities, bonds issued by non-government borrowers. When compared to a government-only index, the weight of JGS is obviously much smaller in an index that includes US GSE securities, Pfandbriefe and other credit products.

4.2 Arbitrage and hedging activity

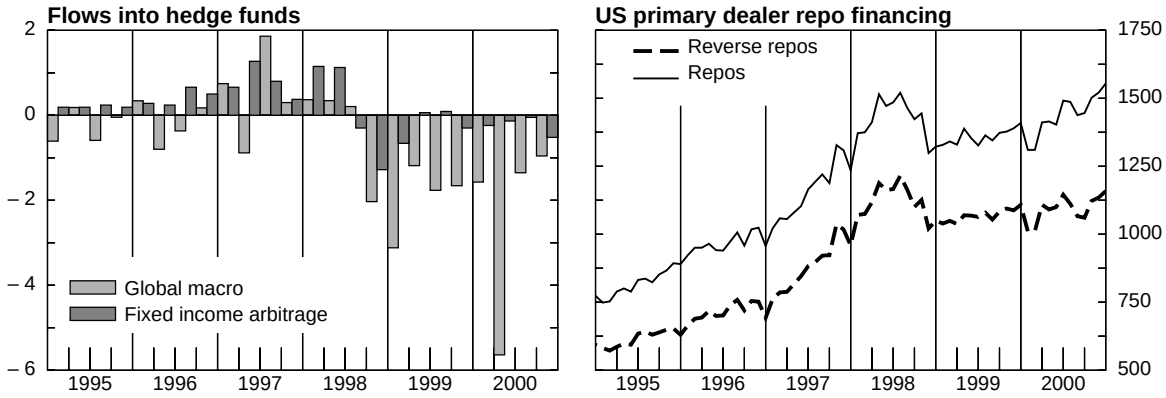
Demand for fixed income instruments was also affected by the reassessment of risk management practices in the wake of the 1998 crisis. Arbitrage and hedging activity were especially affected. Increased sensitivity to liquidity risk made market participants less willing to take directional positions in expectation of a rise or fall in a specific asset's price. Greater awareness of the risks of hedging credit products with government securities prompted a search for more efficient hedging vehicles.

In the late 1990s, some of the major players involved in the US Treasury market began to withdraw risk capital and consequently reduce their trading activity. As early as 1997, concerns about the long-term profitability of their trading activities had led a number of primary dealers to reduce their market making activity in US Treasuries and scale back or close their bond arbitrage operations. Moves in this direction accelerated following the 1998 crisis. This is evident from the sharp decline in late 1998 in the amount of financing that US primary dealers obtain from the repo market (Graph 7). More recently, repo financing has begun to trend upwards again, but at a more gradual pace than seen in the run-up to the LTCM crisis.

Graph 7

Financing flows

Billions of US dollars



Sources: Federal Reserve System; TASS Research.

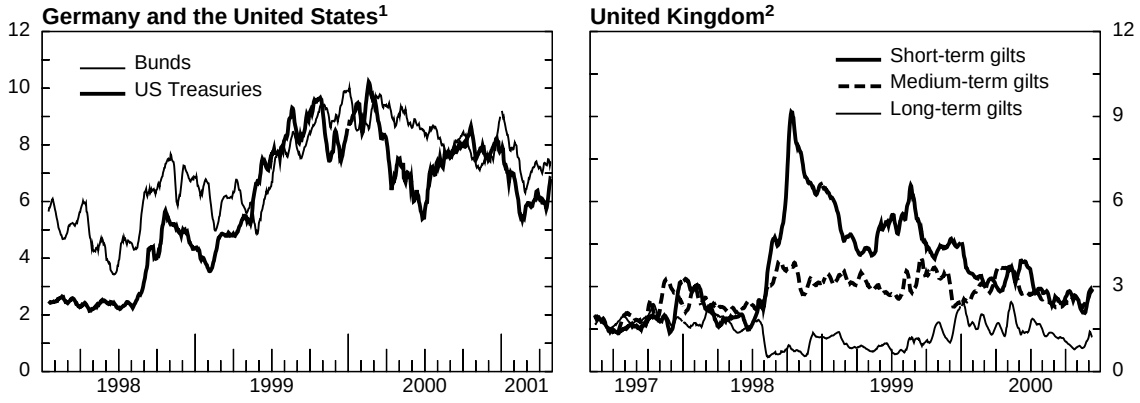
Although leveraged trading appears to be picking up again, dealers and other major players continue to be reluctant to engage in arbitrage activity. Hedge funds that had been active in the US Treasury market – "global macro" funds and "fixed income arbitrage" funds – experienced large investment outflows after the near failure of LTCM (Graph 7). This reduced the number of players likely to take a contrarian view (Tsatsaronis (2000)). Deviations of government bond yields for various maturities from a fitted curve confirm that arbitrage activity has become weaker. The pricing anomalies recorded in Graph 8 previously tended to disappear quickly, but now seem to last longer.

The lack of arbitrage activity made the response of a specific bond's price to broad movements in the term structure harder to predict and so exacerbated the risk of hedging credit products with government securities and related derivatives. As discussed in Section 2, the features that make government securities so unique may at times cause their prices to move out of synch with changes in the prices of non-government securities. This is especially likely to be the case during flights to quality and liquidity, as in the period August-October 1998.

Graph 8

Yield curve arbitrage

Deviations of government bond yields from a fitted yield curve; 10-day moving average, in basis points



[1] Measured as the standard deviation of yield differentials for all bond cash flows from a fitted yield curve, excluding callable bonds. [2] Measured as the absolute deviation of individual bonds from a fitted yield curve.

Sources: Bank of England; Datastream; BIS calculations.

Market participants have long been aware of the risk of using a government rate as a proxy for private rates. Indeed, as early as 1984, the eurodollar futures contract – based on a trimmed average of deposit rates posted by a panel of top-quality international banks located in London, ie Libor – had displaced Treasury bills as the hedging vehicle of choice at the short end of the US dollar yield curve (McCauley (2001)). Yet, until the mid-1990s, there were few attractive alternatives at longer maturities. This changed with the rapid growth of non-government bond markets and over-the-counter derivatives markets. The 1998 crisis and the subsequent decline in arbitrage activity prompted market participants to give greater consideration to the relative efficiency of hedging with non-government instruments. Among euro-based investors, the introduction of the single currency and squeezes in German government bond futures contracts reinforced this search for new hedging vehicles.[17] The result was a switch away from the near-exclusive use of government bonds in favour of a wider array of instruments, including GSE securities, corporate bonds and interest rate swaps.

Interest rate swaps have become especially popular for hedging purposes. Swaps, which are effectively a series of eurodollar futures, are usually based on Libor (except euro-denominated swaps, which are typically based on Euribor). Most of the banks in the Libor contributor panels are rated double-A, and therefore swap rates contain a premium for credit risk (Table 5). As a result, swap rates tend to move closely with the prices of other credit products, including during periods of market turmoil. This makes swaps attractive hedging vehicles. The absence of an underlying asset is an added advantage. Since an entity can enter into as many swap contracts as it chooses, idiosyncratic price movements arising from demand and supply imbalances are infrequent. Also, short positions can be created with relative ease by taking the floating side of a swap. Finally, swaps traded over the counter can be tailored to meet customers' maturity needs or other demands.

A disadvantage of swaps is the risk that a counterparty will default on its end of the agreement. The establishment of triple-A rated derivatives subsidiaries and various risk mitigation techniques, including margining and collateralisation, have allayed concerns about counterparty credit risk (Remolona et al (1996)). Also, swaps are usually structured such that they automatically unwind if a party loses its triple-A rating. Nevertheless, consolidation in the financial industry has reduced the number of active swaps dealers, and so made it more difficult to diversify counterparty credit risk. Furthermore, the financial weakness of Japanese banks continues to weigh on the credit quality of yen-denominated swaps. More participants might be willing to use swaps if swaps trading migrated from the over-the-counter market to an organised exchange, where a central clearing house could act

Table 5

Contributor panels for interbank offer rates

Credit ratings (Moody's / Standard and Poor's) of banks contributing rate quotes

	Number of contributors	Minimum rating	Maximum rating	Average rating	Trimmed average rating[1]
Euribor	49[2]	A2 / BBB+	Aaa / AAA	Aa3 / AA	Aa3 / AA-
Euro Libor	16	A3 / BBB	Aaa / AAA	Aa2 / AA-	Aa2 / AA
Yen Libor	16	A3 / BBB	Aaa / AAA	Aa3 / A+	A1 / A+
Sterling Libor	16	A3 / BBB	Aaa / AAA	Aa2 / AA-	Aa2 / AA
US dollar Libor	16	A3 / BBB+	Aaa / AAA	Aa2 / AA-	Aa2 / AA

[1] Average credit rating of banks ranked in the middle two quartiles. [2] Two banks rotate every six months, and so at any one time the number of contributing banks is 47.

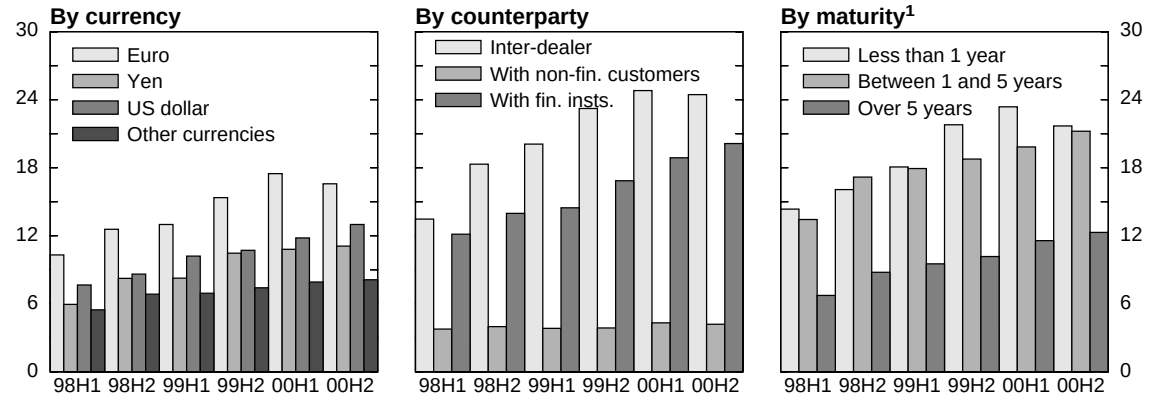
Sources: Bloomberg; British Bankers' Association; European Banking Federation.

[17] In September 1998 and June 1999, market participants had difficulty obtaining the cheapest bond to deliver into the bund futures contract traded on Eurex, and in March 2000 a similar squeeze affected the bobl contract. In their accompanying paper, Schulte and Violi examine why these squeezes occurred and measures that could be taken to prevent such incidents. See also Jeanneau and Scott (2001).

Graph 9

Interest rate swaps

Notional amount outstanding, in billions of US dollars



[1] Includes forward rate agreements (FRAs), which account for approximately 15% of the total notional amount outstanding.

Source: BIS.

as the counterparty to all trades. Steps have been taken in this direction: for example, in the early part of 2001, the London Clearing House, supported by several of the largest swaps dealers, began clearing and settling interest rate swaps; an electronic trading platform for swaps, Swapwire, was launched; and LIFFE revamped its swaps contract. However, activity on such exchanges accounts for a fraction of global swaps activity.

The growing willingness of market participants to use swaps for hedging and positioning purposes is demonstrated by the success of swaps referenced to the euro overnight index average rate (EONIA). Within a few months of the launch of the single currency, EONIA swaps had come to be banks' instrument of choice to manage their short-term interest rate exposure (ECB (2001)). Money market funds also switched to using EONIA swaps to hedge their portfolios and benchmark their performance. Even the pricing of general collateral repos is now linked to the EONIA yield curve. At longer maturities, the bund futures contract remains dominant. However, the longer-term segment of the swaps market is becoming more widely traded.

The wider use of swaps for hedging and positioning contributed to a 32% increase in the size of the euro swaps market between 1998 and 2000, to $16.6 trillion in notional amounts outstanding (Graph 9). The US dollar swaps market too experienced tremendous growth over this period, expanding by 51% between 1998 and 2000, to $13 trillion in notional terms. Dollar swaps are increasingly being used for hedging, price discovery and other purposes for which US Treasuries would have been used in the past. But the development of the dollar swaps market appears to be lagging the euro market. For example, whereas dollar swap rates continue to be quoted in terms of spreads over government securities, euro swap rates are typically quoted in terms of outright yields.

Notwithstanding the rapid development of swaps and other non-government securities markets, government securities have yet to be clearly displaced as the dominant hedging vehicle. Owing in part to the existence of liquid repo and securities lending markets, transaction costs for hedging with government securities are frequently lower than the costs associated with other hedges (see Section 5). Consequently, today market participants tend to use different instruments for different risk exposures. Participants wanting to hedge for longer holding periods often use private debt instruments because the lower transaction costs associated with government bonds are likely to be more than offset by the risk that spreads between government and non-government securities might widen. If a position is to be held for a short period of time, then credit spread risk is not as great a concern, and in these cases interest rate risk is frequently hedged with government securities.

5. Shifts in liquidity

Market liquidity tends to concentrate in large issues by regular borrowers, in markets where trading costs are lowest, and in instruments that can satisfy the varying demands of heterogeneous investors (CGFS (1999b, 1999d)). Recent shifts in liquidity seem to be consistent with this general pattern. Liquidity shows signs of deteriorating in those markets where the trading supply is diminishing and investor demand is becoming more homogeneous, notably the UK gilt and US Treasury markets. At the same time, liquidity is improving in those markets where the trading supply is increasing and investor demand is becoming more heterogeneous, in particular euro and swaps markets.

5.1 Government securities markets

Debt securities issued by industrial country governments have historically been among the most liquid assets available to investors. On the whole, this remains true even today. However, the financial market turbulence in 1998 and consequent changes in investor behaviour appear to have had a lasting deleterious impact on liquidity conditions in the US Treasury market. The deterioration in liquidity was subsequently exacerbated by reductions in supply. Broadly similar developments seem to apply to the UK gilt market. While less information is available for government securities markets in the euro area and Japan, there are signs that these markets have retained, if not gained, liquidity.

5.1.1 UK gilt and US Treasury markets

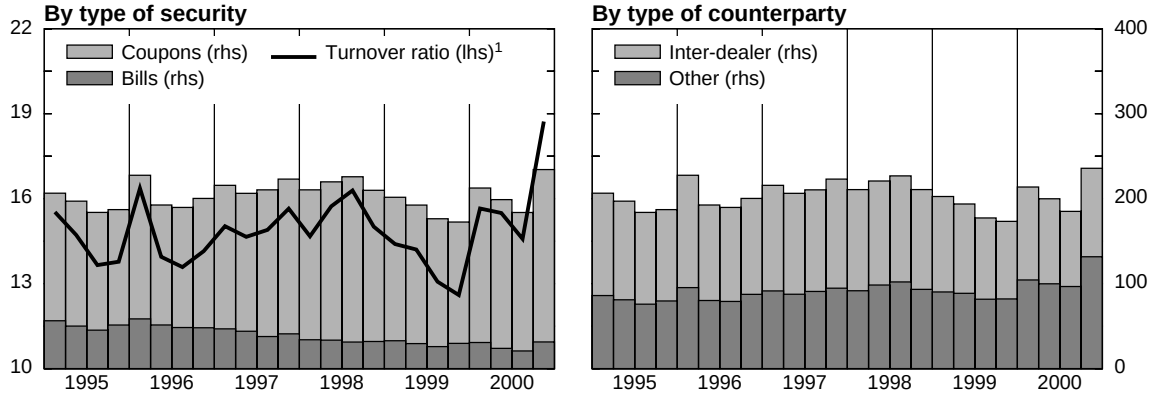
Various indicators confirm that liquidity has declined in the UK gilt and US Treasury markets. Turnover can be a misleading indicator of liquidity because it is also influenced by volatility. Nevertheless, longer-term trends in trading activity tend to be closely correlated with changes in liquidity. Graphs 10 and 11 show a noticeable decline in trading volumes on both cash and futures markets for US Treasuries following the 1998 crisis. Turnover in the cash market began to recover in 2000, but in the futures market it remained well below its peak. Graph 13 shows a similar pattern in the cash market for gilts.

Outright transactions in US Treasury bills have been trending downwards since 1995, but transactions in coupon securities did not start to fall until the third quarter of 1998. Graph 12 reveals how the liquidity of coupon securities has deteriorated in recent years. Quote sizes in the inter-dealer market for two-, five- and 10-year notes began to contract during the second half of 1998. At the same time, turnover fell sharply. As trading activity declined, the impact of a given trade on the prices of these three instruments became more pronounced.

Graph 10

Turnover of US Treasury securities

Average daily trading volume, in billions of US dollars



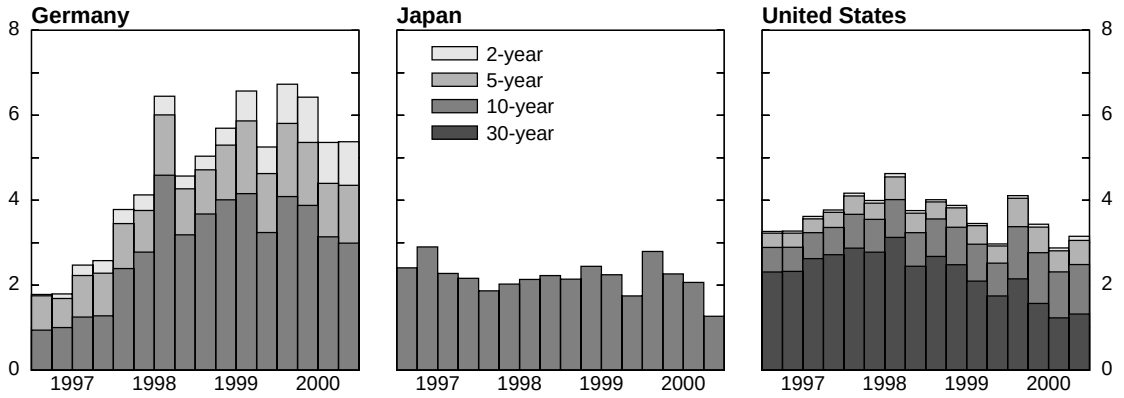
[1] Annualised trading volume divided by amounts outstanding.

Sources: Federal Reserve System.

Graph 11

Turnover of government bond futures

Quarterly trading volume, in trillions of US dollars[1]



[1] Number of contracts traded multiplied by the face value of the futures contract.

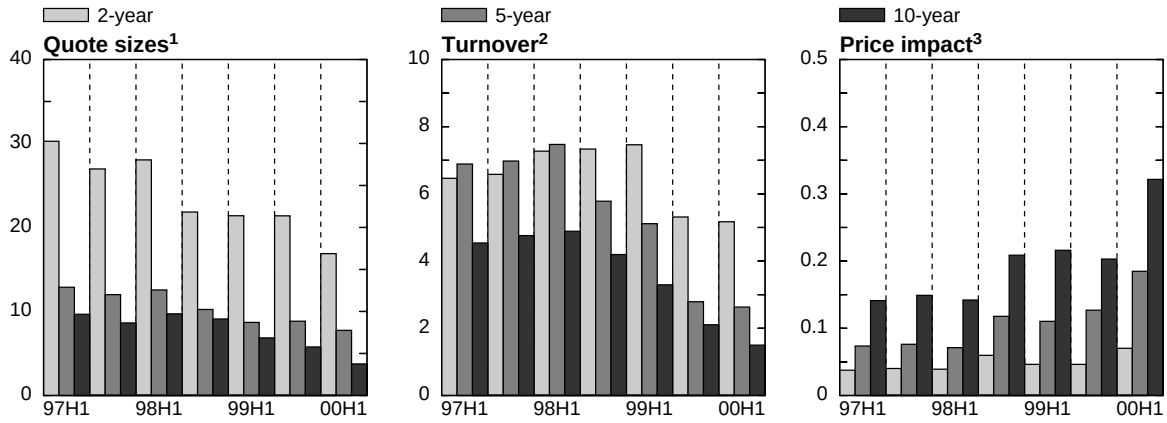
Sources: FOW TRADEdata; Futures Industry Association.

In futures markets, the fall-off in activity has been concentrated in the long-dominant 30-year bond contract: at the end of 2000, turnover was approximately 40% of its peak in the third quarter of 1998. Some market participants have switched to using the 10-year Treasury note contract, boosting its trading volume by almost 50% since 1998. However, the note contract has not established itself as the pre-eminent benchmark instrument that the bond contract was until just a few years ago.

Much of the deterioration in the liquidity of US Treasuries evidently reflects the withdrawal of risk capital in the wake of the LTCM crisis. Inter-dealer trading has historically been an important part of the provision of liquidity in this market and a major contributor to the efficiency of the price discovery process. Therefore, it is significant that in the 1998-2000 period outright transactions among dealers declined more than did transactions between dealers and customers, to the point where the inter-dealer market is no longer larger than the customer market (Graph 10). Moreover, the pick-up in trading activity in 2000 was driven by transactions with customers, not inter-dealer trading.

Graph 12

Liquidity of US Treasury securities



[1] Average quantity of securities bid or offered during the period. [2] Average daily turnover, in billions of US dollars. [3] Basis points per trade.

Sources: GovPX; Fleming (2001).

5.1.2 Euro area government securities markets

In contrast to the situation in the United Kingdom and the United States, government securities markets in the euro area seem to have gained liquidity. Data on the most actively traded bonds on Euroclear indicate that the average daily turnover of German government bonds increased steadily between 1997 and mid-2000 (Graph 13).[18] Trading activity in French government bonds also increased substantially in the run-up to monetary union. The apparent increase in trading activity in these markets does not seem to have come at the expense of activity in smaller government securities markets such as the Netherlands and Spain.

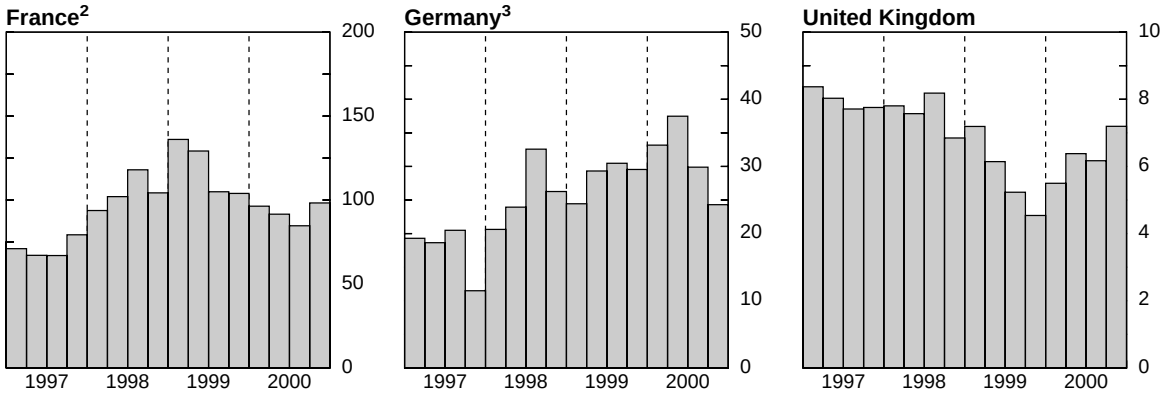
Turnover in futures contracts on German government bonds rose rapidly in the period prior to monetary union. Market participants' rapid acceptance of the 10-year bund contract as a benchmark for euro interest rates and the LTCM crisis boosted the contract's liquidity tremendously in 1998 (see the paper by Schulte and Violi in this volume). Since the introduction of the euro, the 10-year contract has lost some ground to futures on two- and five-year German government bonds. Yet it continues to hold the distinction of being the most actively traded derivatives contract in the world.

Further evidence of an increase in liquidity in euro area markets comes in the form of yield curves that have become smoother over time. Yield curves would tend to be smooth if they truly reflected market expectations, because the curves would trace largely the averages of expected future interest rates. Immediately following monetary union, the yield curves formed individually from government bonds of Belgium, France, Germany, Italy, the Netherlands and Spain had often looked tangled up with one another, indicating a lack of arbitrage across maturities (Graph 14). By January 2001, however, the curves had become smooth enough to be disentangled and to allow straightforward distinctions between markets in terms of credit risk or liquidity. In their accompanying paper, Schulte and Violi find that the transitory component in yields of French, German and Italian government bonds declined in 2000, suggesting that price efficiency improved in these markets. Moreover, Schulte and Violi conclude that among euro area government securities markets, prices appear to be least distorted and liquidity closest to that of the UK and US markets in Italy's cash market. This demonstrates the advantages of size and an advanced trading infrastructure; the Italian government securities market is the largest in the euro area, and most secondary market trading takes place over the MTS system, which originated in Italy in 1988.

Graph 13

Turnover of European government securities

Average daily trading volume, in billions of local currency units[1]



[1] For France and Germany, euros; for the United Kingdom, sterling. [2] Includes futures, options and repo transactions. [3] Turnover of the most actively traded bunds settled through Euroclear.

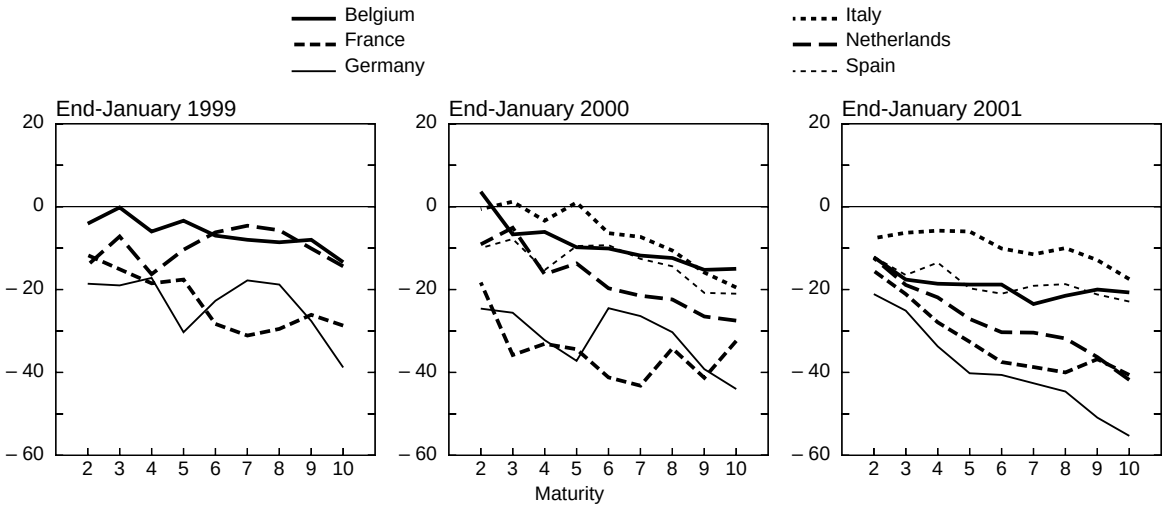
Sources: Euroclear; France Trésor; London Stock Exchange (LSE); BIS calculations.

[18] For a description of the data available from Euroclear, see footnote 19.

Graph 14

Euro area government bond yields

Spreads over swap rates, in basis points



Sources: Bloomberg; Datastream.

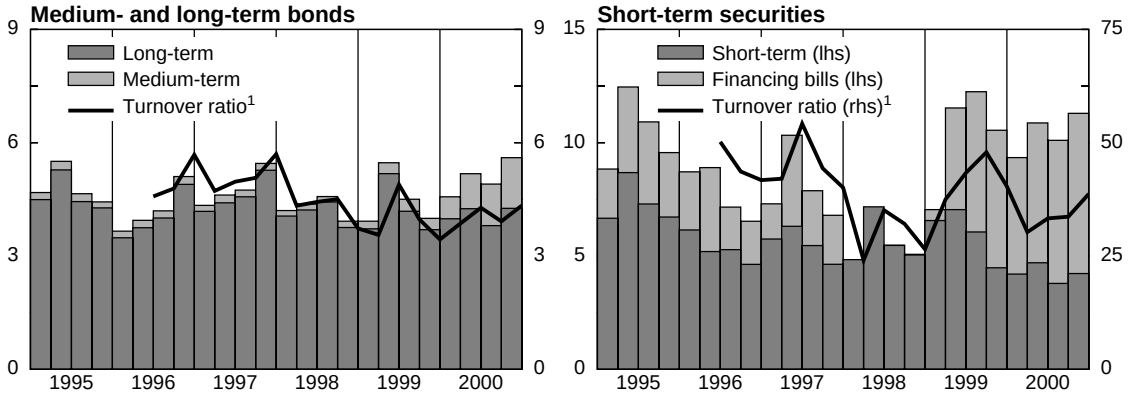
5.1.3 JGS market

The JGS market, which in the past was much less liquid than government securities markets in other industrial countries, also seems to have gained liquidity, although the evidence is somewhat mixed. In a report on market liquidity, the CGFS (1999b) found that in 1997 bid-ask spreads were multiples of those on US Treasuries. In addition, the ratio of trading volume to outstanding JGS was one third that of US Treasuries. This low ratio is explained in part by the public sector's large holdings of JGS. Anecdotal evidence suggests that bid-ask spreads have since narrowed. Also, turnover in the cash market has increased modestly, mainly in medium-term bonds and financing bills (Graph 15). Yet because of the large volumes of issuance, the turnover ratio has actually declined. Moreover, developments in the futures market do not confirm an improvement in liquidity conditions. Trading in the 10-year futures contract fell significantly in 2000 and, despite an increase in issuance across the maturity spectrum, trading in other contracts failed to develop.

Graph 15

Turnover of Japanese government securities

Average daily trading volume, in trillions of yen



Sources: Japanese Ministry of Finance; JSDA.

5.2 Non-government bond markets

The vast majority of non-government bonds are purchased by buy-and-hold investors such as pension funds and insurance companies and as a result trade infrequently after the date of issue. What trading does take place tends to be through bilateral negotiations between dealers and customers and is typically not publicly disclosed. Therefore, limited data are available on liquidity conditions in non-government securities markets. This caveat notwithstanding, there are signs of improved liquidity in non-government securities markets. Efforts by larger non-government borrowers to mimic government issuance programmes, together with changes in the investor base for non-government securities, have boosted trading in certain segments of the market.

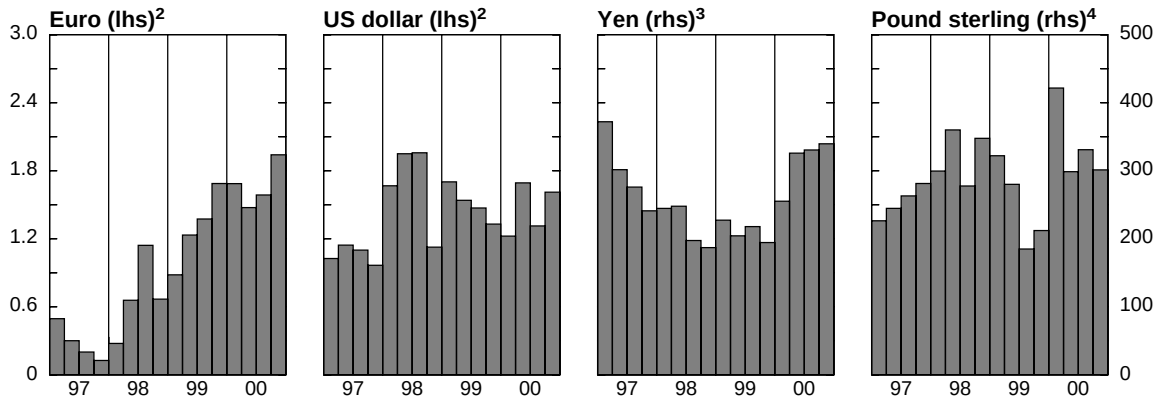
The large number of fixed income indices introduced over the past few years provide anecdotal evidence of an improvement in liquidity. Index providers usually aim to include in their indices only bonds that investors have a reasonable prospect of buying and selling. To this end, rules are established for identifying which bonds are liquid. Almost all indices use issue size as a basic indicator of liquidity. Depending on the index, minimum issue sizes range from approximately $100 million for corporate bonds to $1 billion or more for certain government securities. Some indices have more sophisticated measures of liquidity. For example, JP Morgan excludes from its Euro Credit Index bonds for which no price was quoted by a market-maker for more than five days in a month or for more than three consecutive days. The criteria used to identify liquid issues do not necessarily bear a close relationship to market liquidity. Nevertheless, the launch of so many indices claiming to track liquid bonds suggests that market participants perceive liquidity in non-government securities markets, especially euro area markets, to be at least no worse than in years past.

Data on trading volume provide more concrete evidence of an improvement in liquidity in non-government bond markets. Data from Euroclear indicate that the average daily turnover of the most actively traded US dollar bonds issued by non-government borrowers declined following the 1998 crisis (Graph 16).[19] Nevertheless, trading volumes in the 1999-2000 period exceeded activity in 1997.

Graph 16

Turnover of non-government bonds

Average daily trading volume, in local currency[1]



[1] For euros and US dollars, in billions; for yen, in 10 millions; for sterling, in millions. [2] Turnover of the most actively traded bonds settled through Euroclear, excluding money market instruments and medium-term notes. [3] Turnover of bonds issued in Japan's domestic market. [4] Turnover of bonds listed on the London Stock Exchange.

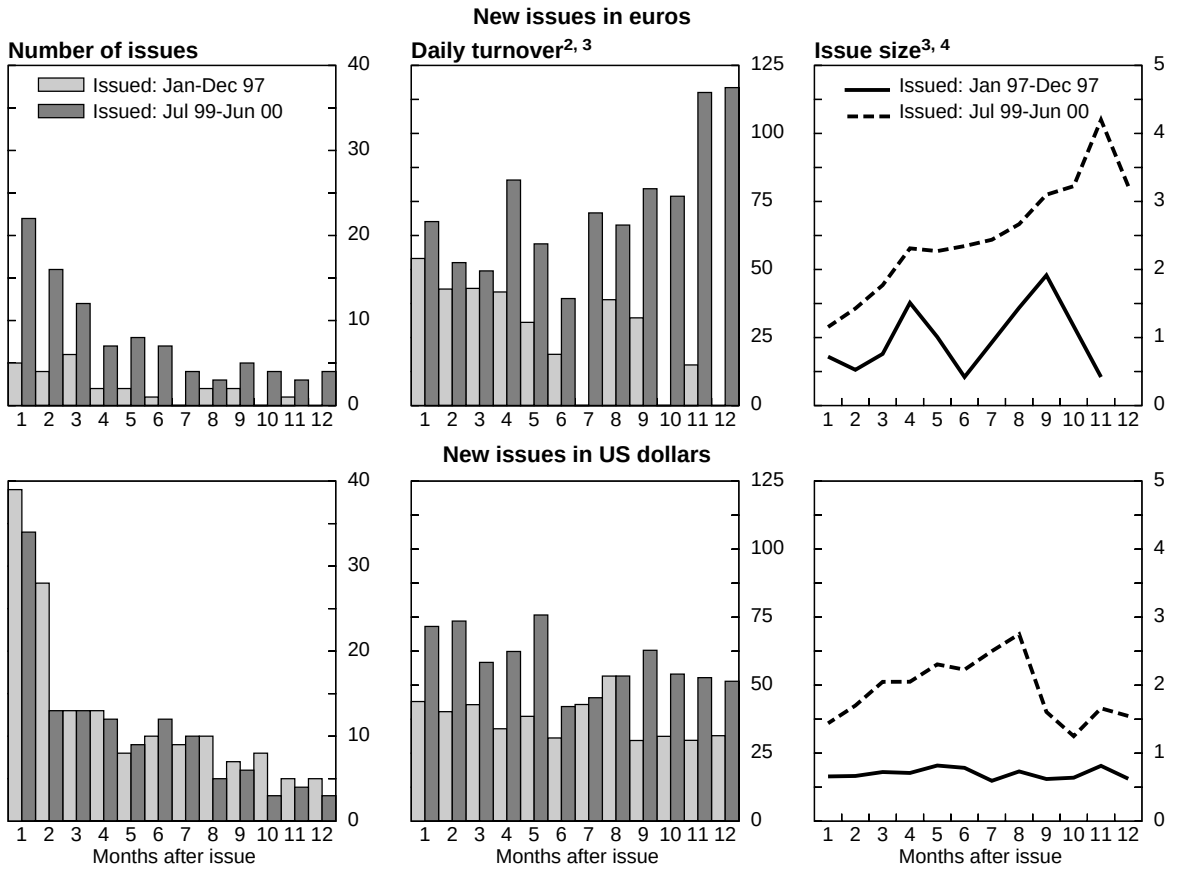
Sources: Euroclear; JSDA; LSE; BIS calculations.

[19] Euroclear, based in Brussels, is one of the world's largest securities settlement systems; well over half of all cross-border transactions in debt and equity securities are settled through Euroclear (Euroclear (2001)). Each month, Euroclear publishes data on the average daily turnover of its most actively traded securities. Trading in euro-denominated securities accounts for the bulk of total turnover on Euroclear, and therefore Euroclear activity is arguably a reasonable proxy for global trading in euro-denominated bonds. In the US dollar market, most trading takes place in the United States, but Euroclear settles much of the cross-border trading in dollar bonds. There is no reason to expect domestic and international investors to concentrate their trading in different issues, and therefore Euroclear activity should also be indicative of liquidity conditions in the dollar market.

Graph 17

Trading cycle of non-government bonds

New bond issues traded actively following the month of issuance[1]



[1] Based on the most actively traded bonds settled through Euroclear. [2] In millions of US dollars. [3] Average of all new issues traded actively during the month. [4] In billions of US dollars.

Sources: Euroclear; BIS calculations.

Trading in sterling-denominated bonds listed on the London Stock Exchange appears to have been adversely affected by concerns about the date change at the end of 1999, but not by the LTCM crisis. By 2000, average daily turnover in sterling bonds had returned to 1998 levels. Turnover in Japan's corporate bond market declined in the 1998-99 period but has since rebounded to 1997 levels.

In the euro-denominated bond market, turnover followed a rising trend. Indeed, Euroclear data indicate that the average daily turnover of the most actively traded bonds denominated in euros (or the legacy currencies) more than tripled between 1997 and 2000. Some of this rise might be explained by a shift from domestic to cross-border trading in the euro area and an increase in Euroclear's share of cross-border settlement activity. Nevertheless, such a large increase in average trading volume on Euroclear in the two years since monetary union would seem to indicate some improvement in liquidity in euro-denominated bond markets.

Another indicator of liquidity is the persistence of turnover. A bond that is consistently among the most actively traded is likely to be more liquid than one that trades infrequently. To assess the part of turnover that is persistent, Graph 17 shows the trading cycle of newly issued euro- and dollar-denominated bonds during successive months following the one in which they were issued.[20] A

[20] Bonds issued under medium-term note programmes are excluded because insufficient data are available on their turnover after issuance.

relatively large number of bonds trade actively in the first month after they are issued. The number of bonds that trade actively in subsequent months rapidly diminishes, probably reflecting the unloading of inventories by underwriters.

The trading cycle in the dollar market was already well developed in 1997, and there are no signs of a deterioration in the persistence of turnover in 2000. In the euro market, relatively few bonds issued in 1997 traded actively on Euroclear more than a month after issuance. However, by 2000, several bonds were still trading actively up to 12 months after issuance.[21] Moreover, the average daily turnover of euro-denominated bonds that continued to trade several months after issuance approximately doubled between 1997 and 2000.

Between 1997 and 2000, there was a noticeable increase in the size of those securities that tended to trade persistently. The size of new US dollar issues that still traded actively several months after issuance was approximately twice as large in 2000 as in 1997: $2 billion versus $1 billion. A similar increase was evident in the euro market. Furthermore, whereas in 1997 there was no clear pattern to the mix of names that traded actively, by 2000 trading was more clearly concentrated in issuers who tended to tap the market on a regular basis (see Annex 3). In the euro market, Pfandbrief issuers (Depfa and Dexia), the Caisse d'Amortissement de la Dette Sociale, the EIB and Kreditanstalt für Wiederaufbau were persistently traded. In the US dollar market, issues by Ford Motor Credit, the Inter-American Development Bank and the World Bank were consistently among the most actively traded bonds on Euroclear in 2000. All of these issuers have large borrowing requirements which ensure a continued supply of new debt.

Trading in US GSE securities further illustrates the boost that large, regular supplies of new issues can give to liquidity. As shown in Graph 18, outright transactions in GSE securities grew rapidly in 2000. Significantly, inter-dealer trading, which is key to the provision of liquidity, more than doubled. Dealers appear to have reallocated some of the risk capital withdrawn from the US Treasury market to trading in Fannie Mae and Freddie Mac securities. In contrast to the Treasury market, however, trading among dealers remains a small fraction of total transactions in GSE securities.

Trading in Freddie Mac's euro-denominated bonds, the first of which was issued in September 2000, illustrates investor interest in GSE securities. Freddie Mac's 2010 bond has consistently been among the most actively traded non-government bonds on Euroclear. Indeed, during the first four months after issuance, its average daily turnover greatly exceeded turnover in other non-government bonds traded on Euroclear: €800 million, compared to approximately €200 million for Pfandbriefe. Freddie Mac's distinction of being the first non-government straight bond to trade on EuroCreditMTS probably helped to boost turnover. Even so, trading in government securities continues to dwarf that in Freddie Mac; daily turnover of the most actively traded German government bond on Euroclear averaged €12 billion in late 2000.

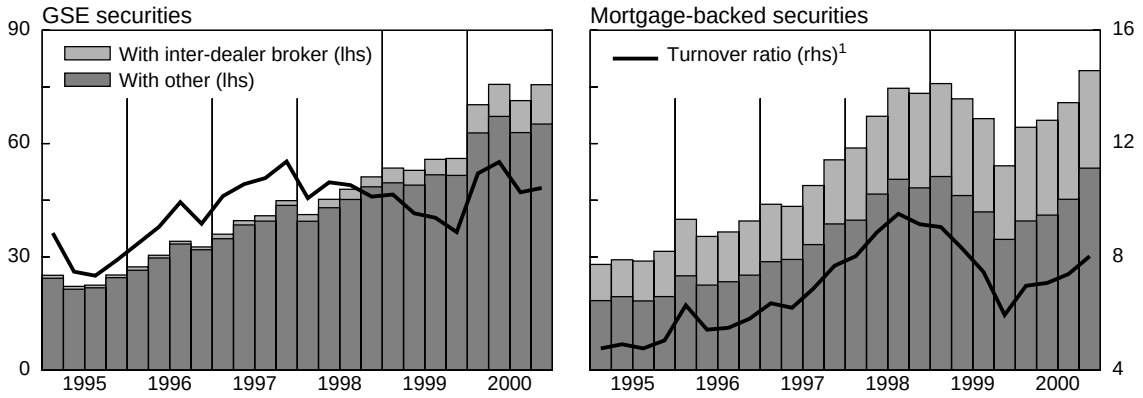
While trends in cash markets indicate that Fannie Mae's and Freddie Mac's "benchmark" programmes have had their desired effect of improving liquidity, activity in futures markets suggests that GSE securities have yet to gain broad market acceptance as instruments for hedging and price discovery. After an initial period of rapid growth, the turnover of futures contracts traded on Fannie Mae and Freddie Mac securities quickly peaked at little more than 1% of the turnover of US Treasury futures. Moreover, whereas the turnover of US government bond contracts picked up noticeably in the first quarter of 2001 following a surprise interest rate cut by the Federal Reserve, trading in agency contracts stagnated. Market participants are evidently reluctant to switch from using Treasury futures to agency futures. Futures contracts traded on Pfandbriefe met with a similar experience after they were introduced in 1997.

[21] The July 1999 to June 2000 sample underestimates trading activity beyond seven months. Euroclear stopped publishing turnover data in January 2001, and so bonds issued between February 2000 and June 2000 could not be tracked for a full 12 months.

Graph 18

Turnover of US non-government securities

Average daily trading volume, in billions of US dollars



[1] Annualised trading volume divided by amounts outstanding.

Source: Federal Reserve System.

Trading in US mortgage-backed securities presents a more mixed picture of shifts in liquidity in non-government bond markets. Graph 18 shows a steady rise in turnover between 1995 and 1998, and then an appreciable decline following the LTCM crisis. Outright transactions in MBS began trending upwards again in 2000, but the turnover ratio is still below the peak levels reached in 1998. From this, it is difficult to conclude that liquidity has improved. At best, perhaps liquidity in the MBS market is no worse than in years past.

In summary, liquidity seems to have improved in some segments of the non-government bond market. This is clearest for the euro market, where trading activity has picked up significantly since monetary union. Any improvement in liquidity would appear to be concentrated in large issues, such as Jumbo Pfandbriefe and GSE securities. The available data do not indicate whether this has come at the expense of smaller bond issues. A number of market participants suggest that liquidity for smaller issues has indeed deteriorated even while the liquidity of the largest issues has improved, at least in the US dollar market.

5.3 Swap markets

Over-the-counter derivatives markets have also experienced an improvement in liquidity in recent years. Whereas the turnover of exchange-traded interest rate derivatives remained more or less flat in the late 1990s, over-the-counter activity in interest rate derivatives and credit derivatives saw continuing growth. Trading in interest rate swaps and default swaps, which constitute the bulk of the over-the-counter market, picked up especially strongly.[22]

The interest rate swaps market expanded by 34% in notional terms between 1998 and 2000, to $48.8 trillion, and the credit derivatives market by more than 100%, to approximately $800 billion. Anecdotal evidence indicates that this growth has been accompanied by tighter bid-ask spreads and greater market depth. For example, EONIA swaps are now the most liquid segment of the euro money market (ECB (2001)). The bid-offer spread for default swaps narrowed significantly in the late 1990s (Remolona (1999)). Market participants certainly perceive that liquidity in swaps markets has improved in recent years, and such perceptions tend to be self-fulfilling. Market participants are more willing to transact in markets that they expect to be liquid, and this willingness in turn boosts liquidity (CGFS

[22] An interest rate swap is an agreement between two parties to exchange a stream of fixed interest rate payments for a stream of floating interest rate payments. A default swap requires one counterparty to pay a fixed spread in exchange for the opportunity to sell a reference bond at face value to the other counterparty in the event of default.

(1999b), (1999d)). Yet concerns remain about the resiliency of the swaps market. Market participants report that liquidity can be quick to evaporate from swaps markets during periods of volatility.

The growing use of swaps for hedging and positioning has been responsible for much of the improvement in liquidity. Each market participant who gives up using government securities to hedge private instruments subtracts liquidity from the government debt market and adds it to the swap market. In the self-reinforcing process whereby liquid markets become more liquid, this raises the incentive for other participants to do likewise. The growth of the inter-dealer segment of the swap market has also added to the liquidity of swaps. Even while inter-dealer trading in the US Treasury market contracted, inter-dealer positions in the swap market continued to expand. The standardisation of documentation was an important factor behind the growth of the credit derivatives market.[23] The rapid adoption of common definitions promoted the commoditisation of default swaps and thereby enhanced their liquidity.

Looking forward, further improvements in the liquidity of swaps could depend on the migration of swaps trading to an organised exchange. Despite the widespread use of structures that mitigate counterparty credit risk, lower quality credits still have difficulty accessing the swap market; trading in the over-the-counter market is dominated by a few highly rated dealers. Owing to this concentration, the swap market probably labours under higher transaction costs and remains less liquid than it might be if swaps were traded on an organised exchange (McCauley (2001)). Moreover, consolidation in the investment banking industry and the consequent decline in the number of market-makers active in the swaps market – indeed, in all over-the-counter derivatives markets – could make it increasingly difficult for dealers to offset customer orders in the inter-dealer market. This could in turn have a negative impact on the liquidity that swap dealers can offer to customers.

6. Price discovery in a changing market

To properly guide decisions to borrow and invest in an economy, capital markets should incorporate all available information about the future prospects of borrowers and the willingness of investors to postpone consumption and take risks. The process by which prices in fixed income markets adjust to new information and move towards their equilibrium value is more efficient when market participants agree on certain instruments that can serve as references – or benchmarks – for pricing other securities.[24] The existence of a pricing benchmark facilitates comparisons of yields across issues, thereby ensuring that instruments with similar risk-reward characteristics trade at similar prices. Moreover, benchmarks with negligible or predictable risk premia can be used to assess market expectations of future short-term interest rates. If benchmarks indexed to real interest rates are available, market expectations of future inflation rates can also be derived. In recent decades, market participants have relied on government securities to develop risk-free yield curves. Private sector debt instruments are commonly used as benchmarks for pricing comparable instruments, especially in the primary market, and are increasingly used as common benchmarks for comparing yields across credit classes.

6.1 The formation of risk-free yield curves

Risk-free yield curves have been integral to the efficient functioning of modern financial markets. Interest rates devoid of credit, liquidity and other types of risks are used in many asset valuation theories, such as the capital asset pricing model, as well as a range of analytical applications, including forecasts of interest rates and estimates of credit spreads. Prices in modern financial markets are effectively anchored by the interest rate on risk-free assets. The government yield curve is

[23] In 1999, the International Swaps and Derivatives Association (ISDA) finalised the Credit Derivatives Definitions, which define the conditions under which a credit derivative can be exercised. The ISDA Definitions were revised in 2001 to clarify issues arising from debt restructurings.

[24] It is important to distinguish pricing benchmarks from performance benchmarks. The latter, which are discussed in Section 4, are hypothetical portfolios of assets against which the performance of asset managers is measured.

typically used as a proxy for the risk-free rate. But private instruments, in particular collateralised obligations and interest rate swaps, also have the potential to serve as risk-free benchmarks.

The benchmark status of government debt comes from a number of features that, when taken together, make government securities unique in financial markets. First, governments in most of the industrial countries are perceived to be the most creditworthy of borrowers; their securities are considered to be essentially free of the risk of default. Second, the large amount of government debt outstanding and the fungibility of issues facilitate trading. Therefore, government paper, especially the most recently issued ("on-the-run") securities, tends to be more liquid than non-government paper. Third, owing to their large borrowing needs and long life, governments are able to offer a wider range of maturities than many other borrowers. This facilitates the construction of yield curves. Finally, the existence of well-developed repo and derivatives markets for government securities enables market participants to take short and long positions that reflect their views of future interest rate movements.

The efficiency of the government yield curve as a proxy for risk-free rates depends on the determinants of the term structure of government yields. The term structure of risk-free rates should at any given time represent the market's current expectations of future short-term interest rates. In other words, no factors other than expected future spot rates should systematically affect forward interest rates. Empirical studies of the government yield curve tend not to support the pure expectations theory of the term structure. The forward rates embedded in government yields appear to be affected by, in addition to expected future short-term rates, factors such as the supply of and demand for securities in specific maturity sectors. For example, regulatory or self-imposed constraints on the maturity structure of investors' balance sheets might distort segments of the government yield curve.[25] Owing to such interactions between demand and supply, forward rates in government securities tend to be biased estimates of expected future spot rates, and consequently of risk-free interest rates. In their accompanying paper, Cooper and Scholtes examine the impact of changes in issuance on government bond yields, and find evidence that yields on US Treasuries and UK gilts have in recent years fallen below risk-free rates.

An efficient proxy for risk-free interest rates need not be an instrument that is itself devoid of risk. To determine the risk-free rate, the risk premia embedded in forward rates need only be predictable. In the past, when government securities markets were less developed than they are today, private sector debt instruments were commonly used to assess market expectations of future short-term interest rates and inflation. In the US dollar market in the 1950s and 1960s, market participants referred to bonds issued by top-grade corporations, in particular American Telephone and Telegraph, to gauge expectations of future interest rates. Similarly, in Japan during the same period, bank debentures and bonds issued by Nippon Telephone and Telegraph effectively served as risk-free benchmarks. These bonds were not necessarily default-free instruments, but at the time the stable nature of the issuer's business activities limited the volatility of any associated credit spreads.

In today's more liberalised commercial and financial environment, the credit ratings of even the highest-quality borrowers are occasionally downgraded. Issuers can employ various mechanisms to demonstrate their resolve to maintain the quality of their assets. Bond covenants might restrict significant alterations in the operational or financial risk characteristics of a firm, or coupon payments might be linked to the issuer's credit rating. Still, it seems unlikely that a market consensus will emerge that elevates the status of bonds issued by a particular private entity to that of a risk-free benchmark. An index of yields on similarly rated bonds is more promising. Indeed, consideration is being given to the construction of a futures contract based on a basket of corporate bonds. Corporate bond indices have long been available. However, to date none have gained broad acceptance among market participants for uses other than performance benchmarks.

Debt instruments issued by GSEs, such as Fannie Mae and Freddie Mac in the United States or Kreditanstalt für Wiederaufbau in Germany, and supranational institutions, for example the World Bank, are possible candidates for elevation. GSEs and supranationals are often as highly rated as the governments that support them. Moreover, the liquidity of their securities appears to have improved in recent years, and repo and derivatives markets are developing. Nevertheless, continuing debate about

[25] Segments of the sterling market exhibit such distortions. For example, strong and relatively price-inelastic demand from pension funds and life assurance companies is widely thought to have put downward pressure on conventional and index-linked gilt yields in recent years.

the scope of and government involvement in the activities of GSEs and supranationals contributes to uncertainty about future credit spreads on their securities.[26]

Averages of yields on collateralised obligations could be used to construct risk-free yield curves. In the major debt markets, interest rates in the general collateral repo market are already widely regarded as the most efficient proxy for risk-free rates at very short maturities (CGFS (1999a)). Risk-free instruments, in particular government securities, have historically been the preferred form of collateral in repo transactions. However, in principle, other instruments could substitute for government securities. In a report on the uses of collateral in wholesale financial markets, the CGFS (2001) suggested that securitisation techniques could be applied to develop substitute instruments with high credit quality and liquidity. Furthermore, the steps that non-government issuers are taking to enhance the transparency and liquidity of their securities could make them more attractive as collateral. Improvements in risk management and market structure could also ease the use of collateral bearing more issuer and liquidity risks. The primary difficulty with using repo rates as proxies for risk-free rates is their illiquidity beyond the very short term. Repo markets in the industrial countries are typically liquid out to about three months (12 months in the United States), and so expectations extracted from the term structure of repo rates are unlikely to be accurate at longer maturities.

The broader collateralised debt market extends out to 30 years or more. The asset- and mortgage-backed securities that comprise this market are often structured such that the risk of default is minimal. Moreover, ABS and MBS are among the most liquid non-government securities available. These features would argue in favour of using yields on collateralised debt as proxies for risk-free rates. However, prepayment risk and other embedded options make it difficult to back interest rate expectations out of many of these instruments. In addition, derivatives and repo markets for ABS and MBS are still in their infancy. Perhaps most importantly, market participants sometimes disagree about how to assess the credit risk of ABS and MBS. Pfandbriefe are the most prominent example. When rating Pfandbriefe, Standard and Poor's focuses principally on the quality of the collateral. Moody's on the other hand also stresses the creditworthiness of the issuing bank. Moody's argues that because of the dynamic nature of the pool backing the security – new assets are added to replace loans that are repaid – it is not possible to monitor the collateral without also monitoring the bank managing the assets.

Another possible proxy for the risk-free yield curve is the fixed rate leg of interest rate swaps. Historically, the credit risk of swap dealers was a concern, and liquidity conditions beyond short maturities were relatively poor. Credit and liquidity premia embedded in swap rates declined significantly in the late 1990s, increasing the attractiveness of swaps as pricing benchmarks. Still, because they are based on unsecured interbank deposit rates, swap rates remain susceptible to changes in the credit quality of banks. For example, the low credit standing of Japanese banks adds to uncertainty about the future path of yen swap rates, and so deters market participants from using yen swaps as a proxy for the risk-free rate.

All things considered, there do still appear to be advantages to using the government yield curve as the proxy for risk-free rates. But repo rates have already displaced government yields at the very short end of the yield curve. Further improvements in the liquidity and structure of collateralised obligations and interest rate swaps could enhance the efficiency of these instruments as proxies for risk-free rates at longer maturities also. Over time, market participants will settle on only one yield curve. The market saves on resources if price discovery about macroeconomic fundamentals is concentrated in only one homogeneous instrument.

6.2 Pricing risk in the primary market

In principle, new bond issues could be priced by referring to the risk-free yield curve and then adding a spread for credit, liquidity and other risks. In practice, underwriters set yields for new issues of non-government bonds by referring to comparable bonds that already trade in the secondary market.

[26] For example, concerns had emerged in the early part of 2000 about the credit standing of Fannie Mae and Freddie Mac after proposals were introduced in the US Congress to remove their government credit lines and local tax exemptions. This legislative pressure abated towards the end of the year when Fannie Mae and Freddie Mac undertook to raise their capital ratios and improve their disclosure practices.

Alternatively, when the pool of comparable actively traded bonds is small, lead managers typically ask a sample of the largest potential investors what yield they would want to receive if they were to purchase a bond from the prospective issuer. The recent changes seen in fixed income markets have not altered this process.

The factors considered in identifying comparator bonds include credit ratings, industry sector, issue size, currency of denomination and contractual structure. To the extent possible, a yield curve is constructed from the existing population of bonds that have the same characteristics as the new issue. Firms that regularly borrow in size often have enough of their own issues trading in the secondary market to allow the construction of a simple yield curve without referring to other issues. An estimate of the appropriate yield for the new issue is then derived from the yield curve. The actual yield at which the issue is marketed may be adjusted further to account for changes in market conditions and investor sentiment. Notably, this process does not require any direct reference to risk-free benchmarks.

While prices in the primary market are usually determined in reference to comparator bonds, issues are quoted, ie marketed, against common benchmarks. The general level of interest rates can change significantly during the marketing period – which can take up to two weeks for less well known issuers – and therefore it is simpler to quote the likely coupon in terms of its intended spread over a common pricing benchmark. This need not be the risk-free yield curve. Rather, the marketing of non-government bonds is done with reference to whatever benchmark the investor is interested in.

6.3 Common pricing benchmarks

Common benchmarks link prices in the primary and secondary markets. A characteristic of efficient markets is that the same series of expected cash flows carry the same prices. In other words, market participants are quick to take advantage of any opportunities for arbitrage. Common pricing benchmarks facilitate arbitrage by making it easier for investors to compare yields across different securities, including between prospective new issues and existing issues. Many instruments can and increasingly do perform this function, with the choice of instrument depending largely on the risk spread the investor is interested in.

In recent decades, government securities have been the most widely used benchmark for comparing alternative investments. One reason for this is that, as previously discussed, government yield curves were considered the most efficient proxies for risk-free interest rates. In addition, many end investors had their financial performance judged against hypothetical portfolios of government bonds. The tendency to consider spreads against government bonds was also supported by the use of government bonds to hedge positions in non-government securities.

Government securities, however, are gradually falling out of favour as common pricing benchmarks. Financial institutions were perhaps the first to make greater use of alternative benchmarks. Banks and other leveraged institutions typically want to know what the spread of a security is relative to their funding cost. The liabilities of most financial institutions are based on a short-term interbank rate such as Libor or Euribor. Therefore, financial institutions tend to benchmark bond prices against the swap curve, which embodies expectations of future Libor or Euribor.

End investors with investment portfolios in multiple currencies and large borrowers with funding programmes in multiple currencies have also gradually been switching over to talking in terms of yield spreads relative to swaps rather than government paper. Using government securities as benchmarks requires a detailed knowledge of government debt markets, and even then it is sometimes difficult to identify from among the often wide range of potential alternatives the most appropriate government securities to use in constructing a benchmark yield curve. Swap curves offer a reasonably simple way to compare returns or borrowing costs in different currency-denominated markets.[27]

[27] In theory, arbitrage should ensure that the common currency costs to a debt issuer of raising funds should be the same, irrespective of the chosen currency of denomination. In reality, however, there can sometimes be cost advantages from issuing debt in one currency and simultaneously swapping the associated cash flows into the currency of choice. This type of arbitrage can occur, for example, if an issuer is less well known to investors in one bond market than in another, or if one market becomes "saturated" by the issuer.

The development of credit derivatives has played an important part in the shift towards non-government benchmarks. In the past, it was difficult to isolate credit risk from other factors, in particular liquidity risk. Credit derivatives facilitate the decomposition of spreads into their various risks and give concrete form to the term structure of credit risk. They thereby allow price differences among similar securities to be exploited more efficiently. While credit derivatives themselves may have credit or liquidity premia, they have the potential to become a benchmark for pure credit risk. As such, they are increasingly driving the pricing of credit risk in financial markets.

The distribution of default swaps over the credit spectrum gives some idea of where the pricing of credit risk is concentrating. Graph 19 shows that for the Americas and Asia, the underlying debt issues are concentrated in triple-B and single-A rated borrowers. For Europe, default swaps are available for a relatively greater number of double-A rated issuers. This is in marked contrast to the situation a few years ago, when price discovery in credit risk focused on the government yield curve. The range of instruments referenced by investors suggests that a consensus has yet to form on a single common benchmark for each major currency (Table 6). Quoting conventions vary with the nationality of the end investor. In the dollar market, US investors tend to focus on yield spreads against Treasuries and GSE debt, while European investors are more interested in swap spreads. Similarly, in the sterling market, domestic investors tend to be more interested in spreads against gilt benchmarks, while foreign investors in the sterling market focus only on swap spreads. In the euro-denominated non-government bond market, both domestic and foreign investors discuss developments in terms of spreads against swaps.

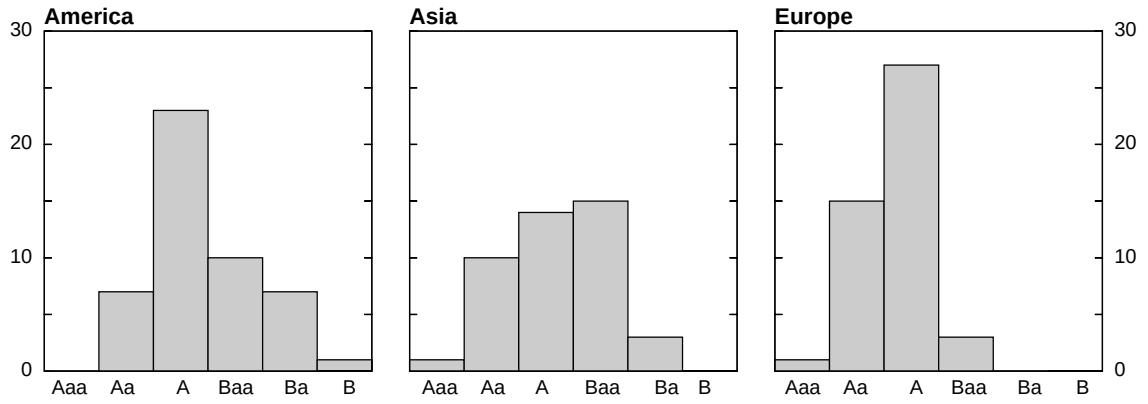
Quote conventions also depend on the credit rating of the security. Bonds issued by triple-A rated supranationals and double-A rated banks are nearly always discussed with reference to swap benchmarks, since the yield spreads for these bonds against swaps tend to be more stable than the spreads to government bond benchmarks. As one moves down the credit spectrum from double-A rated to triple-B rated bonds, the relative stability of swap-based spreads diminishes. Consequently, quotes tend to be more often expressed relative to government bond benchmarks. At credit ratings below investment grade, quotes are often in terms of outright yields rather than spreads relative to a particular benchmark.

The tremendous growth and continuing liquidity of non-government securities markets suggest that the demise of government securities as the pre-eminent benchmark and the rise of multiple benchmarks have not had an adverse impact on the functioning of non-government securities markets. Indeed, the use of multiple benchmarks may make for more efficient markets. The market saves on resources if price discovery is concentrated in only one homogeneous instrument, such as government securities. Yet the same instrument need not be used to price all types of risk. The trading of large corporate issues across a spectrum of credit risks and the growing market in default swaps may provide more robust mechanisms for price discovery in credit risks than government securities. While a few different

Graph 19

Ratings distribution of default swaps

Number of issuers against whom default swaps are traded, by credit rating (Moody's)[1]



[1] As of 27 November 2000.

Source: JP Morgan.

Table 6

Quote conventions for non-government bonds

Common pricing benchmarks[1]

Credit rating	Euro		Yen		Sterling		US dollar	
	Domestic	Foreign	Domestic	Foreign	Domestic	Foreign	Domestic	Foreign
AAA	Swap	Swap	Govt	Swap	Govt Swap	Swap	Govt GSE	Swap
AA to BBB	Swap	Swap	Govt Swap	Swap	Govt Swap	Swap	Govt GSE	Swap
Below BBB	Yields	Swap	Swap	Swap	Yields	Swap	Yields	Swap

[1] Debt instrument against which investment banks tend to quote yield spreads when marketing non-government bonds to domestic and foreign institutional investors: government bonds ("Govt"), bonds issued by government-sponsored enterprises ("GSE"), interest rate swaps ("Swap") or absolute yields ("Yields"). Final quotes are typically made in price terms.

instruments are candidates to serve as proxies for the risk-free benchmark, over time markets will settle on only one yield curve for price discovery about macroeconomic fundamentals. Interest rate swaps look increasingly likely to displace government securities in this role, but swaps still labour under some disadvantages, in particular the present decentralised structure of the market, that could forestall their ascendancy.

Annex 1:
Changes in government debt management, 1997-2000[1]

Instrument	France	Germany	Italy
Zero coupon			
2 months	Not issued	Not issued	Introduced in Oct 00
3 months	Size fell to €1bn from €2.3bn Frequency unchanged at 52/yr	Not issued	Size fell to €2.9bn from €4.5bn Freq fell to 12/yr from 26/yr
6 months	Size unchanged at €0.8bn Frequency unchanged at 26/yr	Size unchanged at €5bn Frequency unchanged at 4/yr	Size rose to €5.3bn from €3.3bn Freq fell to 12/yr from 26/yr
1 year	Size unchanged at €0.8bn Frequency unchanged at 26/yr	Not issued	Size rose to €6.4bn from €4.7bn Freq fell to 12/yr from 26/yr
1.5 years	Not issued	Not issued	Size fell to €1.8bn from €5.7bn Freq rose to 12/yr from 6/yr
2 years	Not issued	Not issued	Size fell to €1.6bn from €5.9bn Freq rose to 12/yr from 6/yr
Floating rate			
7 years	Not issued	Not issued	Size fell to €1.6bn from €8.8bn Freq rose to 12/yr from 4/yr
Fixed rate			
2 years	Size unchanged at €1.8bn Frequency unchanged at 12/yr	Size unchanged at €5bn Frequency unchanged at 4/yr	Not issued
3 years	Not issued	Not issued	Size fell to €3.7bn from €8.3bn Freq rose to 24/yr from 4/yr
5 years	Size unchanged at €2.3bn Frequency unchanged at 12/yr	Size rose to €6bn from €4bn Frequency unchanged at 4/yr	Size fell to €2.6bn from €8.4bn Frequency rose to 12/yr from 4/yr in Jun 00
10 years	Size unchanged at €2.5bn Frequency unchanged at 12/yr	Size unchanged at €7bn Frequency rose to 6/yr from 2/yr	Size fell to €1.8bn from €11.2bn Freq rose to 12/yr from 4/yr
15 years	Eliminated	Not issued	Not issued
30 years	Size fell to €0.7bn from €0.9bn Frequency rose to 12/yr from 2/yr	Size fell to€5bn from €11bn Frequency unchanged at 2/yr	Size fell to €1.5bn from €9.4bn Freq rose to 12/yr from 1/yr
Indexed			
5 years		Not issued	Not issued
10 years	Size fell to €0.3bn from €1bn	Not issued	Not issued
30 years		Not issued	Not issued
Reopenings			
Debt buybacks			

[1] Changes between 1997 and 2000 in the average size of auctioned issues (including reopenings) and the frequency of auctions.

Sources: CGFS (1999b); national data; BIS calculations.

Changes in government debt management, 1997-2000 (cont)

Instrument	Japan	United Kingdom	United States
Zero coupon			
3 months	Last issued in Mar 00	Issuance varies; stock of Treasury bills is to be built up to £15bn over an unspecified period from £4bn in 2000	Size rose to $14bn from $12bn Frequency unchanged at 52/yr
6 months	Size rose to >¥2trn from ¥1.4trn Freq unchanged at 12/yr		Size unchanged $12bn Frequency unchanged at 52/yr
1 year	Introduced in Apr 99 Size rose to >¥1trn from ¥0.8trn Freq unchanged at 12/yr	Not issued	Size fell to $14b from $20b Frequency fell to 4/yr from 13/yr in Feb 00
Floating rate			
5 years	Not issued	Last issued in Jun 96	Not issued
15 years	Introduced in Jun 00 Size unchanged at ¥0.6trn Frequency unchanged at 4/yr	Not issued	Not issued
Fixed rate			
2 years	Size rose to ¥1.4trn from ¥0.1trn Frequency unchanged 12/yr	Not issued	Size fell $10bn from $18bn Frequency unchanged at 12/yr
3-4 years[2]	Last issued in Apr 01	Not issued	Last issued in May 98
5 years	Introduced in Feb 00 Size unchanged at ¥0.9trn Frequency unchanged at 12/yr	Last issued in 1996	Size unchanged at $12bn Frequency fell to 4/yr from 12/yr in May 98 [3]
6 years	Last issued in Apr 01	Not issued	Not issued
10 years	Size rose to ¥1.4trn from ¥1trn Frequency unchanged 12/yr	Size varies from £8bn to 11bn	Size fell to $10bn from $12bn Frequency unchanged at 4/yr
20 years	Size rose to ¥0.6trn from ¥0.4trn Frequency unchanged at 4/yr	Last issued in 1997	Not issued
30 years	Introduced in Sep 99 Size unchanged at ¥0.3trn Frequency unchanged at 3/yr	Issuance varies	Size unchanged at $10bn Frequency fell to 2/yr from 3/yr in Feb 00
Indexed			
5 years	Not issued	Size varies; minimum amount of £2.5bn is auctioned each year, in maturities from 10 to 30 yrs	Introduced in Jul 97 Last issued in Sep 98
10 years	Not issued		Introduced in Jan 97 Size fell to $5bn from $7bn Frequency unchanged at 2/yr
30 years	Not issued		Introduced in Apr 98 Size fell to $5b from $8b Frequency fell to 1/yr from 2/yr in Feb 00
Reopenings	New rules were introduced in Mar 01	Reopenings, switch auctions and conversion offers take place regularly	New rules were introduced in Nov 99 to facilitate the re-opening of securities within one year of issuance
Debt buybacks	No buybacks	Reverse auctions were introduced in 2000; official purchases in the secondary market take place regularly	Reverse auctions were introduced in Jan 00; a regular schedule for buybacks was introduced in May 00

[1] Changes between 1997 and 2000 in the average size of auctioned issues (including reopenings) and the frequency of auctions. [2] Four-year bond in Japan and three-year bond in the United States. [3] When the frequency of five-year auctions was reduced in May 1998, issue sizes were also increased to $18 billion. In 2000, issue sizes were reduced.

Sources: CGFS (1999b); national data; BIS calculations.

Annex 2:
US dollar instruments held by central banks

Composition of US dollar reserves
As a percentage of identified dollar reserves[1]

	1995	1998	June 2000
US Treasury securities	63	62	59
Treasury bills	23	15	16
Treasury notes and bonds	40	47	43
Other short-term instruments	29	27	29
Onshore deposits	4	4	4
Offshore deposits	14	13	15
US money market paper	10	10	10
Other long-term instruments	3	4	6
US GSE securities	2	3	5
US corporate bonds	0	1	1
Equity	5	7	7
Memorandum items (in billions of US$):			
Identified US dollar reserves[1]	740	916	1,014
Total US dollar reserves	835	1,082	1,451[2]
Total foreign exchange reserves	1,347	1,640	1,909[2]

[1] Identified US dollar reserves exclude US dollar-denominated securities held outside the United States, such as international dollar bonds. [2] December 2000.

Sources: Fung and McCauley (2000); US Treasury; BIS calculations.

Annex 3:
Most frequently traded bonds on Euroclear

Bonds that traded actively on Euroclear for six to 12 months during the first year after issuance

Issuer	Currency	Issue size	Credit rating	Maturity	Sector[1]
Bonds issued between January and December 1997					
Asian Development Bank	USD	1,000	AAA	11/06/07	Supra
Asian Development Bank	USD	3,000	AAA	15/08/27	Supra
British Telecommunications	USD	1,000	A	23/05/07	Corporate
Caisse Centrale Crédit Immobilier	USD	750	A+	27/02/02	Financial
Commerzbank Overseas Finance (FRN)	USD	750	not rated	30/01/01	Bank
Inter-American Development Bank	USD	1,000	AAA	07/03/07	Supra
J.L.S. NR 1 Ltd	USD	500	not rated	30/09/99	Financial
J.L.S. NR 2 Ltd	USD	770	not rated	29/09/00	Financial
Toyota Motor Credit	USD	1,000	AAA	11/06/07	Corporate
Bonds issued between July 1999 and June 2000					
Caisse Amortisation de la Dette Sociale	EUR	2,500	AAA	12/07/04	GSE
Depfa Pfandbriefbank	EUR	3,500	AAA	15/01/10	Bank
Dexia Municipal Agency	EUR	1,250	AAA	26/04/10	Bank
European Investment Bank	EUR	6,210	AAA	15/04/04	Supra
Kreditanstalt für Wiederaufbau	EUR	2,500	AAA	04/01/10	GSE
Mannesmann Finance	EUR	2,300	A	13/10/04	Corporate
Development Bank of Japan	USD	750	AA+	30/11/11	GSE
Ford Motor Credit	USD	5,000	A	28/10/09	Corporate
Inter-American Development Bank	USD	2,000	AAA	15/01/10	Supra
Japan Tobacco	USD	1,000	AA-	27/07/04	Corporate
World Bank (IBRD)	USD	2,000	AAA	06/03/02	Supra
World Bank (IBRD)	USD	3,000	AAA	27/01/05	Supra

[1] Supra = supranational institution; GSE = government-sponsored enterprise; Bank = commercial bank; Financial = non-bank financial institution; Corporate = non-financial corporation.

Sources: Bloomberg; Euroclear.

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Pfandbrief-style products in Europe

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Abstract

The Pfandbrief bond market is the biggest segment of the euro-denominated private bond market in Europe and rivals in size the individual European government bond markets. The fact that it developed mainly in a single country as a purely domestic product until the mid-1990s obscured the strong growth of this market segment, regarded as illiquid and arcane by international investors. Following the strong development in issuance of, in particular, the German "Jumbo", a number of jurisdictions in Europe (including many eastern European countries) have now established the regulatory framework for Pfandbrief-style products or are preparing to do so in the near future. This note describes the nature and the main characteristics of Pfandbrief-style products in a number of European countries and concentrates the analysis in particular on Jumbo products, which were launched within a relatively short period of time in Germany, France, Spain and Luxembourg. The existing differences in the national jurisdictions, and the fact that their further harmonisation in the near future is unlikely, should not prevent a successful establishment of the Pfandbrief as an asset class in its own right, both within and outside the European Union. In this respect, the application of Article 22(4) of the EU UCITS Directive, which sets out criteria for defining a common class of assets, could provide the basis for ensuring a minimum level of homogeneity of this type of assets.

1. Introduction

Government securities have played and continue to play an important role in the development and functioning of financial markets. They are deemed an attractive investment for a number of reasons: they have a high level of homogeneity and "fungibility" (ie substitutability between issues);[2] they are perceived as having a negligible credit risk (reflecting the taxation power of governments); and they have a high degree of liquidity compared to other types of assets. In addition, government bonds act as liquid underlying for derivatives and repo markets,[3] and yields on government bonds are used as a reference to price other debt and derivative instruments.[4] Government bonds also perform a "safe haven" role at times of unstable conditions in financial markets.[5] A reduction in the availability of government debt could therefore affect the functioning of bond markets, unless private financial markets develop sizeable and liquid markets for a number of asset classes that enable private

[1] The author wishes to acknowledge the very helpful contributions and comments made by Francesco Papadia, Denis Blenck, Marco Laganà, Sergio Grittini and Arnaud Mares to a previous version of this note prepared in autumn 2000. The author nevertheless remains responsible for the opinions and errors included in this most recent and substantially changed version. The views expressed in this article are not necessarily those of the European Central Bank.

[2] Government securities have only one issuer, which ensures that the bond features are standard across issues. This implies a high substitutability between issues and a higher degree of liquidity (high turnover and lower spreads) compared to private securities.

[3] Futures and options are written mainly on government bonds, as the valuation of these assets requires a large, active and well arbitraged market in the underlying security.

[4] Market participants tend to use (central) government debt as well as swap rates to calculate prices of other debt and derivative instruments; such a "benchmarking" feature is considered to be an important reference for pricing in corporate bond markets. See also Brookes (2000).

[5] In addition, government debt securities are still the main (but not necessarily the only) eligible assets to access central bank credit; they have up to now been the only underlying assets for general collateral repo trades; in many countries, guidelines and/or direct quantitative regulations of private pension funds specify minimum compulsory investment shares in government securities; only government debt securities bear an attractive 0% risk weighting for the purpose of capital adequacy requirements.

securities to assume some of the roles presently fulfilled by government securities. The improved financial position of governments in Europe and the United States in the late 1990s and 2000 has led to a reduction in the net supply of government securities in some countries (Chart 1). Financial markets are adjusting to reduced availability of government debt through increased issuance of securities by the private sector, both financial institutions and corporates.

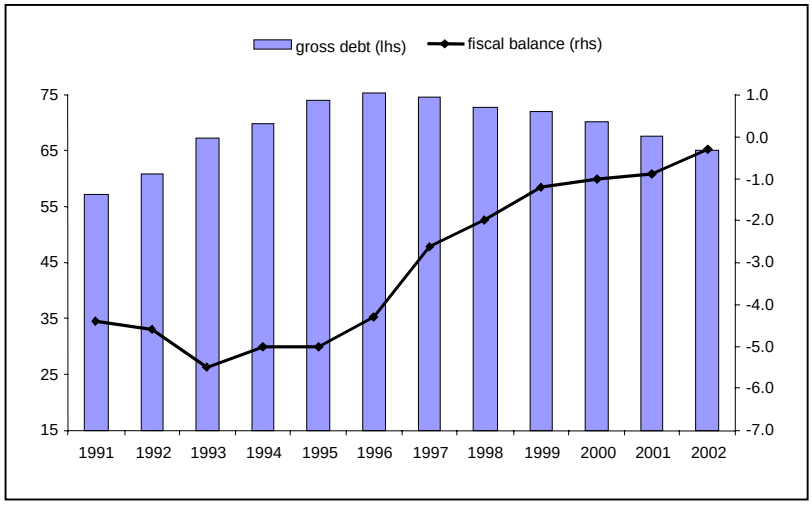
In order to achieve the same level of attractiveness as government bonds in terms of credit risk and liquidity, certain characteristics of non-government securities have to be addressed. A risk status for private bonds similar to that of government bonds can be achieved, for example, through collateralisation or some other form of guarantee. Examples already present on the markets include bonds backed indirectly by private mortgages or public sector loans (eg Pfandbriefe and other asset-backed securities), while an implicit government guarantee such as that enjoyed by Fannie Mae and Freddie Mac in the United States increases the credit quality of private sector collateral. To enhance liquidity, private issues could be given increased "fungibility", ie through issuance of bonds with a limited set of maturities and in relatively large issue sizes (with reopenings of issuance on existing maturities in order to increase the issue size).[6] In addition, quotation on an electronic trading system could improve transparency and liquidity. The development of derivatives and repo markets based on these assets would also help enhance the attractiveness of these private bond segments, allowing for hedging strategies and ultimately supporting efficient market-making. This would promote the development of market benchmarks that would facilitate pricing, also in other market segments.

The scope of this paper is to present some selected facts on a particular segment of the European bond market that has witnessed a very strong development recently, namely that of "Pfandbrief-style" products, in particular the so-called "Jumbo" segment. This particular instrument seems to offer a very high level of "quality" for investors, due to its built-in characteristics that enhance investor protection, thus enabling these products to obtain an issue rating comparable to those of government bonds and higher than the rating of the individual issuer of this type of asset. After briefly describing the securitisation mechanism, the paper presents an overview of some established and nascent funding instruments currently issued in Europe based on Pfandbriefe. It then describes in some depth the main characteristics of the four Jumbo-type products currently being issued in the euro area (the German *Pfandbrief*, the French *obligation foncière*, the Spanish *cédula hipotecaria* and the Luxembourg *lettre de gage*).

Chart 1

General government gross debt and fiscal balance in the euro area

As a percentage of GDP



Source: ECB.

[6] These reopenings would very likely be at more irregular intervals than for government borrowings.

2. On-balance sheet vs off-balance sheet securitisation

Pfandbriefe are covered bonds obtained through a process of securitisation. This can be defined as the technique of converting a credit claim or a pool of claims into negotiable securities, a process that can typically be achieved either "off-balance sheet" (this is the type of securitisation most often referred to as "asset-backed") or "on-balance sheet" (nowadays referred to as "Pfandbrief-style"), or even through "synthetic securitisation" - a technique that has developed more recently.[7]

Off-balance sheet securitisation implies the sale by a bank of a portfolio of assets to an entity (typically a so-called special purpose vehicle (SPV), separate from the issuer), which finances the acquisition of the assets by issuing debt instruments (eg bonds or commercial paper) or shares. The assets are considered securitised insofar as it is the initial assets that serve to secure the ability of the issuing entity to honour its obligations. The generic designation of asset-backed securities (ABS) derives from this direct relationship. Off-balance sheet securitisation is a relatively recent development in Europe, and the amounts involved are still relatively low compared to on-balance sheet securitisation.

On-balance sheet securitisation consists in the issuance of securities backed by securities that remain on the balance sheet of the issuer. The typical (and probably oldest) example of this type of securitisation is provided by the German Pfandbrief, where assets are ring-fenced on the balance sheet of special banks subject to a specific legal regime. The bank then issues bonds, which provide the holders with a priority right to the ring-fenced assets in the event of default by the issuer. The holder therefore benefits from a double protection: the solvency of the issuer and the solvency of the debtors of the original assets. This type of securitised product will be analysed in more detail in the next sections (Table 1).

Table 1

Comparison between Pfandbriefe and asset-backed securities (ABS)

	Pfandbriefe	**ABS**
Level of standardisation	Very high for Jumbos: this makes the bonds very transparent to the investors and favours liquidity in general. Relatively low for traditional Pfandbriefe.	None: the main feature of ABS is their flexibility in relation to issuers' and investors' needs.
Nature of securities	Pfandbriefe are bank securities, where the debtor is the issuer bank. The security is guaranteed by underlying public sector or mortgage loans.	ABS are issued by SPVs based on loans that are transferred from their originator; the risk is also taken off the balance sheet of the originator.
Bankruptcy remoteness	Pfandbriefe are guaranteed by the whole amount of mortgage or public loans issued by the bank (there is a continuous turnover of the loans underlying the Pfandbrief).	ABS are guaranteed by specific pools of assets, which represent only part of the assets of the originator bank.

Sources: Peppetti-Rinaldi (2001); ECB.

[7] "Synthetic securitisation" refers to structured transactions in which a party uses "credit derivatives" to transfer the credit risk of a specified pool of assets to third parties. The best known and most developed type of synthetic securitisation is the *credit default swap*, a bilateral financial contract aiming at buying financial protection on underlying assets or generating exposure to credit risk without actually selling or buying the related assets.

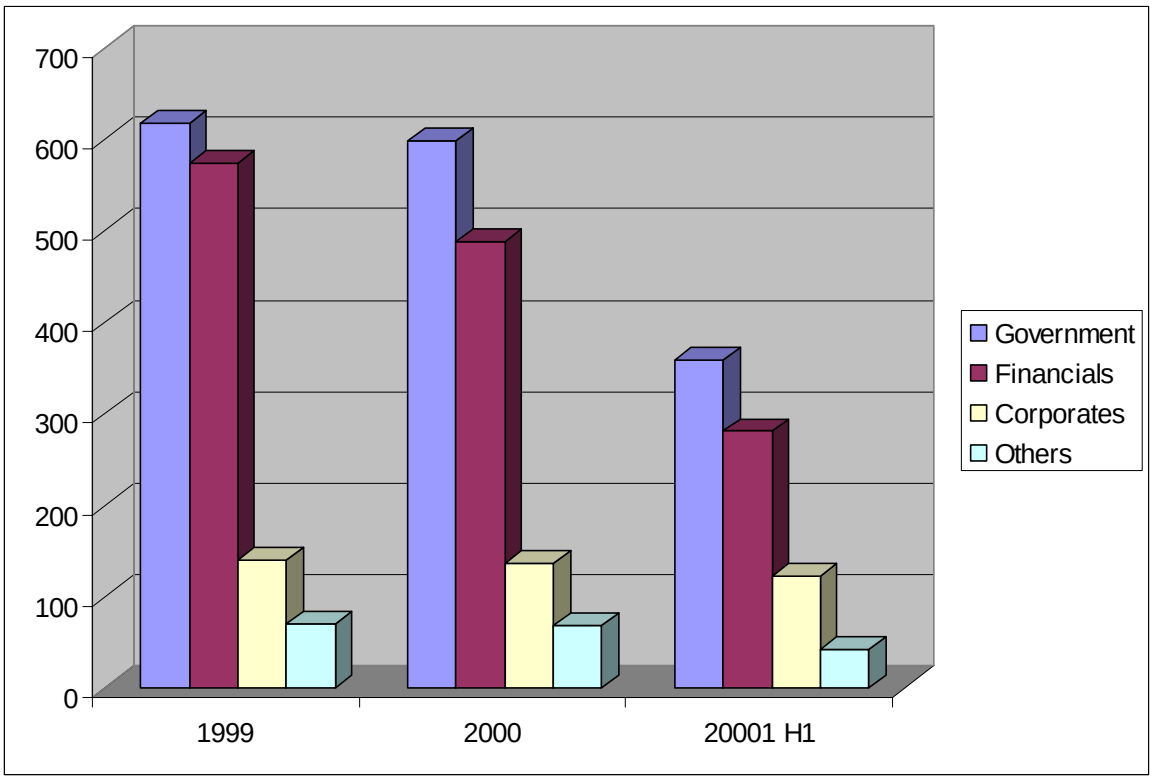
3. Pfandbrief-style products in Europe

In the euro area,[8] private debt markets have grown substantially since the introduction of the euro. The share of outstanding government bonds has fallen from 52% at the start of monetary union to 49% as at April 2001. On the supply side, there has been a large wave of mergers and acquisitions in the wake of the single currency. On the demand side, the introduction of the euro has created a large pool of "domestic" investors with a common currency, which has led to an increasing internationalisation of euro-denominated bond markets in the European Union. These events have fostered strong issuance in private bond markets.[9] While attention has naturally tended to be focused on the corporate bond sector, a substantial share of new issuance has been by financial institutions, with 70% of total issuance in the first half of 2001 (Chart 2); financial institutions accounted for around 73% of total outstanding amounts of private bonds as at April 2001.

Chart 2

Euro-denominated gross bond issuance in the European Union

(EUR billions, 1999 to the first half of 2001)



Source: European Commission.

Among the products issued by financial institutions in Europe, one has established itself as an asset class in its own right and has been a flourishing segment of the euro-denominated bond markets. This is the class of Pfandbrief-style products. At the level of the euro area, Pfandbriefe and similar instruments account for approximately 20% of all outstanding fixed income assets (Chart 3).

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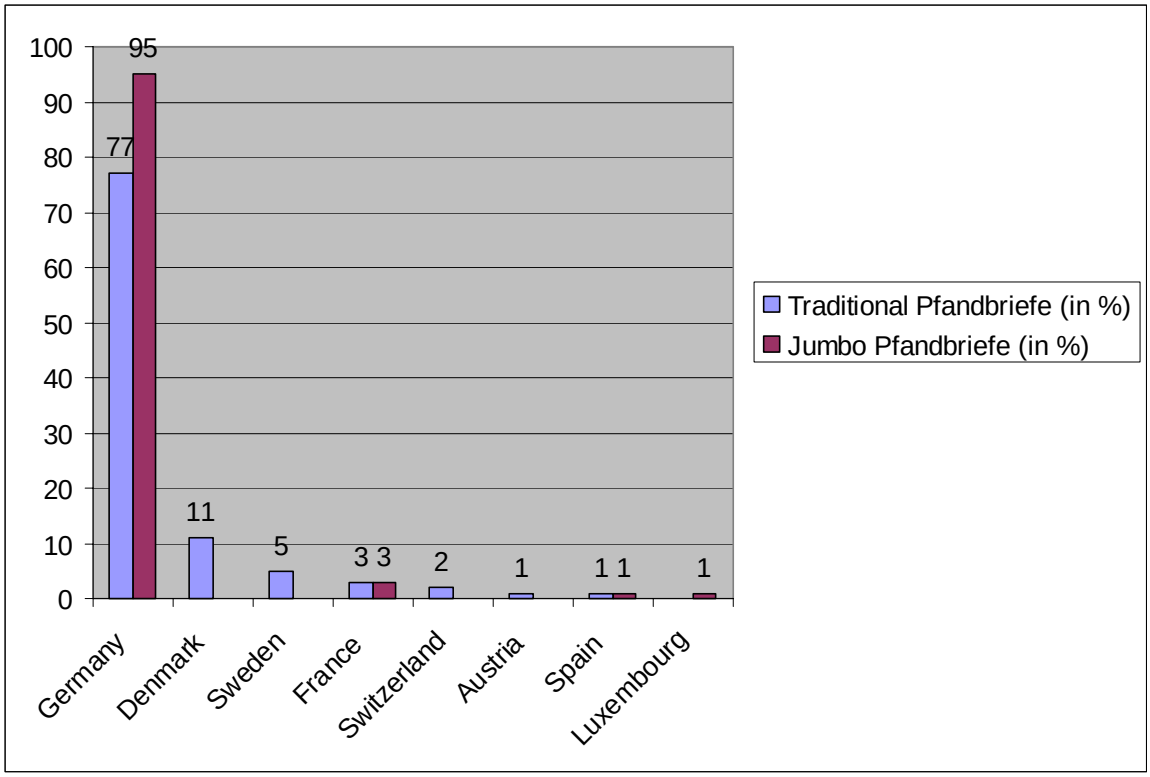
[8] Currently Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal and Spain.

[9] For an extensive description of the developments in euro area bond markets, see ECB (2001a, 2001b) and Santillan et al (2000).

Chart 3

Outstanding Pfandbriefe in selected EU countries and Switzerland

(as a % of total outstanding amounts in these countries, October 2000)



Source: WestLB.

Legislation on Pfandbrief-style products is already in place in most countries in Europe (including some eastern European countries). Some of these products have been around for a long time: in Germany, Spain, Denmark and Sweden, laws providing a framework for the issuance of these products were passed around the start of the last century or even before.[10] In other countries (with the exception of the United Kingdom, which appears to favour the off-balance sheet type of securitisation), introducing or updating the legislative framework is under discussion. This is the case in Sweden, Belgium, Italy and especially Ireland, where a bill introducing the Irish Pfandbrief (very similar to the German Pfandbrief) is already at a very advanced stage and is expected to be approved during 2001. The legislative innovation that has recently taken place in many European countries aims at enabling national financial institutions to specifically issue Pfandbrief-style products, in recognition of the fact that these products have established themselves as a leading financial asset class beyond national borders. To mention but a few of the revisions, in France the law governing *obligations foncières* was revised in 1999. In Luxembourg a substantial revision of the law on *lettres de gage* of 1993 was passed in 1997, whereas Spanish banks started to issue a maxi-version of *cédulas hipotecarias* as from 1999. In Finland legislation on Pfandbriefe was introduced in 2000.

[10] The German Pfandbrief (literally "letter of pledge") is said to be traceable back to a decree of Frederick II of Prussia in the 18th century. However, it was only in 1899 that the Pfandbrief took its present form, when the Mortgage Bank Law was passed. The oldest law on Pfandbrief-style products was issued in France in 1852 with the *Loi sur l'obligation foncière et communale*. The oldest mortgage credit market can be traced to Denmark, where it was generated by a vast demand for housing finance after the Great Fire of 1789. In Sweden, where a mortgage market has existed at least since 1860, there is no specific mortgage legislation; the activities in this field are governed by the more general Law on Credit Companies and there is very close supervision by the Swedish Financial Supervisory Authority.

Table 2

Pfandbrief-style products in the EU

Austria	*Pfandbriefe*: these bonds are issued on behalf of the *Landeshypothekenbanken* by a centralised issuing institution and three separate banking groups. Loans to borrowers in the EEA and Switzerland may be used as backing collateral for these bonds. The bonds have a 10% solvency weighting. The authorities are currently working on a revision of the relevant law.
Belgium	Legislation to allow mortgage bond issuance is being prepared.
Denmark	*Realkreditobligationer*: these mortgage bonds are issued by recognised mortgage institutions, which are responsible for 90% of mortgage bond issuance. The relevant laws are currently evolving, and these bonds may come to resemble Pfandbriefe more closely. At present mortgage bonds are backed only by mortgage loan collateral and are not insulated from the bankruptcy of their issuers.
France	*Obligations foncières*: are backed by mortgages and public sector loans, located anywhere in the EEA. They are issued by *Sociétés de Crédit Foncier* (SCFs), whose sole purpose is to make mortgage and public loans and refinance then through *obligations foncières*. SCFs are normally owned by the parent bank, which acts as the servicer of the loan. Real estate collateral is marked to market. There is an effective "bankruptcy remoteness" as holders of *obligations foncières* rank ahead of all other creditors. SCFs are supervised by a professional auditor, who reports to the Banking Commission. There are detailed disclosure requirements on asset quality, prepayments and interest rate sensitivity of the collateral pools. *Obligations foncières* must be listed on at least two exchanges and have at least two ratings.
Finland	*Kiinteistovaakuudellinen joukovelkakirjalaina/julkisyhteisova-kuudelinnen joukkovelkakirjalaina*: a new law came into effect in January 2000, closely based on the German model, which fulfils the requirements of Article 22(4) of the UCITS Directive. Only specialised institutions are permitted to issue mortgage bonds. There are set rules for valuing mortgageable property. The loan-to-value ratio is up to 60% of the mortgageable value. There is no requirement for an independent trustee. Collateral from the EEA is acceptable. Eligible assets include public sector and mortgage loans, requiring two separate registers. There is currently a limit on substitution of collateral. Mortgage bondholders have a preferential status in any liquidation of the issuing institution.
Germany	*Pfandbriefe*: this is a general term encompassing *Hypotheken-Pfandbriefe* and *Öffentliche Pfandbriefe*. The former are issued to fund loans which are secured by first ranking residential and commercial mortgages or land charges; the latter are issued to fund loans to the public sector (eg federal government, regional governments, municipals and other agencies). Public Pfandbriefe amount for about 80% of the outstanding amount, mortgage Pfandbriefe for the remaining 20%, reflecting the difficulty involved in pooling the necessary EUR 500 million in mortgage loans, within a short time, whereas this is far easier in the case of public sector loans. The collateral of all outstanding *Öffentliche Pfandbriefe* and *Hypotheken-Pfandbriefe* of any mortgage bank must be kept in two separate pools. Investor protection is guaranteed at two levels: through the very clear legislation defining which institutions are privileged by law to issue Pfandbriefe; and through the conservative guidelines determining the quality and size of the collateral backing. The total volume of all Pfandbriefe of a mortgage bank in circulation may not exceed 60 times the amount of its own capital. Loans eligible as pool collateral may not count for more than 60% of their value, regardless of the type of loan. The Federal Banking Supervisory Authority (Bundesaufsichtsamt für das Kreditwesen - BAKred) ensures that the issuers' activities comply with these regulations. They have a 10% solvency risk weighting and qualify for Eurosystem repo operations.
Ireland	A law creating the *Irish Pfandbrief* is currently being discussed and is close to approval. According to the proposal, these assets will be modelled on the existing Pfandbrief legislation in Germany, France and Luxembourg. Only approved "designated credit institutions" will be able to issue these bonds, which will be secured by mortgage loans or public loans. Assets will have to be segregated in the balance sheet of the issuer. The loan-to-value ratio will be 60%. Substitution of assets must not exceed 20% of the total pool value. Holders of bonds will have a priority claim over the cover assets in case of default. Assets from the EEA, Canada, the United States and Switzerland will be allowed, as will certain types of hedging derivatives. There will be rules for asset and liability matching.

Table 2 (cont)

Luxembourg	*Lettres de gage*: at present three institutions have the specialised issuing licence required for issuing these bonds; the first few issues are on the market. The establishing law of 21 November 1997 is closely modelled on the German precedents. The backing collateral for *lettres de gage publiques* is public sector loans, and for *lettres de gage hypothécaires* is mortgage loans. As in Germany, there must be separate public sector and mortgage asset pools. There is a requirement for an independent trustee. A register of the collateral assets must be kept. There are requirements with regard to substitution collateral, which is limited to 20% of all collateral. There are set rules for valuing mortgage property. The loan-to-value ratio is up to 60% of the mortgageable value. Collateral from all OECD countries is eligible to back *lettres de gage*. They have a 10% solvency risk weighting and qualify for Eurosystem repo operations.
Spain	*Cédulas hipotecarias*: these can be backed only by mortgage loans and not by public sector loans. They are collateralised by the issuing entity's entire mortgage pool rather than by a specific pool of mortgage assets. Holders of *cédulas hipotecarias* enjoy a privileged status and have priority over the mortgage book of the issuer in the event of bankruptcy. Only the State or the issuer's employees have higher priority over the proceeds arising from liquidation in case of bankruptcy. Early amortisation is not possible. Mortgage valuation is subject to conservative valuation rules (70% loan-to-value ratio) and mortgage certificates can be issued only up to 90% of an individual issuer's eligible mortgages ("overcollateralisation"). The principle of matching maturities is not covered in Spanish law, which gives Spanish institutions some leeway for taking on interest rate risk arising from maturity transformation.
Sweden	Securitisation of mortgage lending is only just starting. At present, mortgage bonds differ quite materially from the Pfandbrief model, but new legislation is planned. Around 60% of mortgage loans are funded by means of mortgage bonds but these do not enjoy the preferential status of German-style Pfandbriefe. Two institutions currently dominate the issuance of mortgage bonds. The bonds do not qualify for a 10% solvency risk weighting.

Source: Fitch IBCA (2000).

In all countries, the new laws aim at guaranteeing the quality of covered bond instruments with a view to reproducing the popularity and attractiveness to investors of the German Pfandbrief, also at the international level. The adaptation of national laws to the German model is being pursued in the light of the fact that the strong characterisation of Pfandbrief as a quality product has allowed it to obtain a unique, almost privileged, position at the European level compared to other high-quality non-sovereign assets. For example, the Pfandbrief's capital risk weighting is only 10%, compared to the 20% weighting normally required for other bank bonds.[11] In addition, Pfandbriefe issued in the European Union in accordance with the UCITS Directive[12] are not subject to certain limits on investments

[11] Article 11(2) of the EU Solvency Directive.

[12] Council Directive 85/611/EEC as amended by Council Directive 88/220/EEC (the "UCITS Direcive") aims at governing collective investment undertakings with a view to approximating the conditions of competition between undertakings at Community level while at the same time ensuring effective and more uniform protection for unit holders, removing the restrictions on the free circulation of the units in the Community and helping bring about a European capital market. The Directive defines the relevant criteria that bonds must satisfy in order to be included in this EU-wide list of assets which ensure particular protection for the bondholders. This Directive tends to limit the number of potential issuers and ensures that sufficient protection is in place to ensure sufficiently homogeneous instruments and a sufficient degree of transparency. In particular, Article 22(4), which is considered crucial to the essence of the Pfandbrief-style model of mortgage bond issuance, states inter alia that member states may raise the limit laid down in paragraph 1 (ie no more than 5% of its assets may be invested by a UCITS in transferable assets issued by the same body) to a maximum of 25% in the case of certain bonds, when these are issued by a credit institution which has its registered office in a member state and is subject by law to special public supervision designed to protect bondholders. In particular, sums deriving from the issue of these bonds must be invested, in conformity with the law, in assets which, during the whole period of validity of the bonds, are capable of covering claims attaching to the bonds and which, in the event of the failure of the issuer, would be used on a priority basis for the reimbursement of the principal and payment of the accrued interest. These general criteria imply that: (a) the issuer must be a credit institution domiciled in the European Union; (b) the issuer country exercises special state supervision to protect bondholders, eg through state-appointed trustees, special collateral checks or special valuation rules; (c) the sums deriving from the issue of these bonds must be placed in assets which provide sufficient cover for the liabilities deriving from the bonds for their entire duration; (d) in the event of bankruptcy of the issuer, these assets are intended to be used to repay the capital and interest becoming due. The mortgage bank creditors thus have a preferential claim in the case of bankruptcy of the issuing institution.

prescribed for institutional investors (for example, investment companies and insurance companies may buy double the amount of Pfandbriefe and mortgage bonds compared with other securities).[13] Finally, Pfandbriefe and mortgage bonds that comply with the UCITS Directive satisfy the "financial soundness" requirement for assets to be eligible for refinancing operations with the Eurosystem and for TARGET[14] payment system purposes (Table 4).

Table 3

Pfandbrief-style products in other European countries

Switzerland	*Pfandbriefe/Lettres de gage*: at present, Swiss mortgage bonds deviate quite materially from the Franco-German model. The two centralised mortgage bond-issuing institutions have been active for decades and are increasing issuance volume. Mortgage and asset-backed securitisation is also quite widespread.
Czech Republic	*Zastavni list*: the relevant law (July 1995) fulfils the requirements of Article 22(4) of the UCITS Directive. There are only mortgage bonds. These have priority in the event of the bankruptcy of the issuer. Licences to issue these bonds are limited. There are no set rules for valuing mortgageable property. The loan-to-value ratio is up to 60% of the market value. There is no requirement for a register of the collateral assets to be kept: "independent evidence" of their existence suffices. There is no requirement for an independent trustee. There are requirements in regard to substitution of collateral, which is limited to 10% of all collateral.
Hungary	*Jelzaloglevel*: the relevant law (June 1997) fulfils the requirements of Article 22(4) of the UCITS Directive. There are public sector and mortgage bonds. These have priority in the event of the bankruptcy of the issuer. There is a requirement for an independent trustee. There are set rules for valuing mortgageable property. The loan-to-value ratio is up to 60% of the market value. There are requirements in regard to substitution of collateral, which is limited to 20% of all collateral. A register of the collateral must be kept.
Latvia	*Kilu zime*: the relevant law (September 1998) fulfils the requirements of Article 22(4) of the UCITS Directive. There are only mortgage bonds. These have priority in the event of the bankruptcy of the issuer. Licences to issue these bonds are limited. There is no requirement for an independent trustee. A register of the collateral assets must be kept. There are requirements in regard to substitution of collateral, which is limited to 20% of all collateral. There are set rules for valuing mortgageable property. The loan-to-value ratio is up to 60% of the market value.
Poland	*List Zastawny*: the relevant law (January 1998) fulfils the requirements of Article 22(4) of the UCITS Directive. There are public sector and mortgage bonds. These have priority in the event of the bankruptcy of the issuer. There are specialised mortgage bond-issuing institutions. There is a requirement for an independent trustee. There are set rules for valuing mortgageable property. A register of the collateral assets must be kept. There are requirements in regard to substitution of collateral, which is limited to 10% of all collateral. The loan-to-value ratio is up to 60% of mortgageable value.
Slovakia	*Zalozny list*: the relevant law (March 1996) fulfils the requirements of Article 22(4) of the UCITS Directive. There are public sector and mortgage bonds. These have priority in the event of the bankruptcy of the issuer. Licences to issue these bonds are limited. There is a requirement for an independent trustee. There are set rules for valuing mortgageable property. A register of collateral assets must be kept. There are requirements in regard to substitution of collateral, which is limited to 10% of all collateral. The loan-to-value ratio is up to 60% of mortgageable value.

Source: Fitch IBCA (2000)

[13] Another example of preferential treatment in Germany is that investment companies can invest up to 20% of total assets in Pfandbriefe of a single issuer, whereas the normal limit is 10%.

[14] The TARGET (Trans-European Automated Real-time Gross settlement Express Transfer) system was developed by the European System of Central Banks. It consists of 15 national real-time gross settlement systems plus the ECB payment mechanism, all of which are interlinked so as to provide a uniform platform for processing cross-border payments. It is intended mainly for the settlement of monetary policy operations and large-value interbank payments, but can also handle customer payments including smaller cross-border retail transactions.

Table 4

Overview of the legal status of Pfandbriefe in Europe

Country	Special law at the national level	Specific supervision	Complies with Article 22(4) of UCITS Directive
Germany	Yes	Yes	Yes
France	Yes	Yes	Yes
Luxembourg	Yes	Yes	Yes
Spain	Yes	Yes	Yes
Austria	Yes	Yes	Yes
Finland	Yes	Yes	Yes
Sweden[1]	No	Yes	No
Denmark	Yes	Yes	Yes
Switzerland	Yes	Yes	Yes

[1] Special rules apply for mortgage banks.

Source: AGMB (2000a).

Pfandbrief-style products have built-in mechanisms in order to ensure "bankruptcy remoteness" ie ensuring repayment of the bondholder in the event of default either of the bank issuing the Pfandbriefe, or of the underlying issuer of collateral. Although the working of these mechanisms depends very much on the special legislation enforced in each country, for practical purposes three specific situations of protection can be described:

(a) In the case of German Pfandbriefe there are no special purpose vehicles but there is *segregation* into separate asset pools in the issuing bank's books of the loans collateralising *Hypotheken-Pfandbriefe* (mortgage loans) and of those collateralising *Öffentliche Pfandbriefe* (public loans). If the issuing bank goes into liquidation, Pfandbriefe holders will not suffer any untimely repayments or redemption (in fact, no defaults have been recorded for Pfandbriefe in the last 100 years).

(b) The issuance of *obligations foncières* requires creating a special purpose vehicle, a *Société de Crédit Foncier* (SCFs), which is a registered credit institution that does not originate the loans collateralising its *obligations foncières* but rather buys them from another originator - normally the parent bank setting up the SCF. In case of a default, the holders of *obligations foncières* will have a *preferential claim* over all the assets of the issuing SCF so that these preferential creditors will remain fully remunerated and will be paid off in a timely manner.

(c) Issuance of *cédulas hipotecarias* is possible for any financial institution recognised by the Bank of Spain; there are no restrictions on the activities of the issuer, which also originates the loans backing the *cédulas*. Although the instrument is not secured by a separate pool of collateral, the safety is based on the principle of *overcollateralisation* of loans. In case of default, the bank's whole mortgage loan portfolio provides cover and the holders of *cédulas* are granted preferential treatment (though after claims from the State and from employees have been satisfied). Although holders of *cédulas* would be very unlikely to suffer any loss, they could suffer temporary interruption of remuneration and redemption as the liquidation procedures are carried out.

4. The Jumbo Pfandbrief

It was only with the launch of the Jumbo Pfandbrief by the German mortgage banks in mid-1995 that domestic covered bonds crossed domestic boundaries to become a better known instrument internationally. The move of the German banks has been followed by the French, Spanish and

Luxembourg regulatory authorities, which have revised and updated their existing legislation on covered bonds in order to enable the national financial institutions to better compete with other European financial institutions able to attract international investors investing in high-quality bonds. *Obligations foncières* and *lettres de gage* have been issued successfully in Jumbo format and spreads vis-à-vis German Pfandbriefe have always been very tight. However, the three new Jumbo instruments hardly present an immediate threat to the Pfandbrief market in terms of volumes issued (Table 5). A more in-depth description of these four market segments where issuance of Jumbos has occurred is presented in the following sections, and the main characteristics are summarised in the table in Annex 1.

Table 5

Outstanding amount of Jumbo Pfandbrief-type products in the euro area

(at 31 July 2001)

Type of bond	Outstanding amount (EUR billions)	Number of issues
Pfandbriefe	393	284
Obligations foncières	21.2	12
Cédulas hipotecarias	10	7
Lettres de gage	3.5	4

Sources: DG-Bank; PBI Luxembourg; AGMB.

4.1 The German Pfandbrief

The German Pfandbrief market is the largest individual bond market in Europe. With an outstanding amount of over EUR 1.1 trillion as at in July 2001, the Pfandbrief is the largest single non-government asset class in Europe and ranks sixth among fixed income markets in the world in terms of outstanding amounts, bigger than that of the Italian, German or French government bond markets taken individually (Chart 4). Most of the increase in outstanding amounts of Pfandbriefe is due solely to the increased issuance of Jumbo Pfandbriefe, whose outstanding amount increased from EUR 190 billion at the beginning of 1999 (when the euro was introduced) to EUR 393 billion at the end of July 2001, whereas the volume of "traditional" Pfandbriefe in the same period of time only rose by approximately EUR 30 billion. The average size of a Jumbo issue is around EUR 1.3 billion and there is a fairly evenly distributed maturity profile.

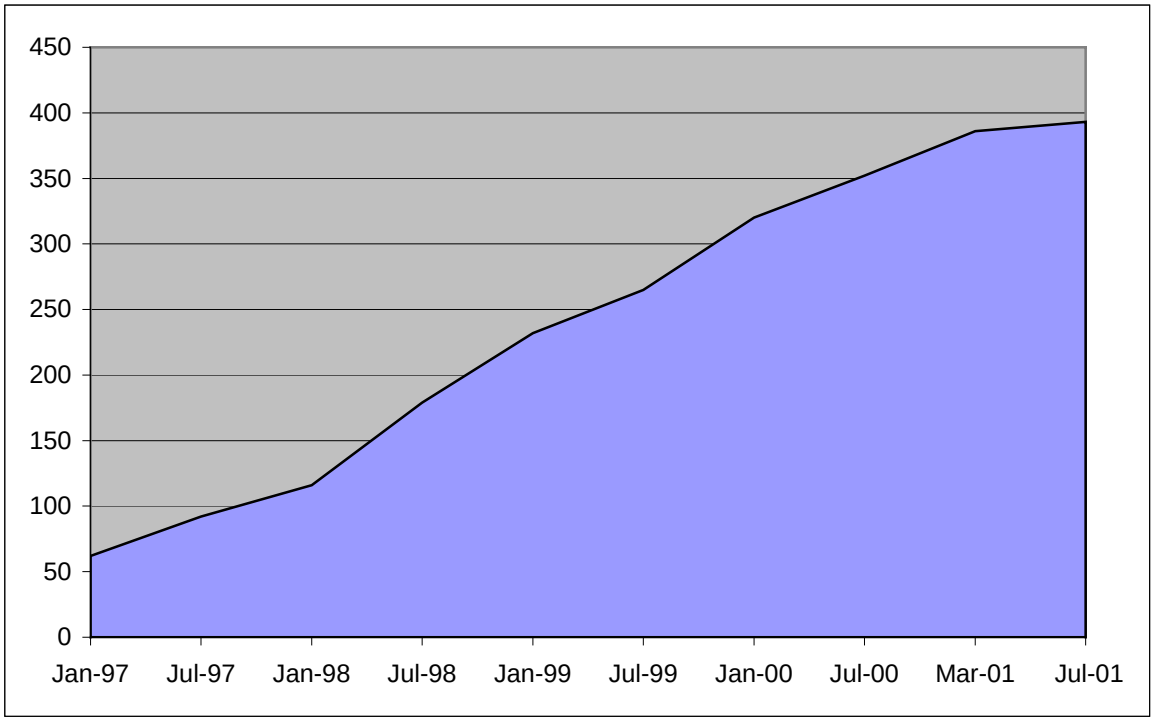
About 20% of the outstanding issues are estimated to be held by non-German residents. The predominant Jumbo to be issued has been and is the "public" Pfandbrief, with a share of over 90% of all Jumbos issued. This can be explained by the fact that it is easier to accumulate the cover collateral needed to achieve the minimum volume required for Jumbos by resorting to public sector loans rather than to mortgage loans.

The Jumbo Pfandbrief was first launched by the German mortgage banks in 1995. Originally a security aimed at domestic investors, the new type of instrument was developed to deliver an increased level of standardisation and enhanced liquidity characteristics in order to attract the interest of international investors wishing to access liquid and secure instruments carrying competitive yields. The introduction of this new instrument reflected the desire of German issuers to ensure an expansion of their refinancing base and to promote the internationalisation of a liquid and secure instrument whose issuing volumes were growing constantly. Jumbos currently represent about 36% of all outstanding Pfandbriefe issued by German residents.

Chart 4

Outstanding amount of Jumbo Pfandbriefe

(EUR billions)



Sources: AGMB; DG-Bank.

Central to the expansion of the Jumbo is the high credit quality of the instrument, as witnessed by the large number of triple-A ratings assigned to the individual issues (which are almost always higher than the rating of the issuer). In the light of their financial soundness, Jumbos (as well as traditional Pfandbriefe) are eligible for Eurosystem repo operations. Furthermore, they carry only a 10% solvency risk weighting. Another very important feature is the high liquidity, which is ensured by the very big issue sizes as well as the existence of a market-making mechanism, ie the commitment by at least three syndicate leaders to quote two-way prices with fixed bid-offer spreads on a continuous basis during normal trading hours.[15] Transparency is achieved by providing quotes on Reuters. Concerning the issue size, the Jumbo Pfandbrief market was introduced by setting minimum requirements for issue size in order to ensure liquidity: initially this was DEM 1 billion, which was then converted to EUR 500 million when the euro was introduced in 1999. Nevertheless, issue sizes of EUR 2-3 billion are not uncommon, and even issues of EUR 5 billion have been made in the recent past. Following the advent of the euro, the average issue size of Jumbos doubled, from EUR 0.6 billion to 1.3 billion.

Aside from the high credit standing and modern issuing practices, Jumbo Pfandbriefe (together with *obligations foncières*) were the first to trade on the EuroCredit MTS electronic trading system for credit products in May 2000.[16] There are currently 25 Pfandbrief plus three *obligation foncière* issues traded

[15] Additional standards for Jumbo Pfandbriefe are that tappings for outstanding issues must have a minimum size of EUR 125 million; the normal trading lot with guaranteed quotations is EUR 15 million, with a minimum of EUR 1 million.

[16] EuroCredit MTS is the new division of EuroMTS, an electronic trading platform initially designed for trading Italian government bonds in Italy that has since been chosen in other European countries for trading selected government securities. EuroCredit MTS is dedicated to the trading of non-sovereign benchmark bonds in the euro zone markets: the first non-government sector bond to be assessed and included on the platform was the Jumbo Pfandbrief. It started trading on 22 May 2000. EuroCredit MTS provides competitive prices and tight bid-offer spreads on all the securities traded. It currently has 22 market-makers and a total of 25 participants.

on EuroCredit MTS, for a total of approx EUR 94 billion nominal value.[17] Average aggregate daily turnover on these products is currently around EUR 500 million.[18]

To give an idea of how the Pfandbrief market compares with the government bond market in terms of liquidity, data on bid-ask and turnover were collected for bunds and Jumbo Pfandbrief issues, both in the German Pfandbrief OTC market-making scheme and on EuroCredit MTS (Table 6). *Bid-ask spreads* on Pfandbriefe compare favourably and show a degree of tightness similar to that of bunds. The *turnover ratios*, however, differ markedly (as could be expected). German government paper has a substantially higher turnover than Pfandbriefe. In particular, the lower turnover ratio recorded for EuroCredit MTS seems to point to the fact that market participants tend to continue to trade on the OTC market proportionately more than on the electronic platform. One explanation is that not all Jumbos traded on EuroCredit MTS are owned by the participants in this electronic trading platform and therefore have to be traded OTC. It may also indicate that traders actually tend to prefer to some degree the opacity of the OTC segment, so as to be able to avoid revealing their activity on the market.

The availability of the Jumbo Pfandbrief has spurred the development of connected market segments trading this product and allowing hedging strategies by market participants. The sustained turnover recorded for Pfandbriefe can be ascribed, among other things, to the existence of two repo market-maker arrangements on Pfandbriefe, which have contributed to an improvement of liquidity in the Jumbo market. In fact, a liquid repo market is a necessary condition to guarantee a liquid secondary cash market, especially when it is characterised by active market-making. The first repo market-making scheme, which is an extension of the market-making commitment seen on cash deals on Pfandbriefe, originated in 1998 on the initiative of 17 market-makers (the lead managers which typically guarantee the market-making in the cash market). They are committed to quoting bid-ask prices for liquid issues with a volume of at least EUR 1.25 billion and a two-year residual maturity. Repo maturities range from one week to one month.[19] In terms of volume, Pfandbrief repo trading volumes presently average between EUR 6 and 8 billion per day.[20] The second repo market-making activity started in January 2001, when the Jumbo Pfandbrief was accepted (together with Freddie Mac and EIB Reference Notes) as underlying for repo trades on the electronic "Repo Trading Facility" managed by EuroCredit MTS.

In addition to the repo market, a futures contract on the Jumbo Pfandbrief started to be traded - even if only for a short time - on the Eurex futures exchange in July 1998. However, the low volumes recorded after a few months of existence led to a discontinuation of this contract.[21]

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[17] In order to be listed on EuroCredit MTS, non-government bonds must be:

(a) collateralised with either mortgages or public sector loans, or a combination thereof;

(b) euro-denominated;

(c) in excess of EUR 3 billion in terms of outstanding size;

(d) issued by an institution with total outstanding debt in excess of EUR 10 billion in respect of the asset class of the bond in question (including that issue);

(e) given a triple-A rating by at least one of Standard & Poor's and Moody's.

[18] By comparison, according to EuroMTS sources, the turnover on German government bonds traded on EuroMTS fluctuates between EUR 300 and 600 million per day. However, this amount is only the "cash" part of the trading for the government bonds traded there and is estimated at 30% of all the turnover on the specific government bonds, whereas another 70% is traded over the counter and is related to "basis" trading connected to the trading of futures contracts.

[19] Market-makers have to quote two-way prices for up to EUR 15 million with a 25 bp bid-offer spread. Depfa has a special arrangement with the market-makers for four of its Global Jumbo Pfandbriefe to quote a 20 bp bid-offer. Jumbos trade around Euribor flat if they are general collateral. There is no particular sector of the curve which is most likely to be special in the repo market. The bigger Jumbo Pfandbrief benchmark issues are typically used for hedging purposes and trade more actively in the repo market. Jumbo Pfandbriefe are mostly made available for repo borrowing by investment funds and the mortgage banks themselves.

[20] This compares with an estimated EUR 400 to 500 billion daily turnover for repos on government securities denominated in euros (AGMB (2000a)).

[21] The timing of the introduction of the futures contract was probably unfortunate, as it coincided with a period of high instability and volatility in the world financial markets in conjunction with the emerging markets crisis, which possibly hindered the development of new types of instruments because of the "flight to quality" that occurred during this period.

Table 6

Patterns of liquidity for government securities and Jumbos

(as at July 2001)

Bunds (central government bonds)		Pfandbriefe		
Bid-ask spread	**In cents**	**Bid-ask spread**	**German Pfandbrief market-maker scheme**[1]	**EuroCredit MTS: five-year and 10-year segments**[1]
Remaining life:1 yr	1	Remaining life:<4 yrs	5	…
1-3 yrs	2-3	4-6 yrs	6	4
4-6 yrs	5	6-8 yrs	8	…
7-10 yrs	5-6	8-15 yrs	10	10
>10 yrs	7-10	15-20 yrs	15	…
		>20 yrs	20	…
Outstanding amount (as at end-July 2001)[2] (a)	EUR 790 bn[3]		Jumbos: EUR 393 bn	Jumbos: EUR 94 bn
Yearly trading volume (b)	EUR 5,925 bn[4]		EUR 1,250 bn[5]	EUR 112.5 bn[6]
Turnover ratio (b/a)	7.50		3.18	1.19

[1] In cents. [2] For German government paper, as at May 2001. [3] Includes all public debt. See Bundesbank, *Monthly Report*, July 2001, Chapter 7: Capital Markets, Table 3. [4] No official statistics exist on the turnover of German government bonds. The figure was estimated by taking the available average daily turnover data on the government bonds settled in Clearstream-Deutsche Börse (see *Market data*, 16 September 2000). The average daily government bond turnover was estimated at 3% of the total amount outstanding (this was judged to be a realistic assumption, given that some of the most traded government bonds can reach up to 30%, but many others were not traded at all on a single day). [5] As no official statistics exist, the volume was estimated assuming a EUR 5 billion per day turnover as reported by some banks. See AGMB (2000a), Chapter 5. [6] The figure is calculated by multiplying the known daily turnover by the number of business days in a year (250).

Sources: Deutsche Bundesbank; EuroMTS; Clearstream.

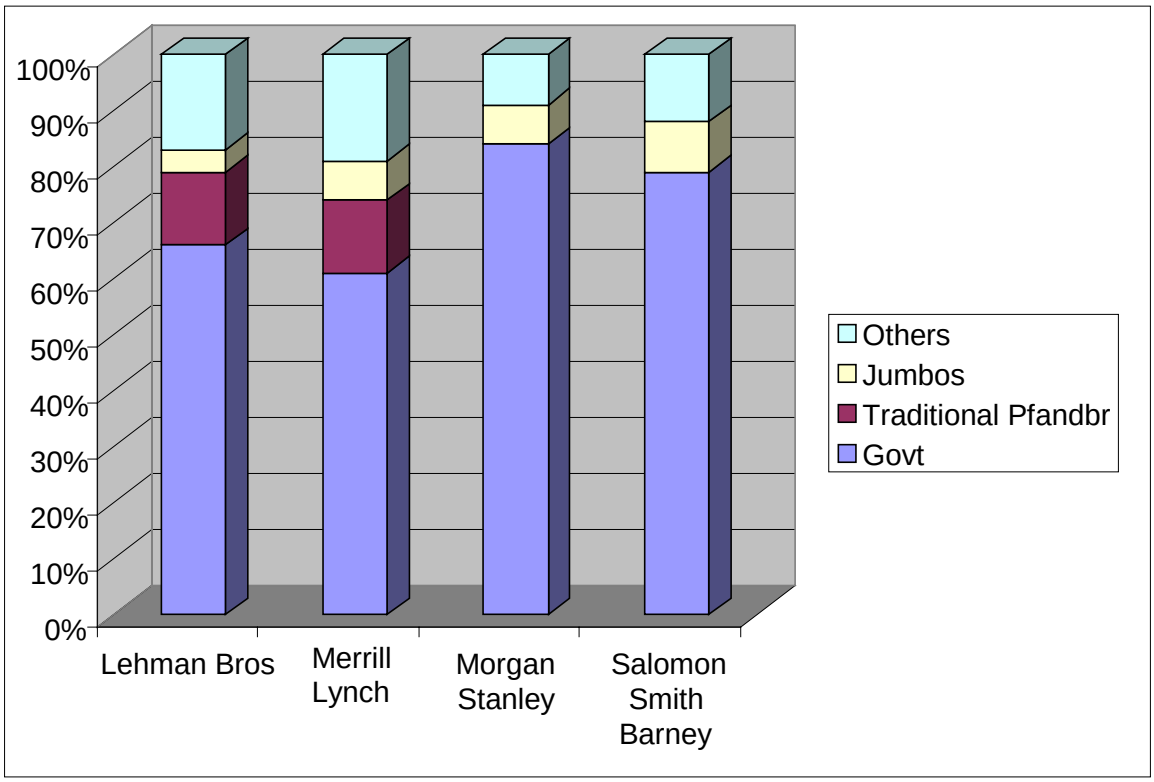
With the introduction of the euro in 1999, the Jumbo Pfandbrief was included as an asset class in a number of European bond market indices (Chart 5).[22] Depending on the index provider, Pfandbriefe account for between 40% and 60% of the non-sovereign segment in Euroland. The substantial weight in such indices implies that the Pfandbrief is an instrument that index-tracking fixed income investors and fund managers cannot overlook. This fact has generated sizeable acquisitions by institutional investors: it is estimated that currently about 20% of Jumbo issues are held by investors outside Germany. Aside from these "world indices", the market for Jumbos is also captured by Reuters' PFANDTOP index (calculated on the basis of market-makers' quotations and published daily) which covers all Jumbos issued in the European Union and tracks their performance.

After the continued growth in issuance recorded in the last five years, the Pfandbrief market appears to be going through a period of consolidation. In the second quarter of 2001 net issuance of Pfandbriefe slowed down substantially, following a deterioration in market conditions. The intention announced by the biggest German mortgage bank to launch in 2001 the first 30-year Jumbo Pfandbriefe ever has not materialised so far. This would have been the first non-sovereign security denominated in euros outstanding on this maturity (only some American corporates have issued in dollars on the 30-year maturity).

[22] These indices are Salomon's Euro Broad Investment-Grade Bond Index, which has a 9% weighting of Pfandbriefe; Merrill Lynch's EMU Broad Market index with 7% (in addition to traditional Pfandbriefe with 12.5%); Lehman Brothers' bond index with 4% of Jumbos (and 13% in traditional Pfandbriefe) and Morgan Stanley's bond index with 7% in Jumbos. The JP Morgan Aggregate Index Europe and the Bear Stearns indices will also include Pfandbriefe.

Chart 5

The Pfandbrief in European bond indices



Source: AGMB.

On the supply side, the substantial widening of yield spreads vis-à-vis government bonds, together with increasingly tighter margins caused by competition, have raised the funding costs for issuers, and caused some of them to hold back from new issuance. Some more structural changes in the markets are also affecting new issuance. New lending to domestic public authorities, which provides the underlying collateral for the vast amount of Pfandbriefe issued, is witnessing lower growth rates because of the ongoing fiscal consolidation in the European Union. Some changes in the tax deductibility rules for housing and a weak property market have reduced the amount of mortgage loans available as underlying. The tighter margins currently characterising issuance require banks to issue higher volumes of Pfandbriefe to ensure profitability. This requires developing lending business outside the traditional lending markets. In this respect, the innovations included in new legislation on Pfandbriefe, which extend the geographical area for mortgage banks' lending activities to a wider area than the EEA, aim at removing some of the bottlenecks that have limited the lending business in recent periods.[23]

On the demand side, a challenge to the Pfandbrief market is coming from corporate issuance, which in 2001 for the first time exceeded Pfandbrief issuance in the European Union.[24] The relative increase in economic growth experienced in this period has favoured the former, whose higher yields vis-à-vis Pfandbriefe have made them interesting in terms of yield-pick-up for those investors with a higher appetite for credit risk.

[23] See for example the innovations included in the Pfandbrief legislation of Luxembourg and Ireland.

[24] According to the European Commission (2001), corporate securities issued in the European Union in the first quarter of 2001 were 14% of the total volume issued, while Pfandbriefe stood at 15%; in the second quarter of 2001 they were 16% and 9% respectively.

4.2 The French *obligations foncières*

Although the legal framework for mortgage-backed bonds has existed in France since 1852, it is only recently that the existing laws were updated (1999). Among the reasons that prompted the French government to review the law on mortgage-backed assets is the success achieved by German mortgage banks in issuing and marketing Pfandbriefe, which allows them to refinance themselves at competitive rates. Other reasons are the introduction of the single currency and the ensuing disappearance of currency risk, which abolished the segmentation between domestic markets and exposed domestic participants to the full force of competition.

Prior to the reform, de facto there was only one mortgage bank on the French market, *Crédit Foncier de France* (CFF), that was authorised to issue mortgage bonds. The reform of 1999 abolished the monopoly that the CFF had enjoyed and allowed all credit and financial institutions to establish their own mortgage institutions. A very detailed definition of the role and responsibilities of mortgage banks was achieved with the reform, as was a strengthening of prudential rules and closer control by the supervisory authorities (Banking Commission).

Central to the new structure is the "bankruptcy remoteness" of issuing vehicles in the French mortgage bond markets: issuance of *obligations foncières* is restricted to specific companies, *Sociétés de Crédit Foncier* (SCFs), that have the sole purpose of acquiring and granting secured loans refinanced through *obligations foncières*. The holders of these bonds enjoy privileged rights ranking even above those of salaried employees and the State itself. Following the enactment of the law, two new mortgage banks issuing *obligations foncières* were created in France.[25]

Although SCFs have the legal status of a bank, they are not allowed to engage in traditional banking activities or to hold equity stakes in any subsidiaries, which effectively makes these vehicles closely resemble a special purpose vehicle in asset-backed securitisation. The bankruptcy remoteness is reinforced through their relationship with their parent company: the law requires SCFs not to be operational but to be managed by another financial institution, which is normally the parent bank. The strength of this legal framework has been recognised in the level of the ratings assigned to these bonds by international rating agencies (normally a triple-A)

Issuance mechanisms are designed to enhance liquidity and transparency; the market-making schemes reflect very closely those adopted for the German Pfandbrief. Issuers and market-makers agreed to set the minimum issue size to EUR 500 million, and to have all issues rated by at least two of the internationally recognised rating agencies. Furthermore, all *obligations foncières* must be assisted by a market-making commitment from at least three banks, which are required to promote liquidity in the market by quoting continuous prices with bid-offer spreads of between five and 20 cents. Currently, only three of all *obligations foncières* qualify (in terms of issue size) to be quoted on the EuroCredit MTS.

4.3 The Spanish *cédulas hipotecarias*

Cédulas hipotecarias have been around for more than 130 years,[26] but it was only after the amendment of the law governing these products in 1981 that issuance of *cédulas* took off, and in 1999 the first international issue was launched on the market. As with *obligations foncières*, in the last few years the main reason for issuers to tap this market has been the prospect of improving their funding costs and widening the investor base, in particular to non-resident investors. *Cédulas* are considered Jumbos if they have an issue size of at least EUR 1 billion; traditional issues are normally between EUR 1 and 10 million.

In contrast to the French, German and Luxembourg products, *cédulas* can be backed only by mortgage loans and not by public sector loans. Compared to the German Pfandbrief, their essential difference lies in the fact that they are collateralised by the issuing entity's entire mortgage pool rather than by a specific pool of mortgage assets. In line with Article 22(4) of the UCITS Directive, credit

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[25] These are *Dexia Municipal Agency* and *Compagnie de Financement Foncier*, to which all mortgages of the CFF have been transferred.

[26] The *Ley del Mercado Hipotecario* was first introduced in 1869.

institutions wishing to enter the mortgage market have to specify this in their by-laws, be authorised by the Ministry of Economic Affairs and be subject to specific supervision by the Bank of Spain. Holders of *cédulas hipotecarias* enjoy a privileged status and have a priority claim on the mortgage book of the issuer in the event of a bankruptcy. Only the State (if the institution owes taxes) or the issuer's employees (limited to 30 days' wages) have higher priority over the proceeds arising from liquidation in case of bankruptcy. Early amortisation is not possible. Mortgage valuation is subject to conservative valuation rules (70% loan-to-value ratio) and mortgage certificates can be issued only up to 90% of an individual issuer's eligible mortgages ("overcollateralisation").[27]

It is worth mentioning that *cédulas* are the most strongly collateralised of the four instruments considered, given that they are covered by the entire pool of assets of the issuer. The principle of matching maturities is not covered in Spanish law, which gives Spanish institutions some leeway for taking on interest rate risk arising from maturity transformation. Domestic *cédulas* are quoted on the Spanish fixed income market (AIAF), whereas the bigger international issues are also marketed outside Spain (Luxembourg, France). Currently, no *cédulas* qualify (in terms of issue size) to be quoted on EuroCredit MTS.

4.4 The Luxembourg *lettres de gage*

The legal framework for Luxembourg's Pfandbrief was created at the end of 1997 and is, in many respects, taken from the German Mortgage Act governing German Pfandbriefe, in particular for those elements that provide the high standards of bondholder protection typical of the German Pfandbrief. This high level of protection means that *lettres de gage* have the same privileges, namely they have a lower risk weighting required by the Solvency Directive, they are eligible for repo operations with the ECB, and they are not subject to certain limits on investments for institutional investors. However, there are some interesting differences compared to the German Pfandbrief law that have attracted the attention of issuers and investors alike. These differences enhance the flexibility of *lettres de gage* compared to Pfandbriefe, although they require some analysis of the potential implications for the overall risk of the instrument.[28] These differences are:

(a) enhanced international diversification is provided for inasmuch as the underlying public loans can be from issuers in the OECD area, where 97% of public sector debt is rated AA or better (the collateral underlying the German Pfandbrief has to be located in the EEA or Switzerland);

(b) issuers are allowed to use hedging instruments (eg derivatives) in the cover pool (a feature present also in the French law on *obligations foncières*, but not in the German Pfandbrief);

(c) some additional safety clauses are included in *lettres de gage*; the trustee of the *lettres* must be specifically qualified (an auditor by profession) and there is a detailed regulation for the unlikely event of default, which foresees that in such a circumstance the cover pool is separated from that of the issuer and the administration taken over by the banking supervisory authority (*CSSF - Commission de Surveillance du Secteur Financier*), which implies that this authority in practice needs to closely monitor events relating to these products. Currently no *lettre de gage* qualifies (in terms of issue size) to be included for trading on EuroCredit MTS.

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[27] If this limit is exceeded, the issuer must offset the exceeding amount either by depositing cash or sovereign bonds with the Bank of Spain, or redeem/repurchase mortgage certificates until the limit is met, or add hew mortgages to the collateral pool. In practice, Spanish banks have issued *cédulas* for much smaller amounts than the value of the eligible loan portfolio (eg 30%). This ratio is currently around 30-40% in the case of big issuers of *cédulas*.

[28] Incidentally, the fact that *lettres de gage* appear to be more flexible than German Pfandbriefe may explain why the three existing Luxembourg Pfandbrief issuers are newly founded subsidiaries of German bank groups. Currently, there are three institutions permitted to issue the Luxembourg Pfandbrief: Eurohypo Lux (a subsidiary of Deutsche Bank), Erste Europäische Pfandbrief und Kommunalkreditbank (owned by Düsseldorfer Hypothekenbank, Hypothekenbank in Essen and Schuppli Group) and the Pfandbrief Bank International (owned by a consortium of German banks, the biggest of which is HypoVereinsbank).

5. Conclusions

Launching the Pfandbrief as an international investment asset was an initiative led mainly by the German institutions, but recently legislation regulating Pfandbrief-style products has been adopted in many other European countries, also outside the European Union. After a period of sustained growth, when Jumbos were being issued at the rate of one per week, the Jumbo market appears set for a period of consolidation. National legislators are using this chance to upgrade their legal frameworks and allow a domestic market for covered bonds to develop.

Notwithstanding the progress made in individual countries, and the boost given to this asset class by the introduction of the single currency, this lack of uniformity between the different Pfandbrief-style products is still perceived as being a drawback: the international investor wishing to invest in Pfandbriefe has to comb through different laws and regulations that characterise separate European covered bond markets. So far there has not been any concerted action at the European level to create a common legislation specifically for covered bonds and in particular for Pfandbriefe. National laws are therefore expected to continue to prevail for some time to come.

Despite the disparities in the national legal frameworks and the fact that a further harmonisation of these regulations appears to be unlikely, this should not prevent a successful establishment of the Pfandbrief as an asset class in its own right, within and outside the European Union. In this respect, the application of Article 22(4) of the UCITS Directive, which sets out criteria for defining a common class of assets, may provide the basis for ensuring a minimum level of homogeneity for covered bonds.

Annex 1

Comparison of the main characteristics of Jumbo Pfandbrief products in the euro area

	Pfandbriefe	Obligations foncières	Cédulas hipotecarias	Lettres de gage
Authorised issuer	German mortgage banks, whose activity is limited by law, and Landesbanken.	French Sociétés de Crédit Foncier (SCFs) whose activity is limited by law.	Spanish banks.	Specially authorised mortgage banks, for the purpose of issuing mortgage bonds or public sector bonds (lettres de gages hypothécaires ou publiques).
Supervisory body	Bundesaufsichtsamt für das Kreditwesen (BAKred)	Commission Bancaire (COB)	Banco de España (BdE)	Commission de Surveillance du Secteur Financier (CSSF)
Direct supervision	An independent trustee is proposed by the mortgage bank and approved by the BAKred. The trustee must ensure that the prescribed cover for Pfandbriefe exists at all times. Landesbanken are not obliged to have a trustee.	At the individual SCF level, a specific controller and substitute are appointed to monitor compliance and report to the COB. Controllers are drawn from the list of auditors and must be approved by the COB.	BdE, which has the power of performing inspections and has the responsibility of ensuring that assets exist and have been valued in accordance with regulations by recognised surveyors. BdE may prevent issuance of cédulas if guidelines have been breached.	Independent supervisory body appointed by the CSSF.
Collateral type	Preferential claim on separate pools of mortgage loans (mortgage Pfandbriefe) and public sector loans (public sector Pfandbriefe).	Preferential claim on a single pool of eligible mortgages and public sector loans on the SCF's books.	Preferential claim on first ranking commercial and residential mortgages on the issuer's books.	Preferential claim on mortgage or public loans, and mortgage or public sector bonds.
Collateral location	EU, EEA and Switzerland. Banks can also make real estate loans to other European states that are OECD members, but these loans cannot be included in the cover pool.	EEA and French overseas territories.	Spain. All mortgages must be registered with the Spanish register of property.	OECD, theoretically no limit.
Valuation guidelines	Valuation cannot exceed the prudently assessed market value. Only permanent characteristics of the property and yield are taken into account. The mortgage bank must publish instructions on valuation that must be approved by the BAKred. Land and uncompleted buildings may not exceed 10% of total cover mortgages or double the own capital.	Conservative evaluation which excludes any element of speculation. Based on the lasting long-term characteristics of the building, the local market conditions, current use and other possible uses. Valuation carried out by an expert who is not accountable to the lending department.	Property valuation to be carried out in compliance with Ministry of Finance and Economics criteria by a registered surveyor who may, or may not be, an employee of the issuer.	Independent prudent professional valuation of the real estate required, made by a special supervisor; active valuation based on real estate characteristics and revenues generated.

Comparison of the main characteristics of Jumbo Pfandbrief products in the euro area (cont)

	Pfandbriefe	Obligations foncières	Cédulas hipotecarias	Lettres de gage
Loan to value limit	60% for all mortgage loans.	60% or 80% if all loans in the SCF are residential mortgages. SCFs may lend up to 100% if the loan is covered by a qualifying guarantee, or up to 80% if the portion above 60% is financed by funds not covered by the statutory lien.	70% for commercial mortgages, 80% for residential mortgages.	60% for real estate sector, 100% for public sector.
Asset coverage of secured bonds	100% legal minimum, although in practice higher levels of cover are maintained to ensure AAA ratings.	Obligations foncières and other liabilities benefiting from the statutory lien must be at least covered 100% by eligible assets.	Cédulas cannot be issued for amounts greater than 90% of the unamortised amount of all the qualifying loans.	No overcollateralisation required by law but rating agencies will require it.
Mark-to-market collateral	No formal requirements to revalue property.	All building valuations must be reassessed at least annually, either individually or statistically.	No formal requirement to revalue property. Lenders may force borrowers to provide additional collateral for mortgages where the mortgage property has fallen in value by more than 20%. Maximum loan-to-value requirements do not have to be adhered to on an ongoing basis.	
Matching principle	The total value of mortgage bonds in circulation must at all times be covered at their nominal value by mortgages of at least the same amount and with at least the same interest earned. The currency of the mortgage bonds can only diverge from currency of cover assets if exchange risk is precluded by appropriate measures.	SCFs must have a risk management system capable of managing asset/liability risks. Regulatory disclosure must be sent to the specific controller, who must notify management and the COB of insufficient asset/liability matching.	No requirements to match maturities. Size (at 90% limits) is matched.	Interest and maturity matching are required under the Law of 3 April 1993, amended by the laws of 21 November 1997 and 8 May 2000. Use of hedging products allowed to reach this objective.
Prepayment of underlying loans	The right to prepay the mortgage may be contractually suspended for up to 10 years.	Mortgage prepayments are possible and no penalty is due if the borrower moves house due to a change of location in professional activity.	There are no rules relating to prepayment of underlying loans.	No limit. The prepayment risk has to be covered by the use of derivative products.
Disclosure requirements	Mortgage banks must publish information on the number, type and location of mortgages; arrears and repossessions.	SCFs must publish asset quality information, prepayment data and information on interest rate sensitivity.	Reporting of eligible loan portfolio to BdE once a month.	

Comparison of the main characteristics of Jumbo Pfandbrief products in the euro area (cont)

	Pfandbriefe	Obligations foncières	Cédulas hipotecarias	Lettres de gage
Insolvency ranking	Pfandbrief holders rank ahead of all other creditors. In the event that cover assets are insufficient to repay Pfandbrief holders, they also have a claim against the non-cover assets of the bank.	Holders of OFs rank before all other SCF creditors.	Holders of cédulas are accorded the status of privileged creditors, ranking ahead of all other creditors with respect to all mortgage loans registered in favour of the issuer with only two exceptions: employee salaries up to the amount of twice 30 days' salary for the lowest paid employee, and the Spanish tax authority.	Holders of lettres de gage rank ahead of all other creditors. If the asset pool is not large enough, pari passu with other senior, unsecured creditors.
Bankruptcy remoteness	Since April 1988 the collateral pools have been accorded the status of "special assets" and would not be included in the insolvency of the related mortgage bank.	Insolvency of the owner of an SCF cannot be extended to the SCF. Insolvency of the manager of an SCF leads to immediate termination of the management contract.	Default on cédulas directly linked to default by issuing bank.	Default on lettres de gage linked to the issuer, but as soon as the mortgage bank defaults, the CSSF will make timely payments of the lettres de gage as long as there are sufficient funds in the collateral pool.
Prepayment in insolvency	Insolvency proceedings against a mortgage bank do not make Pfandbriefe due for payment. The BAKred may institute separate bankruptcy proceedings against the cover pools if required.	The judicial winding-up of an SCF does not make OFs due for payment.	In the event of issuer insolvency, cédulas would default. Because of the security provided to cédulas, the recovery rate should be higher than unsecured debt.	
Default history	No German mortgage bank has defaulted since the introduction of the German Mortgage Bank Act in 1900. There has never been a case of principal default over the entire 225 years of history of Pfandbriefe. However, nine mortgage banks became insolvent following the 1873-75 recession, resulting in several instances of interest default.	OFs existed before Law 99-532 of 25 June 1999 and were issued by Crédit Foncier de France and Crédit Foncier et Communal d'Alsace et de Lorraine under existing legislation dating back to 1852. There has been no default on OFs during this period.	Prior to 1981 issuance of cédulas centred on a single issuer: Banco Hipotecario, which monopolised Spanish mortgage lending from 1869-1981. There have been no defaults of cédulas during this period, or since then.	Very short history and few issues.
Liquidity factors	One of the largest European debt markets, more than 5,000 issues outstanding and a large number of market participants. The market is dominated by small structured deals aimed primarily at domestic investors. The Jumbo sector is much more liquid.	Liquidity for existing OFs has been somewhat mixed in the past. The new legal structure combined with a larger group of issuers is expected to improve liquidity.	Cédula issuers must contribute to the "Public Regulation Fund" operated by the BdE to ensure liquidity. Institutionally targetted cédulas are also exchange-traded. They are not directly comparable to the German Pfandbrief market due to the much smaller market size.	Few issues available. There are market-makers to ensure liquidity.

Comparison of the main characteristics of Jumbo Pfandbrief products in the euro area (cont)

	Pfandbriefe	Obligations foncières	Cédulas hipotecarias	Lettres de gage
Investment eligibility	Pfandbriefe are eligible Tier 1 collateral for ECB credit operations.	OFs are eligible Tier 1 collateral for ECB credit operations.	Cédulas are eligible Tier 1 collateral for ECB credit operations. In Spain they are eligible for investing the technical reserve of insurance companies, mutual funds, and the reserve funds of entities belonging to the Spanish social security system.	Lettres de gage are eligible Tier 1 collateral for ECB credit operations.
Risk weighting	Pfandbriefe are 20% risk-weighted for the Basel solvency ratio; 10% for the European solvency ratio in Germany, Belgium, Luxembourg, France, Italy and Spain; 20% in the United Kingdom.	OFs are 20% risk-weighted for the Basel solvency ratio; 10% for the European solvency ratio.	Under Basel rules, cédulas have a 20% risk weighting. Bank of Spain assigned a 10% for the European solvency ratio.	Under Basel rules, lettres de gage have a 20% risk weighting. 10% in Germany, Belgium, Luxembourg.

Sources: Morgan Stanley Dean Witter; Dexia Capital Markets.

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Interactions between cash and derivatives bond markets: some evidence for the euro area

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Abstract

This paper provides a broad empirical examination of the interactions between cash and derivatives markets for government bonds in the core euro area countries (Germany, France and Italy) in the aftermath of the launch of the third stage of European monetary union (EMU). Since the launch of the euro, liquidity in derivatives markets has concentrated in a handful of capital market futures contracts, in particular those traded on Eurex. The tremendous level of activity in Eurex contracts has raised concerns about the risk of a shortage in the cheapest bond to deliver. The paper assesses cash market-, repo market- and futures market-based approaches to preventing such shortages, and finds that a combination of approaches is preferable.

The paper goes on to analyse how changes in liquidity and trading activity in government bond markets since the start of EMU have affected price formation. Based on the conceptual framework set out by the financial market microstructure and asset market equilibrium literature, econometric evidence on the determinants of yield spreads is presented. The results confirm that fluctuations in yield spreads across euro government bonds contain a significant transitory component, which could represent temporary deviations from fundamental values. This “mispricing” component increased at the time of the Russian and LTCM financial crises and peaked around the launch of the euro. Based on the size of the estimated mispricing component in bond yields, liquidity in euro government bond markets returned to pre-1998 levels during 2000. Moreover, liquidity conditions appeared to converge across the G5 countries, although UK and US bond markets maintained a positive liquidity differential with respect to euro area markets. Among euro area government securities markets, prices appear to be least distorted, and liquidity closest to that of the UK and US markets, in Italy's cash market, perhaps reflecting the advantages of an advanced trading infrastructure.

1. Introduction

This paper provides a broad empirical examination of the interactions between cash and derivatives markets for government bonds in the core euro area countries (Germany, France and Italy) in the aftermath of the launch of the third stage of European economic and monetary union (EMU). In our analysis we place special emphasis on the changes under way in the government bond market structure, integration and linkages and their implications for the relationship between prices, trading volume and liquidity in the main segments of the European fixed income securities markets.

Since the advent of the euro, market participants have been intensively discussing the effects and consequences of a more integrated money and bond market in Europe. While the precise role of EMU may be difficult to determine, the euro is widely recognised as perhaps the major factor that triggered the dramatic transformation of European capital markets.[2] By wiping out currency risk, the euro has eliminated an important source of segmentation in the supply of debt instruments. By speeding up the process of market integration, the single currency has increased the potential demand for national bonds and intensified competition among sovereign issuers, providing a strong incentive to reform

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[1] Not for quotation without permission. The authors are grateful to Maria Pia Mingarini for research assistance. Keywords: EMU, bond markets, market integration, liquidity; JEL classification: G15, G14, E43, E44, F21.

[2] See Danthine et al (2000) for a broad assessment of the impact of the euro for the emergence of a pan-European capital market.

markets and pursue efficiency and transparency standards. Unprecedented issues in public debt management for the 12 independent sovereign states have been raised concerning whether, and to what extent, coordination and cooperation among them would be required to foster market integration. More recently, decreasing public debt and the prospect in Europe of further budget consolidation and, possibly, surpluses, as a result of the implementation of the Stability Pact, may have profound implications for the smooth functioning of European capital markets. In addition, the impact of more recent government measures, as triggered by the announcement of buyback plans by the US Treasury and the sales of UMTS mobile phone licences in the core countries of the EMU, has spurred relative value adjustment across the maturity range and issuers in the European bond markets.

As the fixed income markets change shape in Europe a process of adjustment is under way in the dynamic of price discovery about macroeconomic fundamentals owing to shifts in supply and liquidity. As a result, yield spreads are responding to a new ebb and flow of liquidity across markets. We aim at providing some assessment of the main factors underlying the recent trend of widening bond and swap spreads in the euro area. Some econometric evidence is brought to bear on the determinants of such recent developments, in order to identify the sources of changes in the factors driving the adjustment process. We intend to ground our econometric analysis in the conceptual framework provided by the recent literature on financial market microstructure and asset market equilibrium.

The paper is organised as follows. Section 1 attempts to provide an overview of changes and innovations in the European cash and derivatives markets for government bonds resulting from stronger competition between futures exchanges and products. One of the most interesting and heavily traded markets is the segment for 10-year government bonds and the related interest rate futures and swap contracts. Section 2 examines both the consequences of the transition to monetary union and the strategic innovations introduced by Eurex and MATIF on the 10-year Euro Bund futures contract and the 10-year Euro Notional futures contract respectively as the most important 10-year interest rate futures contracts traded in Europe. The data used for this part of the paper cover the period from mid-1998 to mid-2000. In Section 3 we provide a methodological assessment of the relevant concept of liquidity and related liquidity measures based on the dynamic decomposition of price effects into transitory ("mispricing") and permanent ("fundamental value") parts. In Section 4 we deal with the econometric application on the measurement of information efficiency and price behaviour of bonds, swaps and interest rate derivatives in the euro area. Finally, Section 5 concludes by summarising our main results.

2. Upheaval in the European cash and derivatives markets - an overview of developments since the transition to monetary union

Derivatives markets, being an integral part of the international financial markets, are subject to constant change. One of the most extraordinary changes regarding exchange-traded interest rate derivatives has been the worldwide increase in electronic trading, leading to an ongoing displacement of floor trading in interest rate futures. Furthermore, the growing corporate and agency bond markets have affected international interest rate derivatives markets, resulting either in more intensive trading in derivatives products or leading probably to shifts in the respective weight of OTC and exchange-traded interest rate derivatives. Finally, the transition to EMU has caused lasting changes, adjustments and problems for the European derivatives markets, which are presented in detail in the following sections.

Looking first at exchange-traded interest rate derivatives in the three main trading areas Asia, North America and Europe, the respective development of turnover shares for interest rate futures demonstrate that no major shift has occurred in trading activities among these areas.[3] The ongoing tendency towards electronic trading of interest rate derivatives has apparently caused major shifts within each trading area, particularly in Europe, but there is no evidence of major changes worldwide, despite remote membership of electronic exchange trading systems for interest rate derivatives. However, a clearer trend between the two main interest rate derivatives, swaps and futures, has

[3] See Annex 1.

become apparent during the past few years. While the global outstanding amounts of interest rate futures, primarily used for hedging cash positions in government bonds, remained stable during 1998 2000, the outstanding amounts of interest rate swaps expanded strongly during the same period.[4] A similar evolution, with slightly decreasing amounts of interest rate futures outstanding, is evident in the euro area.[5] As interest rate swaps and non-government bonds as a rule show stronger correlations in terms of their yield movements compared with those of interest rate futures and non-government bonds, the global growth of swap markets seems to be attributable to the worldwide increase in cash market activities in non-government bonds, leading to rising hedging requirements.

Following this more general overview of the evolution of interest rate derivatives markets, the focus will now turn to the European exchange-traded derivatives markets.

At the beginning of 1998, the respective percentage shares of the major European futures exchanges in capital market products already revealed a slight lead of Eurex over LIFFE, which up to 1997 was the largest European futures exchange.[6] However, MATIF and the Spanish futures exchange MEFF also accounted for sizeable percentages of the total contract volume in European capital market futures.

The situation changed fundamentally in mid-1998 and moved further in favour of Eurex, which accounted for nearly 4 out of every 5 futures contracts on fixed income underlyings traded prior to the start of stage three of EMU. This constantly rising trend in the trading share of capital market futures won by Eurex was broken by MATIF in December 1999, when Eurex's market share of the total trading volume in European capital market futures peaked at 95%. In the course of 2000, MATIF gained market share in contracts relating to European capital market products, rising to as much as 25%.

What is the reason for the marked increase in MATIF's market share?

Annex 5 shows the market shares of 10-year interest rate futures contracts held by each European futures exchange. It confirms that the revival in trading in capital market products at MATIF has been based almost exclusively on an increase in traded contracts in the 10-year Euro Notional futures contract which, in fact, reached a market share of over 36% in April 2000. It is noteworthy that this remarkable revival in turnover in the 10-year Euro Notional futures contract has not been created by the market itself but rather as the result of an initiative of the French banking federation. The liquidity required for raising turnover in this contract has been provided by market-making, conducted by eight French market participants. However, winning new interest in trading this contract has apparently been difficult during recent months because open interest peaked at around 150,000 contracts on average in June 2000.[7] The leap in open interest in this contract from May 2000 is due to a change in the method of calculating open interest by MATIF.[8]

Apart from the revival of the 10-year Euro Notional futures contract, the following decisions made by MATIF immediately after the transition to EMU revealed the intention to intensify competition among European futures exchanges:

2.1 Adjustment of products

By launching the two-year E-Note futures contract at the end of January 1999, MATIF rounded off the spectrum of its range of capital market products, so that both MATIF and Eurex now offer interest rate futures contracts for two-year, five-year, 10-year and 30-year government bond maturities.

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4 See Annex 2.

5 See Annex 3.

6 See Annex 4.

7 See Annex 6.

8 Open interest was previously calculated by MATIF as net open interest; since 23 May 2000 it has been calculated as gross open interest.

While turnover and liquidity in the 10-year Euro Notional futures contract have increased since December 1999, liquidity in the two-year and five-year MATIF futures contracts has as yet been insufficient, in contrast to the equivalent Eurex contracts.

2.2 Change in contract conditions

In response to two squeezes in deliverable issues of the Euro Bund futures contract (September 1998, June 1999 deliveries), MATIF extended the number of government bonds deliverable in the two-year, five-year and 10-year futures contracts from originally French issues only to include German issues, too, while for the 30-year E-Bond futures contract, designed as a multi-issuer basket, sovereign issues of France, Germany and the Netherlands are deliverable.[9]

As government bond yields during the first half of 1999 clearly moved below the level of the notional contract coupon used for futures contracts at Eurex (6%) and MATIF (5.5%), MATIF decided to lower the notional contract coupon of the 10-year Euro Notional futures contract from 5.5% to 3.5%, and of the five-year Euro futures contract from 4.5% to 3.5% as well.[10] Simultaneously, LIFFE took the same decision by lowering the notional contract coupon of its 10-year Euro Bund futures contract from 6% to 4%.[11]

Despite squeeze risk, Eurex, at the same time, felt compelled neither to open up the deliverable basket of the Euro Bund futures contract to other euro area sovereign issuers nor to lower the notional contract coupon of this contract. Only the contract conditions of the five-year Bobl futures contract were modified in June 2000 by making exclusively German government bonds with remaining terms between 4.5 and 5.5 years eligible for delivery.[12]

Turning from the derivatives markets to the European cash markets, efforts to raise the size of sovereign issues, particularly those of German government bonds, are desirable to avoid the risk of squeezes in deliverable bonds. While the largest size of German 10-year government bonds issued before mid-1999 amounted to EUR 15.3 billion, the size of the last three German equivalent bonds was raised by between EUR 5 and 8 billion to EUR 20-23 billion, thus approaching the size of the largest French 10-year OAT issues amounting to EUR 22 to 25 billion.

In the light of these strategic decisions by Eurex and MATIF, the following section seeks to describe and analyse their consequences for the relationship between European cash and derivatives markets since the transition to EMU.

3. Consequences of the transition to EMU for the relationship between European cash and derivatives markets

3.1 Squeeze concerns in the Euro Bund futures contract

Before looking at the range of problems faced, it is necessary to define what is meant by a squeeze. In this context, a squeeze is taken to mean a shortage in the cheapest-to-deliver (CTD) bond deliberately caused by market participants so as to make it difficult for other market participants to fulfil their obligations either in the futures market or in the cash and repo market as well. In fact, at no time - including during the September 1998 and June 1999 squeezes - has any failure or a delayed delivery of the Euro Bund futures contract at the contract's delivery date occurred. Nevertheless, squeeze

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[9] Two-year E-Note futures contract: dual-issuer basket since March 1999 delivery; five-year Euro and 10-year Euro Notional futures contract: dual-issuer baskets since June 1999 delivery.

[10] Adjustment of the notional contract coupon for both futures contracts since June 1999 delivery.

[11] Adjustment of the notional contract coupon of this contract since June 1999 delivery. The notional contract coupon was changed again by LIFFE from 4% to 6% on 20 December 1999 for March 2000 delivery.

[12] Previous remaining term to maturity for bonds deliverable in the Bobl futures contract: 3.5 to five years.

concerns circulated in the market owing to the confluence of various circumstances, which are examined in detail below. But, if no squeeze has happened yet in the futures market, in which market has a squeeze or a shortage in the CTD bond actually occurred? The following description of the range of problems might give an answer.

3.1.1 Range of problems

In mid-1998, half a year before the transition to EMU, the capital market environment across European cash and derivatives markets may be described as follows:

1. Apart from the Eurex Euro Bund futures contract, no other liquid alternatives traded on other European futures exchanges were available for hedging 10-year European government bonds. Moreover, this futures contract has usually been used in addition for hedging non-government 10-year issues (eg German Pfandbriefe) and 30-year bonds. These issues are not eligible for delivery in the Euro Bund futures contract. Comparing the real deliverable volume of the Euro Bund futures deliverable basket with the potential deliverable volume calculated via the open interest in this contract at peak times reveals that the potential volume exceeded the real deliverable volume of the basket several times over. Then as now, squeeze concerns have been stimulated by this fact.

2. During 1999, yields on 10-year government bonds dropped to a historically low level, far below the level of the notional contract coupon of the Euro Bund futures contract (6%). Only at the yield level of the notional contract coupon is the adjustment of the price differences of the deliverable bonds, caused by coupon and term inequalities, calculated correctly by the conversion factor of each deliverable bond. A deviation from the real yield level to the yield level of the notional contract coupon leads to a bias when calculating the CTD bond at the contract's delivery date. If real yields stay above the level of the notional contract coupon (6%), the conversion factor would determine the deliverable bond with the highest modified duration within the basket as being CTD, while real yields below 6% would determine the bond with the lowest modified duration as being the CTD bond, assuming that all deliverable bonds stay at the same yield.

3. An exceptionally low yield level such as prevailed during the Euro Bund futures squeezes in the September 1998 and June 1999 deliveries may become a problem if the deliverable basket of a futures contract consists of only a few government bonds with very different modified durations. If, however, the price sensitivity of several different deliverable bonds is largely identical, these bonds will probably be able to become CTD after small relative yield changes, so that the deliverable volume of the bonds likely to become CTD will potentially increase. In fact, the deliverable basket of the Euro Bund futures contract, during both squeezes, was composed of few bonds with very different modified durations, so that the probability of a rotation of the CTD bond was low.[13] Furthermore, predicting the CTD bond at the contract's delivery date was easy, due to the bias of the conversion factor when real yields differ from the yield level of the notional contract coupon.[14] Under these circumstances, it was possible for market participants to squeeze the CTD bond in the cash market, particularly when the size of this bond was insufficiently large.

4. The previous discussion on squeezes of the Euro Bund futures contract was mainly focused on the insufficient deliverable volume of the Euro Bund futures basket and the respective CTD bonds. However, another essential problem was given less consideration: the arbitrage mechanism between the cash and derivatives markets did not function smoothly, owing to an insufficiency in the repo market that is the liquidity provider for this arbitrage. Cash-and-carry arbitrage (if the implied repo rate is above repo rate) as well as reverse-cash-and-carry arbitrage (if the implied repo rate is below repo rate) will be possible if the CTD bond is either clearly predictable at the end of the contract or the net basis of the CTD bond is negative. But, obviously, market participants did not exploit the risk-free opportunities for profit. Looking at the single arbitrage steps suggests that one reason for the inadequately

[13] See Annex 8: Euro Bund futures contract: September 1998 and June 1999 deliveries.

[14] When both squeezes occurred, CTD was the bond with the lowest modified duration within the basket.

functioning arbitrage mechanism was the repo market, where the CTD bond was not expected to be redelivered in time.

Cash-and-carry arbitrage (long CTD bond, short future)

1. After raising a loan in the repo market, the debtor buys the CTD bond, being cheaper than its fair price, on the cash market, which is then given as collateral to the creditor of the loan (long bond).
2. Simultaneously, the debtor initiates a short futures position (short future).
3. At the contract's delivery date, the debtor can deliver any bond eligible for delivery, but he will deliver the bond he has given as collateral to the creditor in the repo market. If the creditor failed to return this bond to the debtor or were not able to deliver it in time according to the futures settlement date, the debtor would personally fail to satisfy the obligation to deliver this bond into the futures contract. High penalties from the futures exchange would be the consequence.

Reverse cash-and-carry arbitrage (short CTD bond, long future)

This arbitrage consists of

1. borrowing the CTD bond in the repo market,
2. selling this bond in the cash market, while simultaneously
3. buying futures contracts.

This arbitrage will work successfully only if arbitrageurs are able to predict with a high degree of probability which bond within the deliverable basket is going to be CTD at the contract's delivery date, because they need to recover the CTD bond they previously sold in the cash market via the futures contract at the delivery date. The last step would be to return the CTD bond to the lender in the repo market after the futures contract's settlement. However, the existence of insufficient fulfilment of repo contracts will cause market participants not to borrow the CTD bond that is "special" in the repo market, so that reverse cash-and-carry arbitrage would not work.

Even though risk-free profitable arbitrage opportunities were offered by the market, most of the market participants were not willing to pick them up because of insufficient fulfilment in the repo market. If the arbitrage mechanism between the cash and derivatives markets had functioned well, price inefficiencies between the futures and cash market would have been unlikely, because the repo market would have provided sufficient liquidity when deviations between real and fair prices of the futures contract and the CTD bond, respectively, had been realised by arbitrageurs.

3.1.2 Solutions for the prevention of squeezes

Different approaches to preventing squeezes in futures contracts can be envisaged. Depending on the market they refer to, cash market, repo market and futures market-based solutions are possible. However, it is worth noting that the solution is not based on just one of the three markets mentioned above. In fact, composite approaches straddling the three markets seem to alleviate or prevent the shortages of the CTD bond.

3.1.2.1 Cash market-based solutions

Cash market-based solutions are designed to optimise the liquidity of each deliverable bond by increasing the size of a bond. Market participants who attempt to buy large amounts of the CTD bond are likely to be unsuccessful if they try to cause a squeeze in this bond. In this light, the size of the last three German government issues (nos 113513, 113515 and 113516) was increased by between EUR 5 and 8 billion to EUR 20-23 billion. However, it has to be pointed out that despite the high real

delivered volume of the CTD bond on the futures contract delivery date, when squeezes occurred no real problems were noticeable in the delivery of the CTD bond.[15]

An alternative approach to avoiding the risk of a squeeze focuses on the price sensitivity of a deliverable bond and seeks to create deliverable baskets with bonds of similar price sensitivities. The measure for the calculation of bond price sensitivity in terms of yield changes is the modified duration,[16] which is determined by the coupon (exogenously fixed according to the prevailing market yield at the issue date) and the term to maturity of a bond. It is quite possible that two bonds, despite being issued on different issue dates, mature on the same date.[17] The difference in the modified durations of these two bonds is then exclusively based on the coupon difference. If, however, two or more deliverable bonds have similar price sensitivities in terms of yield changes, even small relative yield changes between these bonds will be sufficient to cause a rotation in the CTD bond even if there are clear deviations between the market yield level and the level of the notional contract coupon. In that case, the CTD bond would no longer be clearly predictable, so that it would be difficult for market participants to cause a shortage in a CTD bond.

3.1.2.2 Repo market-based solutions

Approaches to avoiding and alleviating squeeze risk via the repo market are aimed at fulfilling repo contracts in an orderly fashion. Therefore, high penalties for non-fulfilment or delayed fulfilment of repo contracts might be a possible solution to the problem. A more far-reaching approach, however, might be to set up a central counterparty within the repo market in order to avoid the counterparty default risk of repo market participants. Both approaches are suited to activating both the arbitrage mechanism between cash and derivatives markets and the liquidity-providing function of the repo market. Finally, one should bear in mind that longer-term requirements for delivery or delayed delivery of securities could be reduced significantly within Europe by setting up a central European clearing house via which all cross-border transactions would be settled.

3.1.2.3 Futures market-based solutions

In the aftermath of the squeezes in the Euro Bund futures contract, MATIF and LIFFE made two decisions regarding the futures markets:

1. MATIF extended the deliverable basket of the 10-year Euro Notional futures contract to German government bonds deliverable in the Euro Bund futures contract.
2. MATIF and LIFFE simultaneously changed the notional contract coupon from 5.5% (MATIF)/6% (LIFFE) to 3.5% (MATIF)/4% (LIFFE), respectively.

In the following, the consequences of both steps in terms of contract behaviour will be demonstrated.

Dual/multi-issuer basket

The reduction of squeeze risk in an environment of increasing trading volume and open interest by extending the outstanding volume of the 10-year Euro Notional futures basket to include German issues was the main reason MATIF gave for changing the contract specifications of its futures contracts.[18] However, as stated above, it is not the total volume of the deliverable basket but rather a small outstanding amount of the CTD bond - ie the bond mainly delivered at the contract's delivery date - that is one of the primary reasons for squeeze risk. Nevertheless, the extension of the deliverable basket of MATIF futures contracts might prove a quite successful approach for avoiding squeezes. A look at the price sensitivities in terms of yield changes of the deliverable issues in the 10-year Euro Notional futures contract reveals that the combination of German 10-year sovereign

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[15] See Annex 8: Euro Bund futures contract: September 1998 delivery: delivered volume of the CTD bond: 29% of the size; June 1999 delivery: delivered volume of the CTD bond: 35.5% of the size.

[16] Modified duration is defined as the relative change (in %) of the bond's price in terms of a yield change of 1 bp.

[17] See eg DBR 4.75% 04.07.2008, issued on 10.07.1998 and DBR 4.125% 04.07.2008, issued on 30.10.1998.

[18] See MATIF press release: Dual issuer base for Euro Notional and five-year Euro contracts, 27 January 1999. For the June 1999 delivery, the outstanding volume of the Euro Notional futures contract was EUR 127 billion compared with EUR 63 billion of the Euro Bund futures contract.

issues, to be redeemed in January and July, and French 10-year sovereign issues, to be redeemed in April and October, reduces the gap between the modified durations of the deliverable bonds. This, however, leads to a more homogeneous price behaviour of single bonds deliverable in this basket after relative yield changes. Under these circumstances, the CTD bond should change fairly smoothly.

Since the June 1999 delivery, when the 10-year Euro Notional futures basket was redesigned as a dual-issuer basket, a smooth rotation of the CTD bond in this contract has not occurred. Due to the yield spread between German and French government bonds, only French issues have been CTD so far.[19] As long as this yield spread exists, a CTD change as a response to small relative yield changes will, in fact, be impossible. Despite this obvious shortcoming in functioning, the features of this dual-issuer basket, as far as the price behaviour of the deliverable bonds after relative yield changes is concerned, are more positive than those of the 10-year Euro Bund futures contract.

In conclusion, a dual/multi-issuer basket is able to reduce squeeze risk if

1. there are no large yield spreads between different sovereign issues,
2. there is only a small gap between the modified durations of the deliverable bonds, so as to change the CTD bond after only small relative yield changes,
3. each deliverable bond is large in size.

Change in the notional contract coupon

As mentioned above, the conversion factor of each deliverable bond will be able to correctly adjust the price differences, due to coupon and term differences of these bonds, if the market yield level equals the yield level of the notional contract coupon. In this ideal scenario, all deliverable bonds will be CTD. As, therefore, several bonds in the deliverable basket might become CTD despite their unequal modified durations, the potential CTD volume at the contract's delivery date will increase, so that the squeeze risk will diminish. Yield deviations from the level of the notional contract coupon will cause a bias by increasing the likelihood that bonds with the highest modified duration within the basket will be CTD if the market yield level stays above the level of the notional contract coupon. On the other hand, if market yields stay below the level of the notional contract coupon, the bond with the lowest modified duration will be CTD.[20] However, the adjustment of the notional contract coupon, as carried out by MATIF and LIFFE in response to the two Euro Bund futures squeezes, will lead merely to a temporary solution of the squeeze problem. As soon as the market yield level moves away from the level of the adjusted notional contract coupon, the bias of the conversion factor will again clearly favour a bond within the basket if the deliverable basket consists of bonds with very different modified durations. The squeeze problem is then once again focused on only one single bond.[21]

Turning to the 10-year Euro Notional futures contract, the bond with the highest modified duration within this basket has been CTD since the lowering of the notional contract coupon from June 1999 deliveries onwards.[22] Since the bond with the highest modified duration is the last issued bond (benchmark bond), this bond, therefore, carries a double function, being CTD and benchmark bond simultaneously. In order to avoid squeezes in this bond - as long as the yield spread between German and French sovereign issues averages 10 to 15 bp, this bond, carrying a double function, will be a French OAT bond - the issuer is forced to place this bond with a high issue size as soon as possible. Given the small amounts of the CTD bond for this contract which have actually been delivered at the contract's delivery date, no shortages have occurred in the CTD bond during the contract periods investigated.[23] This suggests that, compared to the Euro Bund futures contract, the essentially smaller open interest in the Euro Notional futures contract and the large size of French OAT issues might be reasons for this.

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[19] See Annex 8: Euro Notional futures contract; the yield spread averages about 10 to 15 bp in favour of German 10-year government bonds.

[20] Assumption: all deliverable bonds have the same yield.

[21] See Annex 7.

[22] See Annex 8: Euro Notional futures contract June 1999 delivery onwards.

[23] See Annex 8: Euro Notional futures contract, column: Delivered volume.

In conclusion, it should be pointed out that changes in the notional contract coupon will help to alleviate the squeeze risk as long as the adjustment is not too extreme. As for the rest, it should be remembered that, for currently traded contracts, a change in the contract parameters is not possible. Since three contract deliveries, for instance in the Euro Bund futures contract, are traded permanently, the earliest opportunity to adjust the notional contract coupon in this contract is nine months later. In the face of such a large time lag, an adjustment of the notional coupon makes sense and is likely to be successful only if the adjusted coupon covers the yield level of deliverable bonds with a high probability over a long period of time.

3.2 Hedge quality of futures contracts and OTC derivatives

Concerning the hedging of German, French and Italian 10-year sovereign issues with 10-year Eurex/MATIF futures contracts or 10-year swaps, the transition to EMU has led to different results for each of the three core euro area countries. The hedge quality of both 10-year futures contracts and 10-year swaps is measured by calculating the daily and weekly correlations of the effective price changes of the 10-year futures/swap contracts and the respective German, French or Italian 10-year benchmark or CTD bonds. The following results should be noted:

1. The transition to EMU, which, in fact, started in May 1998 with the fixing of the bilateral exchange rates between the 11 EMU member countries, has not affected the hedge quality of 10-year Eurex/MATIF futures contracts for German and French sovereign bonds to any great extent. Instead, both the Russian and the LTCM crisis in summer/autumn 1998 and the Euro Bund futures squeezes in September 1998 and June 1999 deliveries did seriously affect the hedge quality of both 10-year futures contracts, especially the Euro Bund futures contract, and 10-year swaps for the corresponding sovereign bonds.[24] On the other hand, prior to the start of stage three of EMU, hedging Italian 10-year government bonds with Italian 10-year swaps proved to be more successful than hedging via 10-year Eurex/MATIF futures contracts.[25] Ever since June 1999 deliveries, however, weekly correlations have shown that 10-year futures contracts of Eurex and MATIF, as opposed to 10-year Euro-swaps, are the better hedge instrument for Italian 10-year government bonds, due to a stabilisation of yield spreads of these bonds in terms of German and French sovereign issues.

2. As far as the hedge quality of 10-year futures contracts compared to 10-year swaps is concerned, the appropriate hedge instruments for German and French 10-year benchmark and CTD bonds during the time period investigated (September 1998 - September 2000) have been 10-year Eurex and MATIF futures contracts.

3. Another interesting question arising in terms of hedging sovereign issues of the core euro area countries is which of the two 10-year futures contracts of Eurex and MATIF has had the better hedge quality during the period under review. Looking at the effective daily price changes of both futures contracts and benchmark bonds, the 10-year Euro Notional futures contract has demonstrated better hedging properties in terms of daily price changes, with the exception of the December 1998 delivery. However, looking at the effective price changes on a weekly basis, the results have been different. Weekly correlations during December 1998, June 1999, December 1999 and June 2000 deliveries show that the 10-year Euro Bund futures contract has been the better hedge instrument at least for German benchmark and CTD issues, although not for French and Italian government bonds.[26]

What are the reasons for different results in hedge quality of the Euro Bund futures contract measured either daily or weekly?

One explanation might be that this contract is used both as a hedge instrument and as a speculative trading tool. Furthermore, due to its tremendous liquidity, the contract is used as a hedge instrument

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[24] See Annex 8: Correlations for September 1998 and June 1999 deliveries.

[25] See Annex 8: Correlations for September 1998 to March 1999 deliveries for Italian benchmark bonds.

[26] See Annex 8: Daily/weekly correlations between German/French benchmark bonds and 10Y EUREX/MATIF futures contracts.

for a variety of domestic and foreign government and non-government issues (eg German Pfandbriefe) with maturities from 10 to 30 years. In both cases, the price of the Euro Bund futures contract changes, although the prices of the respective benchmark or CTD bonds do not necessarily change to the same extent. After the announcement of news causing price movements in the Euro Bund futures contract, these movements might be stronger within a daily trading period. During a weekly trading period, however, these exaggerations in prices recede or even out. Therefore, the hedge quality of the Euro Bund futures contract seems to be better from the weekly point of view.

Daily price movements in the Euro Bund futures contract seem to play an important role in this context. Looking at daily price movements of the respective CTD bonds of this contract, according to which the price of the futures contract itself should normally move, correlations show that prices of the futures contract and the CTD bond have not moved in tandem, leading to visible movements of the net basis of the CTD bond.[27]

In what way has the change in the notional contract coupon of the 10-year Euro Notional futures contract as of June 1999 (from 5.5% to 3.5%) affected hedging of the French benchmark bond?

As long as yields of 10-year government bonds stay above the level of the notional contract coupon (3.5%) of this contract, the deliverable bond with the highest modified duration, ie the last issued bond within the deliverable basket, will, as a rule, be CTD.[28] Therefore, either the French benchmark bond or, assuming that yield spreads between 10-year government bonds of Germany and France do not exist, the German benchmark bond would be CTD in this contract. Since the price of the futures contract should normally follow the price movements of the CTD bond, hedging the respective French benchmark with the Euro Notional futures contract is likely to be more successful than hedging the respective German benchmark bond, which should not be CTD simultaneously, with the Euro Bund futures contract.[29]

4. Liquidity, market efficiency and price discovery: a conceptual framework

A financial market is said to liquid when at all times there are a large number of buyers and sellers, such that incoming orders can easily be matched without causing prices to move by a large amount. Liquidity measures should account for both trading volume and concurrent price change. A liquid market absorbs large volume with little price change. Hence, price changes should be relatively invariant to the size of transactions and display limited. An illiquid market yields price concessions on low trading volume. No uniformly accepted single, unambiguous, theoretically correct measure of liquidity exists; all measures suffer one or more limitation. Hence, there are both different concepts of liquidity and different ways of measuring liquidity.[30]

Asset prices change both in response to transitory variations in supply and demand and a result of permanent shifts in the equilibrium value of the asset. In the absence of new information, buy and sell orders would come into the market in a random fashion, leading prices to swing back and forth without any trend. As new information arrives, however, prices are driven to a new level. In these instances, big price movements can occur even on small volume trading. This is where the distinction between liquidity and efficiency becomes most significant.[31]

The critical factor in the analysis is the recognition that price changes are not all alike in origin and significance. Random variations in price are noise and liquid markets keep those random variations tight and minimal, regardless of the size or number of transactions.

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[27] See Annex 8: Correlations of the CTD bonds of the Euro Bund futures contract.

[28] Assumption: the yields of all deliverable bonds are the same.

[29] This result is supported by comparison of the daily/weekly correlations between the Euro Notional futures contract/Euro Bund futures contract and the respective benchmark bonds within each futures contract from June 1999 deliveries onwards.

[30] Cf Bernstein (1992), who concludes that “no single measure tells the whole story about liquidity” (p 61).

[31] Dimson and Mussavian (1999) provide a clear presentation of the distinction between market efficiency and liquidity.

4.1 Price change, volatility and measurement of market efficiency

Price efficiency is synonymous with accurate reflections of equilibrium values. Prompt price changes in response to new information are essential as they are the key signal to fundamental values and expectations. An efficient market should let prices move fast when market participants' perception changes, hence price changes tend to be discontinuous. As a result, efficient markets may not attract large number of active investors, especially knowledgeable investors who are able to profit from pricing errors. Yet, liquid and efficient markets both need a large number of active interested and investors. This is where tension arises between liquidity and efficiency or, in terms of market participants, between noise traders and information traders. In an efficient market information-motivated shifts in supply and demand should have a free rein impact on prices; conversely, in a liquid market random swings in supply and demand should have a minimal impact on price. Noise traders, acting on imperfect information, will frequently push prices away from equilibrium values. The resulting undervaluation or overvaluation attracts information traders (arbitrageurs), who push prices back to equilibrium values. Therefore the dynamic properties of price changes and the price effects of trading need to examined. Ideally a theoretical model of prices and price revisions due to trading would provide a framework to decompose price changes into transitory and permanent parts.

To measure informational efficiency in two different markets, financial economists look at the so-called lead-lag relationship. The basic intuition is that in an efficient frictionless market, the prices of two identical assets should be identical (law-of-one-price) - therefore perfectly correlated - and instantaneously reflect all available information.[32] A lead-lag relationship, with one price adjusting earlier than the other one, will develop if market imperfections are present. To detect the presence of a lead-lag relationship, the first task would be to model the intertemporal and cross-market characteristics of returns in both market. Additional insight into the informational efficiency of the two markets can be obtained by comparing the time series properties of volatilities. If returns are driven by information arrival and the rate of information arrival is non-constant, possibly stochastic, then volatility will evolve over time.[33] For example, periods with few news releases might be followed by periods with fast information arrival inducing changes in return volatility. Two efficient and frictionless markets trading the same asset and receiving the same information shocks should exhibit a similar volatility pattern. If, however, volatility patterns differ across the two markets, then we may conclude that either (i) information flows to one market prior to the other, or (ii) the two markets receive the same information, but differ in their speed of adjustment to information shocks. As the former proposition is very difficult to test, one would normally assume that the two markets receive the same information and examine the differences in volatility adjustment mechanisms by employing a model of time-varying volatility.

4.2 Dynamic analysis of price discovery

The endogenous character of the pattern of price changes and activity and the asymmetric information revelation across markets induce lagged effects on the adjustment process driving market price discovery. To take into account the statistical properties of financial series (including their non-stationarity), the vector error-correcting model (VECM) seems a suitable multivariate framework for modelling interest rate dynamics. Vector autoregression (VAR) models have already been widely introduced into the market microstructure literature.[34]

Let Z_t be a vector of (nx1) of financial (eg interest rates) series, integrated of order 1 (eg I(1)) and with mean 0, for simplicity, and assume that the rank of cointegration is m, namely there exists a matrix A (nxm) of rank m - the number of cointegrating vectors - such that the linear combinations $W_t \equiv A'Z_t$ are stationary (eg I(0)) vector of variables. It follows that changes in Z_t admit the VAR representation

[32] See, for example, Dimson and Mussavian (1998).

[33] See Tauchen and Pitts (1983), Andersen (1993).

[34] See Hasbrouck (1993).

$$\Delta Z_t = \Gamma A' Z_{t-1} + \sum_{i=1}^{q} \Gamma_i \Delta Z_{t-i} + \varepsilon_t^{\Delta Z},$$
$$\text{cov}(\varepsilon_t^{\Delta Z}) = \left\langle \sigma_{\Delta Z}^2 \right\rangle \tag{1}$$

where Γ is a an (mxn) matrix, $\{\Gamma_i\}$ are (nxn) matrices and $\langle \cdot \rangle$ indicates a (nxn) diagonal matrix. In our analysis Z_t may also include stationary (eg I(0)) variables; matrix Γ would be adjusted accordingly to take this case into account.

The element of Z_t can be explained in terms of a smaller number (n-m) of I(1) variables, F_t , called common factors, plus a vector of I(0) (stationary) components, T_t:

$$Z_t = A_1 F_t + T_t \tag{2}$$

One can estimate such a common factor decomposition from the VECM (1); to identify the long-run common factors, one has to impose that F_t be the linear combination of the observed time series vector of variables Z_t [35]

$$F_t = \Gamma^{*\prime} Z_t \tag{3}$$

We identify $P_t = A_1 F_t$ as the permanent (long-run) component of Z_t, with factor loadings represented by matrix A_1. Analogously, the transitory part, T_t, can be expressed in terms of a common set of factors, W_t, again constructed as a linear combination of the observed time series vector of variables Z_t, $W_t = A' Z_t$, where $T_t = A_2 W_t$, with factor loadings represented by matrix A_2. As a result, we can summarise the permanent transitory decomposition as

$$P_t = A_1 F_t = A^* (A^{*\prime} \Gamma^*)^{-1} F_t$$
$$T_t = A_2 W_t = \Gamma (A' \Gamma)^{-1} W_t \tag{4}$$

where A' is the matrix of cointegrating vectors; Γ is the matrix of the contribution of the "correction" term in the VAR, given by the (transitory) deviation, $W_{t-1}=A'Z_{t-1}$, from the stationary (long-run) equilibrium level, on the changes of Z_t; A* and Γ* orthogonal matrices to A and Γ, respectively (eg A'A*=0 and $\Gamma'\Gamma^*=0$).

It is convenient to provide an AR representation for the factor decomposition written down in equations (2)-(4):

$$\begin{pmatrix} a(L) & b(L) \\ c(L) & \text{d(L)} \end{pmatrix} \begin{pmatrix} \Delta P_t \\ T_t \end{pmatrix} = \begin{pmatrix} \varepsilon_t^{\Delta P} \\ \varepsilon_t^{T} \end{pmatrix},$$
$$\text{cov} \begin{pmatrix} \varepsilon_t^{\Delta P} \\ \varepsilon_t^{T} \end{pmatrix} = \begin{pmatrix} \Omega_{\Delta P} & 0 \\ 0 & \Omega_{\text{T}} \end{pmatrix} \tag{5}$$

where ΔP_t denotes the time changes of the permanent (long-run) component of decomposition (2) and a(L) to d(L) are polynomials in the lag operator; the error terms, $\left(\varepsilon_t^{p}, \varepsilon_t^{x}\right)$, are supposed to be uncorrelated (eg the covariance matrix of disturbances is diagonal).

4.3 Dynamic decomposition through the VAR impulse response function

The AR representation (5) allows a very general dependence of the decomposition Z_t into permanent and transitory components as a function on contemporaneous and past shocks. However, a restriction

[35] See Gonzalo and Granger (1995) for a formal proof.

on the polynomial lags structure (multipliers) follows from equation (3); it requires that T_t, the transitory component, does not Granger-cause P_t, the permanent component, in the long run (eg at frequency 0)

$$b(1) = 0 \tag{6}$$

The effects of shocks on the decomposition can be computed from the impulse response of an AR model by transforming (4) into the following vector moving average (VMA) representation:[36]

$$\begin{pmatrix} \Delta P_t \\ T_t \end{pmatrix} = \begin{pmatrix} \alpha(L) & \beta(L) \\ \gamma(L) & \delta(\mathrm{L}) \end{pmatrix} \begin{pmatrix} \varepsilon_t^{\Delta P} \\ \varepsilon_t^{T} \end{pmatrix} \tag{7}$$

To illustrate the usefulness of the VMA form, consider the equation for the long-run changes in more detail

$$\Delta P_t = \sum_{j=0}^{\infty} \alpha_j \varepsilon_{t-j}^{\Delta P} + \sum_{j=0}^{\infty} \beta_j \varepsilon_{t-j}^{T} \tag{8}$$

In words, long-run changes are infinite sums of past innovations $\left(\varepsilon_t^{\Delta P}\right)$ and $\left(\varepsilon_t^{T}\right)$. The effect of unit innovations on the *change* in the long-run component k periods ahead is measured by α_k and β_k, respectively; the effect of unit innovations on the short-run component k period ahead is measured by γ_k and δ_k, respectively

$$T_t = \sum_{j=0}^{\infty} \gamma_j \varepsilon_{t-j}^{\Delta P} + \sum_{j=0}^{\infty} \delta_j \varepsilon_{t-j}^{T} \tag{9}$$

Thus the coefficients of the VMA are exactly the desired impulse responses. The effect of a unit shock on the *level* of the permanent component k periods ahead is measured by partial sums of the impulse response:

$$p\varepsilon_{\Delta p}(k) = \sum_{j=0}^{k} \alpha_j, p\varepsilon_x(k) = \sum_{j=0}^{k} \beta_j \tag{10}$$

the total long-run effects of shocks are easily determined as limits of the partial sums as $k \to \infty$:

$$p\varepsilon_{\Delta p}(\infty) = \sum_{j=0}^{\infty} \alpha_j, p\varepsilon_x(\infty) = \sum_{j=0}^{\infty} \beta_j \tag{11}$$

Cochrane (1988) notes that this definition of the long-run effects of innovations is unique and independent of any particular decomposition of the price process into permanent and transitory parts (see De Jong et al (1996)).

4.4 "Noise" and "fundamental" value as decomposition of price change into transitory and permanent component

The impulse responses (8)-(9) provide all necessary information for decomposing Z_t into permanent and transitory components. Such a decomposition can be interpreted as an identification technique that separates "fundamental" factors, eg variables with a long-lasting effect on prices, from "noise" effects; the former measuring the efficient component of price changes, the latter the deviation of the

[36] Sims (1980) popularised the use of such a representation for VAR models.

observed price from the efficient price.[37] This approach is a natural extension of the Hasbrouck (1993) methodology, which decomposes an asset price into a random walk (permanent) component and a stationary component around the random walk, with the former representing the underlying equilibrium (efficient) price of the security in which all public information is reflected and the second, transitory, component generally regarded as the pricing error,

Hasbrouck (1993) proposes using the standard deviation of "efficient" and "noise" price components

$$\begin{aligned} \text{var}(\Delta P_t) &= \left(\sum_{j=0}^{\infty}\alpha_j\right)\Omega_{\Delta P}\left(\sum_{j=0}^{\infty}\alpha_j\right)' + \left(\sum_{j=0}^{\infty}\beta_j\right)\Omega_T\left(\sum_{j=0}^{\infty}\beta_j\right)' \\ \text{var}(T_t) &= \left(\sum_{j=0}^{\infty}\gamma_j\right)\Omega_{\Delta P}\left(\sum_{j=0}^{\infty}\gamma_j\right)' + \left(\sum_{j=0}^{\infty}\delta_j\right)\Omega_T\left(\sum_{j=0}^{\infty}\delta_j\right)' \end{aligned} \tag{12}$$

as a summary measure of the "quality" of a securities market. Intuitively they reflect how closely observed market prices track the "efficient" price on average. He suggests a market quality measure (mqm) of a noise-to-signal ratio type of indicator, namely the pricing error variance of the security divided by the "efficient" price change:

$$mqm = \sqrt{\frac{VARIANCE(T_t)}{VARIANCE(\Delta P_t)}} \tag{13}$$

The mqm indicator can be thought of as a measure of market efficiency for the price-discovery process. In practice, several factors can impinge upon the speed with which the process takes place, such as, among other things, transaction costs (large bid-ask spreads that prevent crossing the trade at the mid-price) as well as the lag with which securities prices adjust to the arrival of new information. In this sense it is understood as a "dynamic" measure of transaction costs that generalises the traditional Roll's estimator (Roll (1984)). Under Roll's special assumption VARIANCE(T_t) would be equal to half the realised bid-ask spread. A larger variance in the noise component would signal a rising uncertainty in the price discovery and declining informational efficiency.

5. Data description and statistical properties of interest rates in the euro area

The measurement technique presented in the previous section is used to assess bond cash market efficiency in the euro area. We concentrate our study on the long-term segment of the market (10-year maturity), focusing on the swap and government bond market benchmark yield. We confine our estimates to the largest government bond markets of the euro area (France, Germany and Italy) using the US and UK markets as a benchmark reference.

To achieve this goal we have assembled a data set of market interest rates covering the main segments of the euro area, including the interbank market (three-, six- and 12-month interest rate), the short futures rate (Eurex three-month futures rates up to one year maturity), the long futures price (on the 10-year bund), swap rates (with a maturity of two, three, five, seven and 10 years), Treasury benchmark (Bund, OAT and BTP yields with a maturity of three, five and 10 years) and corporate benchmark (10-year);[38] the data are daily quotes and cover the period from 3 January 1990 to 31 August 2000. Table 1 provides summary statistics over the period used in the estimation. Chart 1

[37] Other decompositions into permanent and transitory components are also possible. Hasbrouck (1993), who adopts the Beveridge and Nelson (1981) approach, shows that the Beveridge-Nelson decomposition gives a lower bound for the variance of the stationary price part among all possible decompositions.

[38] Data come from Datastream and Bloomberg; BTP benchmark yields are calculated by the Bank of Italy.

reports some of the spread for the larger countries in the euro area vis-à-vis the 10-year German bund yield.

Before going through the econometric estimation, we check some statistical properties of the series used in this paper. We first consider long-run properties for the level of interest rates, that is non-stationarity and cointegration; this is required since many papers have given evidence of non-stationary behaviour of interest rates.[39] In that case dealing with rates in level calls for a proper econometric handling. At this stage, we have to restrict our attention to a five series system $Z_t=(\Sigma_t,S_t,Y_t,L_t,R_t)$ of interest rate levels; these rates are as defined as follows:

Σ_t = implied forward rates in the three-month futures yield on the Euribor

(average of four consecutive three-month delivery dates).

S_t = 10-year interest swap rate on the euro.

Y_t = 10-year yield to maturity on German bund.

L_t = 12-month interbank rate (Libor) on the euro.

R_t = three-month interbank rate (Libor) on the euro.

Standard unit-root tests (as reported in Table 2, Panel A) allow us to conclude that interest rates in our sample can be considered non-stationary. Hence the framework laid out in the previous section provides a meaningful tool for assessing the extent to which changes in fundamental values vs the "noise" (idiosyncratic) component have impinged upon interest rates in the euro area. The following yield spreads are used for dynamic analysis:

(St - Yt , Σt - Rt , Rt - Lt , Lt - Yt)

These include a 10-year swap spread, $S_t - Y_t$, a forward term spread, $\Sigma_t - R_t$, a short-term rate spread, $R_t - L_t$, and a long-term yield spread, $L_t - Y_t$. In Chart 2 we plot the 10-year swap spread vis-à-vis the German bund; it displays a fair amount of volatility and an upward trend seems to have appeared since the start of EMU; a corporate bond spread displays a similar pattern. Although we expect to find yield spreads mostly stationary, unit-root tests for spreads (not reported) lead to a somewhat less clear-cut conclusion than on levels; all in all, the stationary component in the spreads does appear to be predominant at the significance level of 1%.

This is confirmed by the Johansen Maximum Likelihood (JML) procedure for the testing of cointegration relationships. For a VAR of order 7 (order suggested by the Akaike information criterion) at the significance level of 1% only one cointegrating vector appears to be selected by the trace test for cointegration rank (Table 2, Panels B-C). However, at the 5-10% significance level we could not reject the hypothesis of two cointegrating vectors. With two cointegrating vectors out of five variables there are 3 I(1) common factors driving the long-term dynamics of the interest rates. In addition, the (unrestricted) cointegrating vector coefficients nearly add up to zero, which would be consistent with the hypothesis that the long-run relationship among interest rates can be restricted to involve the information content of spreads only; a formal χ^2-square test of the unit restriction would not be rejected at the 1% significance level for both cointegrating vectors.

The JML procedure for the testing of cointegration relationships is applied to a sample of 10 bond yields in the G5 countries (Germany, France, Italy, the United Kingdom and the United States), as reported in Table 5; the data consist of 2,090 daily observations from 1993:1 to 2000:365. For a VAR of order 7 (order suggested by the Akaike information criterion) at the 5% significance level we cannot reject the hypothesis of only one cointegrating vector; as a result there are four common I(1) factors driving the whole system of interest rates in the long run and one common I(0) factor, the transitory component, capturing the common source of deviations from the permanent component ("mispricing" effect).

[39] See, for example, Hall et al (1992), Engsted and Taggart (1994), Drudi and Violi (1996) and Avouyi-Dovi and Jondeau (1999).

5.1 Econometric estimates of the determinants of bond market liquidity and price efficiency in the euro area

Cointegration and stationary spreads allow us to turn to a simple univariate equation estimate defining the long-run relationship between swap spread and forward spread, short-term spread and long-term spread:

$$S_t - Y_t = \lambda_0 + \lambda_1(\Sigma_t - R_t) + \lambda_2(R_t - L_t) + \lambda_3(L_t - Y_t) + \varepsilon_t^{SY} \quad (14)$$

The information content of the forward spread for the 10-year swap spread and the slope of the yield curve (short and long) are quite significant determinants of the swap spread; the adjusted R^2 of the regression is relatively high (0.34; Table 3) and the estimated slope parameters are significantly positive, although very far from 1 (actually close to zero or negative for the short-term slope of the yield curve). Deviation from 1 for the slope parameters (and zero for the constant term) in the regression does not imply immediate rejection of the no-arbitrage-restriction characterising the estimated model; it may simply be a consequence of the shorter horizon of the forward spread (one-year as against 10-year horizon) entering the estimated regression. However, while the estimated relationship seems fairly robust in recent years,[40] there are still clear signs of heteroskedasticity and autocorrelation in the regression residuals. A Garch (1,1) estimation of the conditional volatility process[41] for the swap spread equation (14)

$$(\sigma_t^{SY})^2 = \mu_0 + \mu_1(\sigma_{t-1}^{SY})^2 + \mu_2(\varepsilon_{t-1}^{SY})^2 \quad (15)$$

suggests that estimated time-varying volatility has been definitively higher since the beginning of EMU compared to the rest of the sample (see Chart 3). Most of the "excess volatility" does not seem to originate from increased forward and term spread volatility, rather it appears to reflect additional "noise" specific to the swap spread. We provide evidence for this hypothesis by extending equation (12) to a "state-space" (Kalman filter) specification in which the forward rate spread is only imperfectly observed - the 10-year consecutive forward rates are not traded in the market for the outer horizon - and the "true" forward spread Σ_t^* - R_t follows an AR(1) process

$$\begin{aligned} S_t - Y_t &= \lambda_0 + \lambda_1(\Sigma_t^* - R_t) + \lambda_2(R_t - L_t) + \lambda_3(L_t - Y_t) + \varepsilon_t^{SY} \quad (16)\\ \Sigma_t - R_t &= \phi_0 + \phi_1(\Sigma_t^* - R_t) + \varepsilon_t^{\Sigma R} \\ \Sigma_t^* - R_t &= \varphi_0 + \varphi_1(\Sigma_{t-1}^* - R_{t-1}) + \varepsilon_t^{\Sigma^* R} \end{aligned}$$

The fit of the swap spread "measurement" equation improves substantially (R-squared increases to 0.99) and estimated coefficients for the spreads are much larger than those estimated for equation (14).

Swap spread equation errors increase significantly in the first six months of this year, especially at times when the swap spread widened during the second quarter of the year, in the wake of the UMTS mobile phone licence auction in Germany.

All in all, the econometric evidence suggests that, at least in part, fluctuations in the euro swap spread vis-à-vis the bund, over and above the movements related to the changes in the term structure of interest rates, may be due to idiosyncratic movements in the German government 10-year bond yield; only the French OAT has partially kept pace with the growing German swap spread, while the Italian swap spread has remained fairly stable.

A measure of the extent to which such fluctuations have affected efficient price discovery for euro interest rates can be gauged by estimating the parameters of the VECM (1); such estimates allow us to compute the impulse response associated with the system of equations (7); finally the market quality indicator, mqm, can be obtained from equation (13).

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[40] Eliminating the observations for 1999-2000 (ie the EMU sub-sample) from the data set little changed the results of the estimation, leaving the explanatory power of the forward spread almost identical.

[41] See for example Bollerslev, Chou and Kroner (1992) for details of Garch application in econometric finance.

Table 4 reports the calculated efficiency measures for each interest rate evaluated for several sub-samples. There is a clear worsening of "market quality" as witnessed by the increase in the mqm indicator from 1998 to 1999; it almost doubles for all interest rates but the average three-month futures rate. For the 10-year bund the mqm indicator continues to rise (from 0.019 to 0.026) signalling a further slight worsening in mispricing. Conversely, the 10-year swap rate mqm remains unchanged.

5.2 Comparing bond market liquidity and price efficiency in G5 countries: euro area vis-à-vis the United Kingdom and the United States

Table 6 reports results of the permanent-transitory decomposition of 10-year bond yields for the G5 countries (France, Germany, Italy, the United Kingdom and the United States; see Table 5 for some descriptive statistics). The standard deviation of the stationary part (transitory component) provides a measure of the extent of the "mispricing" (liquidity effect) as a result of deviations from the "fundamental" value (permanent component) of current bond yields. The proportion to the latter standard deviation (mqm indicator) shows a worsening of liquidity across countries in 1999 compared to 1998, especially in Germany and Italy (from 9 to 13.6 and 5.9 to 8.2 respectively); to a lesser extent the decline in market liquidity also affects the United Kingdom and, to a very limited scale, even the United States. Such a global phenomenon may be partly related to the consequences of the Russian/LTCM liquidity crisis; this is confirmed by inspecting the standard deviation of the common liquidity risk factor,[42] which exhibits a sharp increase in August 1998 (Chart 4).

It is worth noting that in 1999 the deterioration of market liquidity is caused by the increase in the standard deviation of the transitory part, whereas the standard deviation of the fundamental value (permanent component) is virtually unchanged across countries. The worsening of liquidity conditions, according to the mqm indicator, seems to have receded during 2000, when liquidity measures reverted to levels below the pre-crisis level. For Germany, the United Kingdom and the United States, the differences in the level of mqm is attributable to the standard deviation of the transitory part, a sort of absolute measure of "mispricing"; in Germany this measure is 5-16 times higher than in the United Kingdom and the United States, as evaluated in 2000. Italy displays an absolute level of its bond market liquidity measure much closer to that of the United Kingdom and the United States, eg a significantly lower "mispricing" than Germany and France. This is a persistent feature over the time span of our sample and it might be related to the advanced trading infrastructure and market participation developed by the Italian MTS in the early 1990s.

All in all relative liquidity measures confirm the high degree of bond yields convergence across the G5 countries, especially across the largest economies of the euro area. The United Kingdom and the United States bond markets still maintain a positive liquidity differential, as measured in relative terms, with respect to those of continental Europe.

Global convergence in bond yield fundamental values, especially vis-à-vis the United States (see Chart 5), broadly explains recent trends of liquidity convergence. According to the estimated VECM for the G5 countries, implied equilibrium 10-year bond yields - ie estimated permanent (price-efficient) components - only differed by less than 50 basis points at the end of 2000 between the euro area (taken as a simple average of French, German and Italian government bond market rates) and the United States. Long-run equilibrium rates in the United States have been persistently above those of the euro area since 1997; similarly, euro area equilibrium 10-year rates are estimated to be just over 50 basis points above those of the United Kingdom. Consequently, euro area 10-year bond rates are estimated at the end of last year to have been just over 25 basis points above their equilibrium level; UK rates were almost 75 basis points above their long-run equilibrium value; conversely, US rates were some 20 basis points below their long-run equilibrium level (Chart 6).

[42] The standard deviation refers to the simulated volatility of a GARCH(1,1) model for the common stationary factor, W_t, implied by the VAR-based decomposition in equation 4.

6. Concluding remarks

Notwithstanding increasing money and bond market integration in continental Europe since the launch of the euro, a reliable government yield curve is still struggling to establish itself. Market participants have responded to the introduction of the new currency by concentrating liquidity on Eurex's Euro Bund futures contract. The rapid expansion of the Eurex capital market futures contracts in the last few years and an active repo market have reaffirmed the benchmark prominence of German government bonds. However, the budgetary developments in Germany - implementation of the Stability Pact, tax reform resolution and the sale of UMTS mobile phone licences - may further reduce the already narrow base of deliverable bonds in the existing futures markets. The disproportion of futures and cash markets, if not properly counteracted from the supply side, could leave the euro area government bond market less liquid than it might otherwise be.

In the run-up to monetary union, there were far-reaching changes on OTC and exchange-traded derivatives markets in the core euro area countries (France, Germany and Italy). OTC derivatives trading, especially interest rate swaps, has expanded significantly both worldwide and at the European level when compared with exchange-based derivatives trading. This trend seems to be driven mainly by a rising demand for hedging instruments on spread products like agency and corporate bonds. Liquidity on European exchange-traded derivatives markets has become concentrated on a handful of futures exchanges, but this trend has not been evident on European cash and repo markets. With the transition to EMU, the European exchanges have intensified their efforts to create a joint market for exchange-traded European assets through mergers and cooperative ventures. For the cash markets, this intention has not yet been successfully carried out. In the case of exchange-traded derivatives, however, market participants made their decision at an early stage by bundling liquidity: LIFFE and Eurex have established themselves as the most liquid trading place for money market derivatives and capital market derivatives, respectively.

Electronic trading of derivatives has increased substantially on futures exchanges in Europe. By concentrating liquidity on a handful of exchanges, another decision has been made by the market: the electronic trading of derivatives, with the additional aim of organising cash and repo trading on a joint electronic trading platform. Although a liquid, electronically driven market for European government bonds with a connected repo trading facility has been created by EuroMTS, London, the Europe-wide landscape of trading opportunities for fixed income products remains fairly fragmented. A considerable share of the secondary market activity in European government bonds is still concentrated on the domestic market. The development in the last two years of electronic inter-dealer bond markets in several European countries (Belgium, France, the Netherlands, Portugal and, more recently, Germany), based on the Italian MTS trading system, has so far only partly changed the overall picture of country-based concentration of market liquidity. Clearly, the expansion of the MTS platform across Europe and the rapid development of EuroMTS bode well for the prospect of strengthening market integration in the euro area, but new challenges are still ahead for the successful establishment of a single cash bond market in Europe.

Concentration of trade in capital market futures on Eurex has produced positive effects in terms of liquidity. However, concerns about squeezes in capital market futures have not been dispelled, especially under certain stressed market conditions (flight to quality, reduced supply of on-the-run benchmark securities, scarcity of deliverable securities, etc). Even though no squeezes in capital market futures have actually occurred so far, there are recognisable deficiencies in the fulfilment of cash and repo market transactions, which may reinforce squeeze concerns. The success of an electronic trading platform in Europe (like EuroMTS) will, therefore, mainly depend on how fixed income products and their derivatives as well as the repo market are integrated on this platform and whether it will be able to eliminate counterparty risk. So far the integration has taken place on a very limited scale; the repo trading facility available on the Italian platform of MTS is the only case in point.

Since the start of monetary union, yield spreads have widened in the euro area. Liquidity considerations are becoming more important in the context of EMU, where investors are no longer confined to their domestic markets by either exchange rate concerns or restrictive regulations and investment rules. Several determinants of liquidity seem to be at play: segmentations related to legal and regulatory differences; increased basis risk related to the quality of hedging bond positions in the futures markets; variable access to an active repo market and obstacles in the cross-border management of collateral; differences in bid-ask spreads across markets. While such factors are likely to be relevant in explaining euro area yield spreads, their relative importance is difficult to assess.

Changing segmentation is bringing about adjustments in the pricing differentials across markets and variations in bonds' liquidity, thus affecting the process of price discovery. Price formation in the bond markets has been hit by shifting liquidity and trading activity; market participants are reassessing relative bond values in the euro area as a result of changes in the market structure and supply.

Preliminary econometric evidence confirms that fluctuations in yield spreads across the European Union contain a significant transitory part, which can be identified as a source of "mispricing" (ie a temporary deviation from fundamental values). According to the liquidity indicator estimated in this paper the level of "mispricing" temporarily increased around the euro launch date. This increase appears by and large to have been reversed in 2000, as the impact of the launch of the euro on market participants' learning process kept on unfolding and the global implication of the Russian/LTCM crisis receded. The reversal of liquidity conditions during 2000 brought liquidity measures back to levels below that of the pre-1998 crisis.

Liquidity measures display a high degree of convergence across the G5 countries. However, according to our indicator of relative market liquidity, UK and US bond markets still maintain a positive liquidity differential with respect to those of continental Europe. Within the euro area, relative measures of bond market liquidity are now fairly similar. Italy, however, displays an absolute level of its bond market liquidity indicator (standard deviation of the transitory component) much closer to the estimates for the UK and US markets, ie significantly higher than the level estimated for Germany and France. This might be related to the advanced trading infrastructure and market participation developed by the Italian MTS since the early 1990s.

All in all, relative liquidity measures confirm the high degree of bond yield convergence across the G5 countries, especially across the largest economies of the euro area. UK and US bond markets still maintain a positive liquidity differential, measured in relative terms, with respect to those of continental Europe. Global convergence in bond yield fundamental values broadly explains recent trends of liquidity convergence. At the end of 2000, implied equilibrium 10-year bond yields only differed by less than 50 basis points between the euro area and the United States, whose long-run equilibrium rates have been persistently above those of the euro area since 1997. Similarly, euro area equilibrium 10-year rates are estimated to have been just over 50 basis points above those of the United Kingdom. Consequently, euro area 10-year bond rates are estimated at the end of last year to have been just over 25 basis points above their equilibrium level at the end of last year. UK rates were almost 75 basis points above their equilibrium values. Conversely, US rates were some 20 basis points below their long-run equilibrium level.

Table 1

Euro short and long interest rate[1]

daily data

1993:1 2000:365	**Descriptive statistics**				
	S_t	Y_t	L_t	R_t	$Sigma_t$
mean	6.16	5.83	4.43	4.39	4.4
median	6.15	5.86	4.00	3.69	4.06
standard deviation	0.94	0.99	1.09	1.48	1.08
min	4.03	3.63	2.69	2.59	2.66
max	8.03	7.77	5.99	9.12	7.37
Correlations					
S_t	1	0.99	0.68	0.55	0.69
Y_t		1	0.67	0.57	0.68
L_t			1	0.89	0.95
R_t				1	0.91
$Sigma_t$					1

[1] German rates before 1999.

$Sigma_t$ = implied forward rates in the three-month futures yield on the Euribor (average of four consecutive three-month delivery dates). S_t = 10-year interest swap rate on the euro. Y_t = 10-year yield to maturity on German bund. L_t = 12-month interbank (Libor) rate on the euro). R_t = three-month interbank (Libor) rate on the euro.

Table 2

Panel A	**Unit root tests**				
1993:1 2000:365	S_t	Y_t	L_t	R_t	$Sigma_t$
ADF	–1.16	–1.31	–0.05	–1.04	–0.94
(P-values)	*0.92*	*0.89*	*0.99*	*0.93*	*0.95*
PHILLIPS	–5.51	–4.61	1.56	–3.02	–2.76
(P-values)	*0.78*	*0.85*	*1.00*	*0.93*	*0.95*
WTD-SYM	–1.48	–1.62	–0.54	1.85	–0.11
(P-values)	*0.89*	*0.85*	*0.99*	*1.00*	*1.00*
(Number of lags)	12	12	28	20	6
Panel B	**Cointegration vectors: Johansen ML proc.**				
1° cointegration vector	1.00	–1.06	–0.17	–0.07	0.20
2° cointegration vector	1.00	5.31	46.78	–7.93	–45.66
Eigenvalues	0.0363	0.0082	0.0078	0.0032	0.0003
Panel C	**Cointegration rank test**				
No of cointegration vectors: r	*Trace test*		*P-values*		
HO: r=0	157.07		0.000		
HO: r<=1	54.26		0.054		
HO: r<=2	31.27		0.103		
HO: r<=3	9.62		0.505		

Table 3

Econometric estimates

Sample: 1993:1 2000:365	Constant	$Sigma_t$-R_t	R_t-L_t	L_t-Y_t	ADJ.R^2	SER	DW	LOG-LIK
OLS								
S_t-Y_t	0.43	0.0893	-0.0196	0.06937	0.34	0.106	0.13	2334
T-Statistic	*103.6*	*12.3*	*-3.08*	*26.9*				
Standard Error	*4.1.E-03*	*7.3.E-03*	*6.3.E-03*	*2.6.E-03*				
GARCH								
S_t-Y_t	0.30	-0.03329	-0.107	0.0153	0.70	0.042	0.54	3670
T-Statistic	*167.4*	*-12.7*	*-68.9*	*13.9*				
Standard Error	*1.8.E-03*	*2.6.E-03*	*1.6.E-03*	*1.1.E-03*				
Volatility param.	mu_0=0.234.E-03	mu_1=0.697	mu_2=0.336					
T-Statistic	*9.3*	*17.1*	*15.6*					
Standard Error	*2.5.E-05*	*4.1.E-02*	*2.1.E-02*					
KALMAN FILTER								
S_t-Y_t	0.00177	0.5507	0.697	0.452	0.99	0.015	0.56	12560
T-Statistic	*13.3*	*3328.8*	*4199.9*	*3545.9*				
Standard Error	*1.3.E-04*	*1.7.E-04*	*1.7.E-03*	*1.3.E-04*				
Volatility param.	mu_0=0.265.E-02	mu_1=0.716	mu_2=0.283					
T-Statistic	*17.1*	*15.6*	*14.0*					
Standard Error	*1.6.E-08*	*4.6.E-02*	*2.0.E-02*					

$Sigma_t$ = implied forward rates in the three-month futures yield on the Euribor (average of four consecutive three-month delivery dates). S_t = 10-year interest swap rate on the euro. Y_t = 10-year yield to maturity on German bund. L_t = 12-month interbank (Libor) rate on the euro). R_t = three-month interbank (Libor) rate on the euro.

Table 4

Government bond interest rates and market liquidity in G5 countries

		Market quality measure[1]				
		S_t	Y_t	L_t	R_t	$Sigma_t$
MQM: 1993:1	2000:365	0.053	0.061	0.013	0.006	0.007
MQM: 1993:1	1997:365	0.051	0.064	0.014	0.005	0.007
MQM: 1998:1	1998:365	0.010 (0.016)	0.008 (0.012)	0.002	0.003	0.001
MQM: 1999:1	1999:365	0.021 (0.032)	0.019 (0.028)	0.004	0.005	0.001
MQM: 2000:1	2000:365	0.021 (0.036)	0.026 (0.046)	0.003	0.007	0.003
Factor loadings		**A2:**		**A1:**		
		W1	**W2**	**F1**	**F2**	**F3**
S_t		0.00011	-0.000069	0.0056	0.0225	0.0054
Y_t		0.00005	-0.000010	0.0060	-0.0336	0.0019
L_t		-0.00019	0.000025	0.0146	0.0260	-0.0101
R_t		0.00014	-0.000026	-0.0221	-0.0640	0.0407
$Sigma_t$		-0.00011	3.13300D-07	-0.0130	0.0075	-0.0358

[1] In brackets: calculation with only one cointegration vector.

Table 5

Descriptive statistics

1993:1 2000:365	**Germany**	**France**	**Italy**	**UK**	**US**
mean	5.79	6.01	8.19	6.77	6.15
median	5.81	5.74	7.65	7.03	6.07
standard deviation	0.98	1.16	2.98	1.32	0.72
min	3.63	3.72	3.89	4.14	4.15
max	7.81	8.41	13.81	9.05	8.03
Correlations					
Germany	1.00	0.98	0.93	0.94	0.80
France		1.00	0.95	0.91	0.75
Italy			1.00	0.91	0.60
UK				1.00	0.74
US					1.00

Table 6

Ten-year government bond yield: liquidity measures in the G5 countries

Panel A	**Liquidity measures**				
	Germany	**France**	**Italy**	**UK**	**US**
Sample: 1993:1 - 2000:365					
MQM indicator	37.59	31.02	50.95	12.37	3.66
St. dev. (transitory)	5.25	8.05	1.75	0.84	0.22
St. dev. (permanent)	0.14	0.26	0.03	0.07	0.06
Sample: 1993:1 - 2000:365					
MQM indicator	23.69	20.21	35.18	8.80	2.76
St. dev. (transitory)	4.09	6.27	1.37	0.65	0.17
St. dev. (permanent)	0.17	0.31	0.04	0.07	0.06
Sample: 1993:1 - 2000:365					
MQM indicator	8.96	5.71	5.87	1.31	0.32
St. dev. (transitory)	0.45	0.69	0.15	0.07	0.02
St. dev. (permanent)	0.05	0.12	0.03	0.05	0.06
Sample: 1993:1 - 2000:365					
MQM indicator	13.57	6.43	8.24	1.81	0.50
St. dev. (transitory)	0.69	1.06	0.23	0.11	0.03
St. dev. (permanent)	0.05	0.16	0.03	0.06	0.06
Sample: 1993:1 - 2000:365					
MQM indicator	3.79	1.99	2.42	0.51	0.12
St. dev. (transitory)	0.16	0.24	0.05	0.03	0.01
St. dev. (permanent)	0.04	0.12	0.02	0.05	0.05
Panel B	**A2:**	**A1:**			
Factor loadings	**W1**	**F1**	**F2**	**F3**	**F4**
Germany	–0.02	0.0212	0.0196	0.0205	0.0011
France	0.04	0.0486	–0.0118	0.0077	0.0096
Italy	–0.58	–0.0033	–0.0110	0.0135	0.0093
UK	0.10	0.0345	0.0244	–0.0169	0.0443
US	0.18	0.0079	–0.0054	0.0248	0.0495

Panel C	**Cointegration rank test**		
No of cointegration vectors: r	*Trace test*	*P-values*	*Eigenvalues*
HO: r=0	79.96	0.057	0.0177
HO: r<=1	40.5	0.449	0.0086
HO: r<=2	22.96	0.481	0.0072
HO: r<=3	8.24	0.625	0.0027
HO: r<=4	2.78	0.89	0.0014

Chart 1

Euro area 10-year spread vs German bund yield: France, Italy and Spain

(daily data; in percentage points)

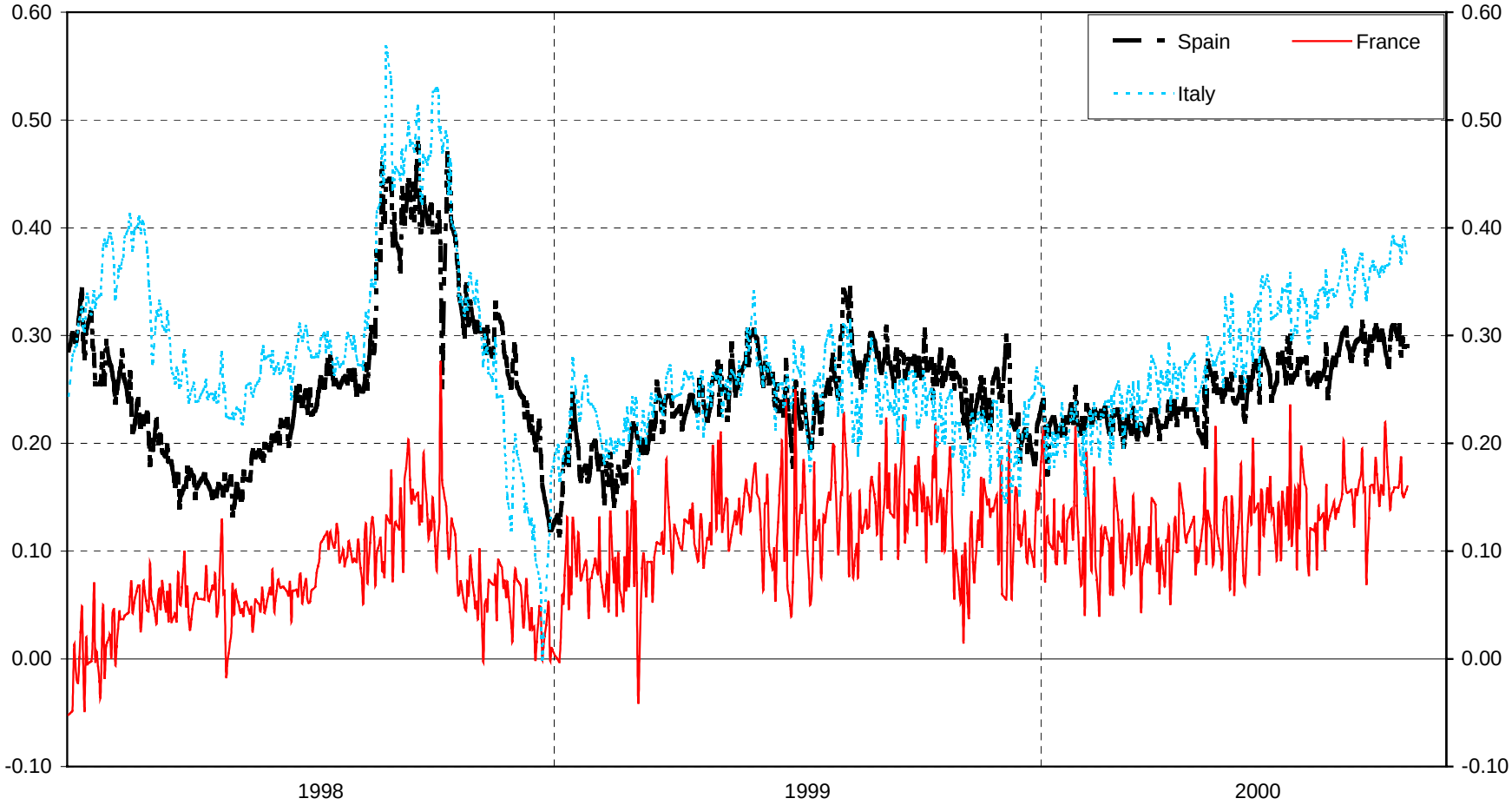


Chart 2

Euro 10-year spread vs German bund yield and corporate

(daily data; in percentage points)

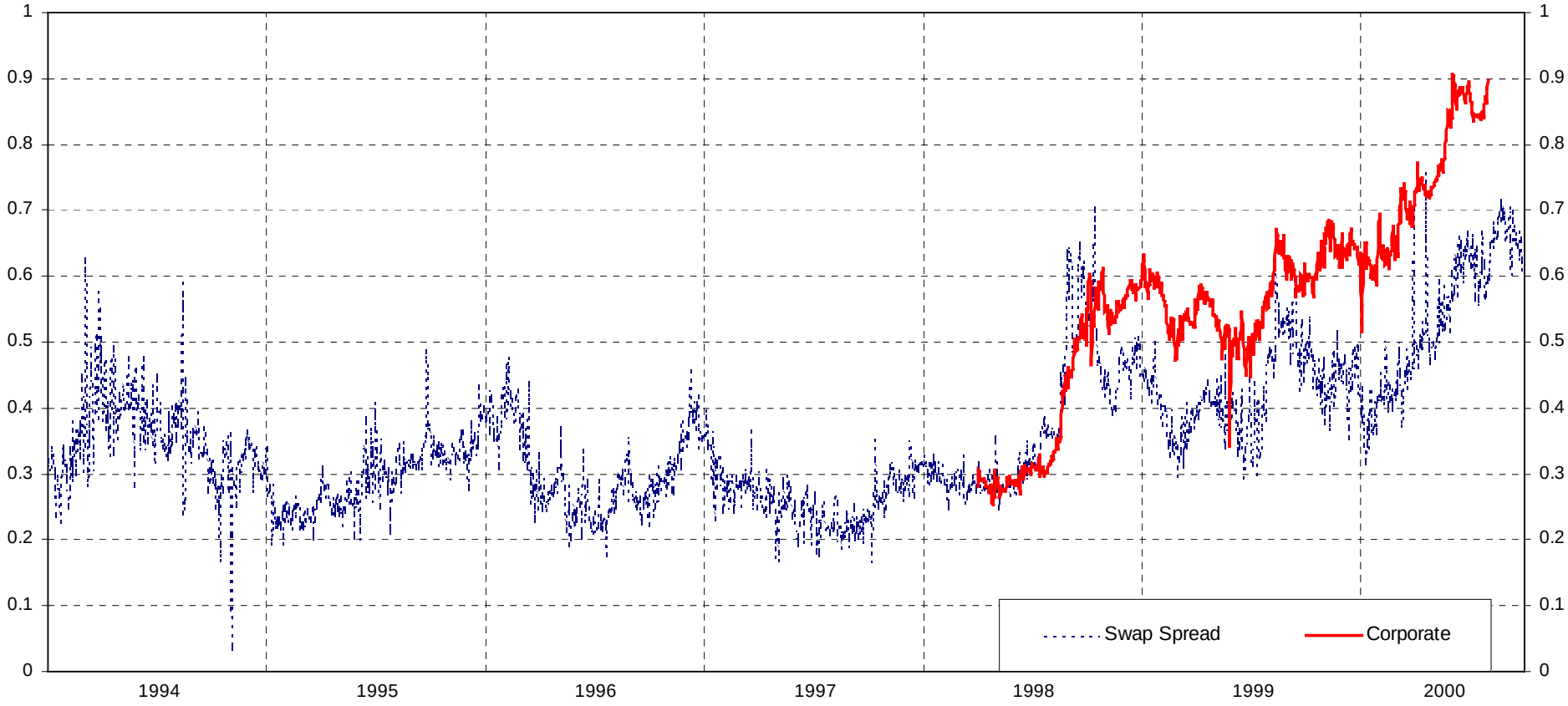


Chart 3

Estimated GARCH volatility of 10-year swap spread vs German bund

(daily data; in percentage points)

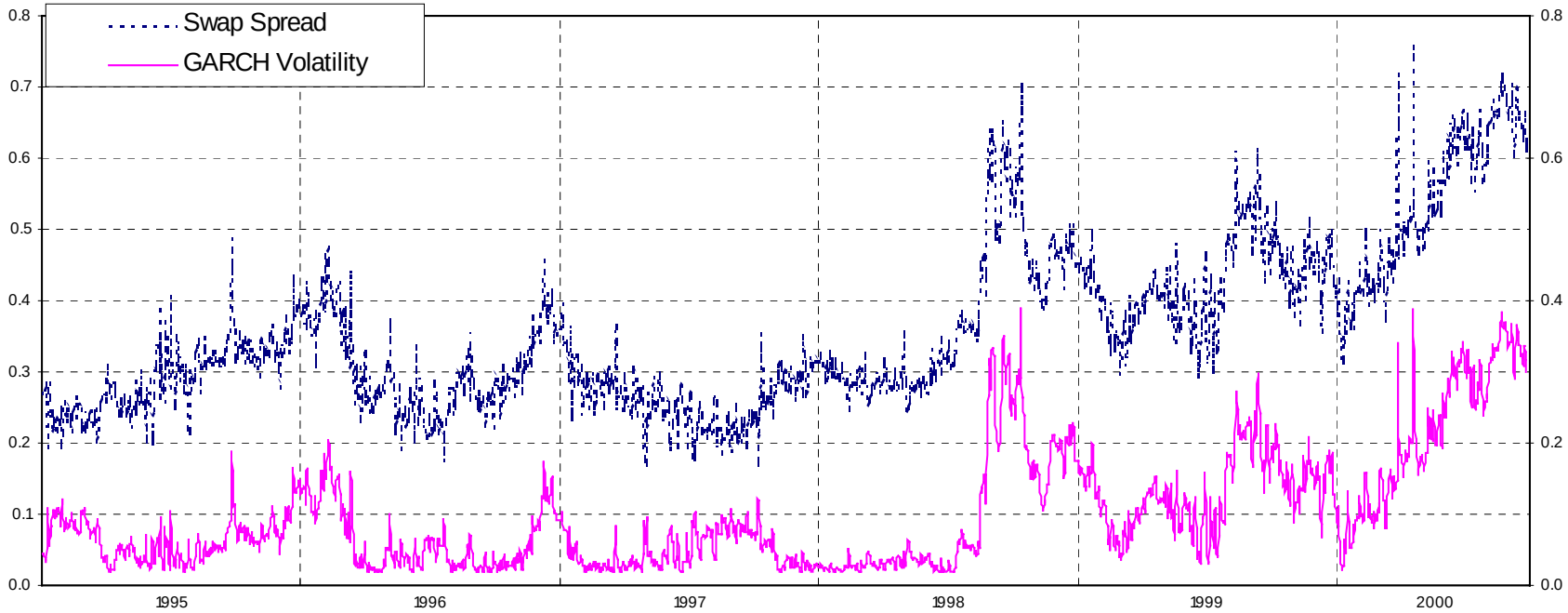


Chart 4

Common liquidity risk measure for the G5 countries

(daily data; in percentage points)

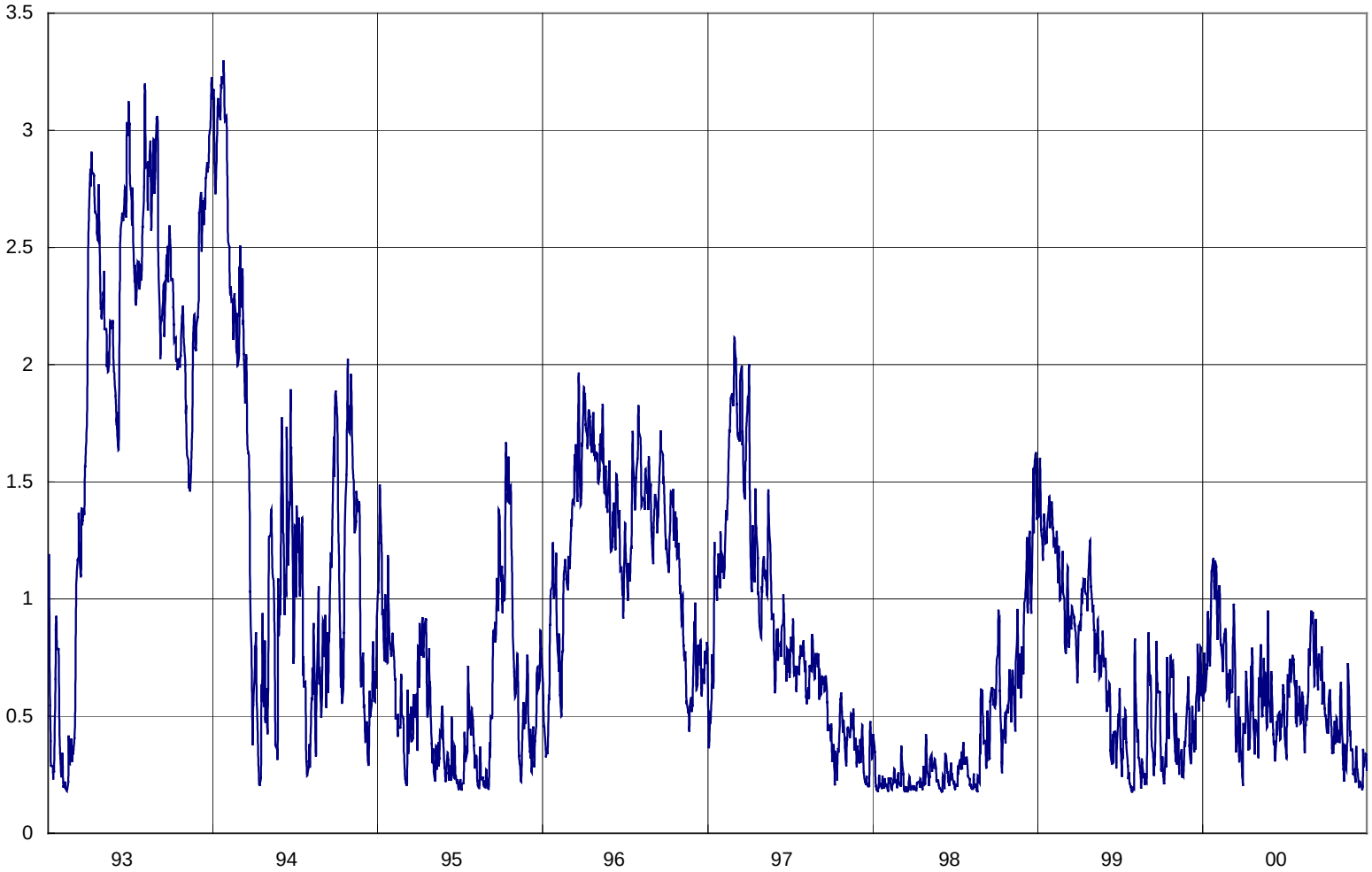


Chart 5

US, UK and euro area (France, Germany and Italy) government bond yields: deviation from fundamental values

(daily data; in percentage points)

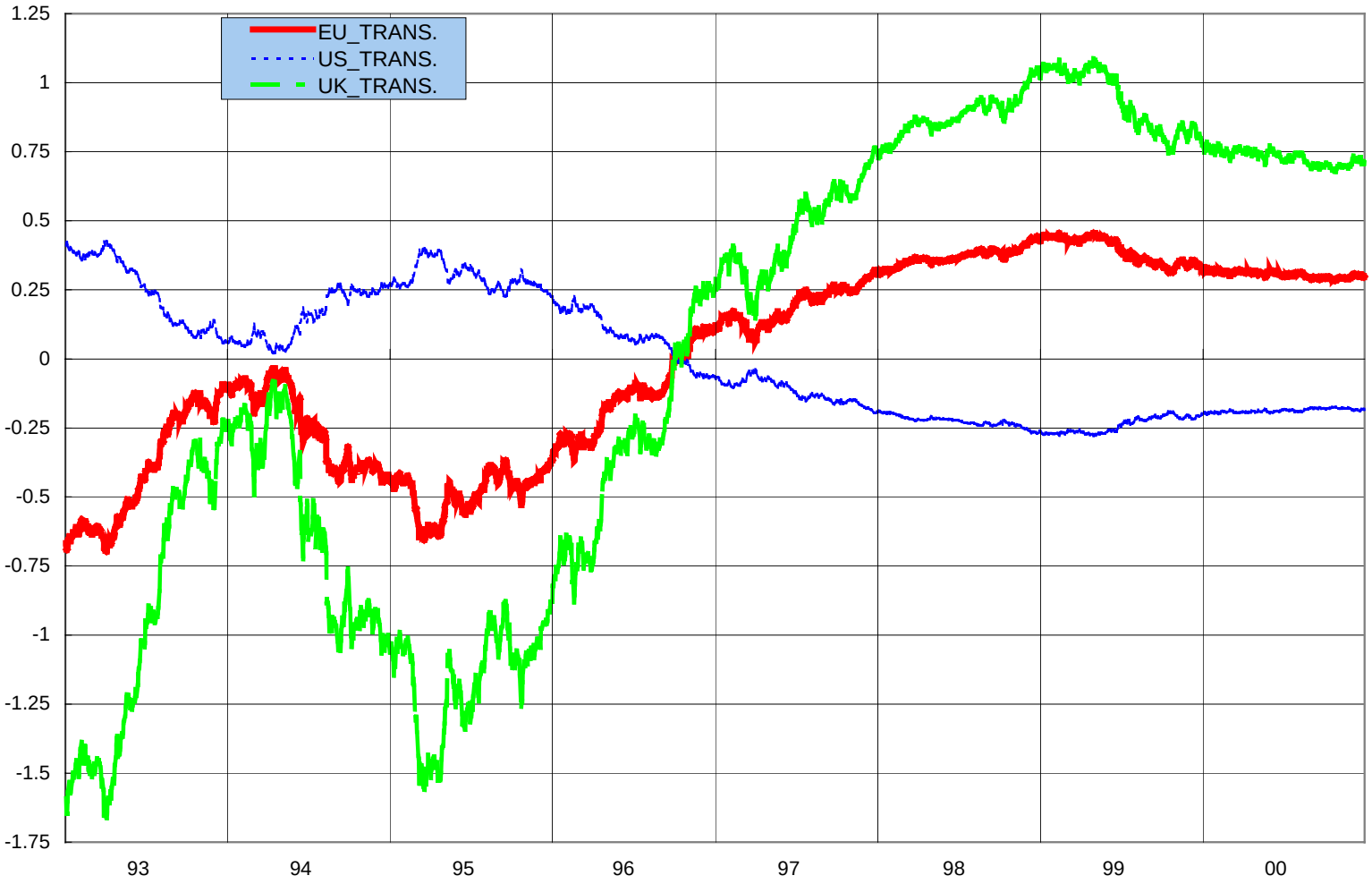
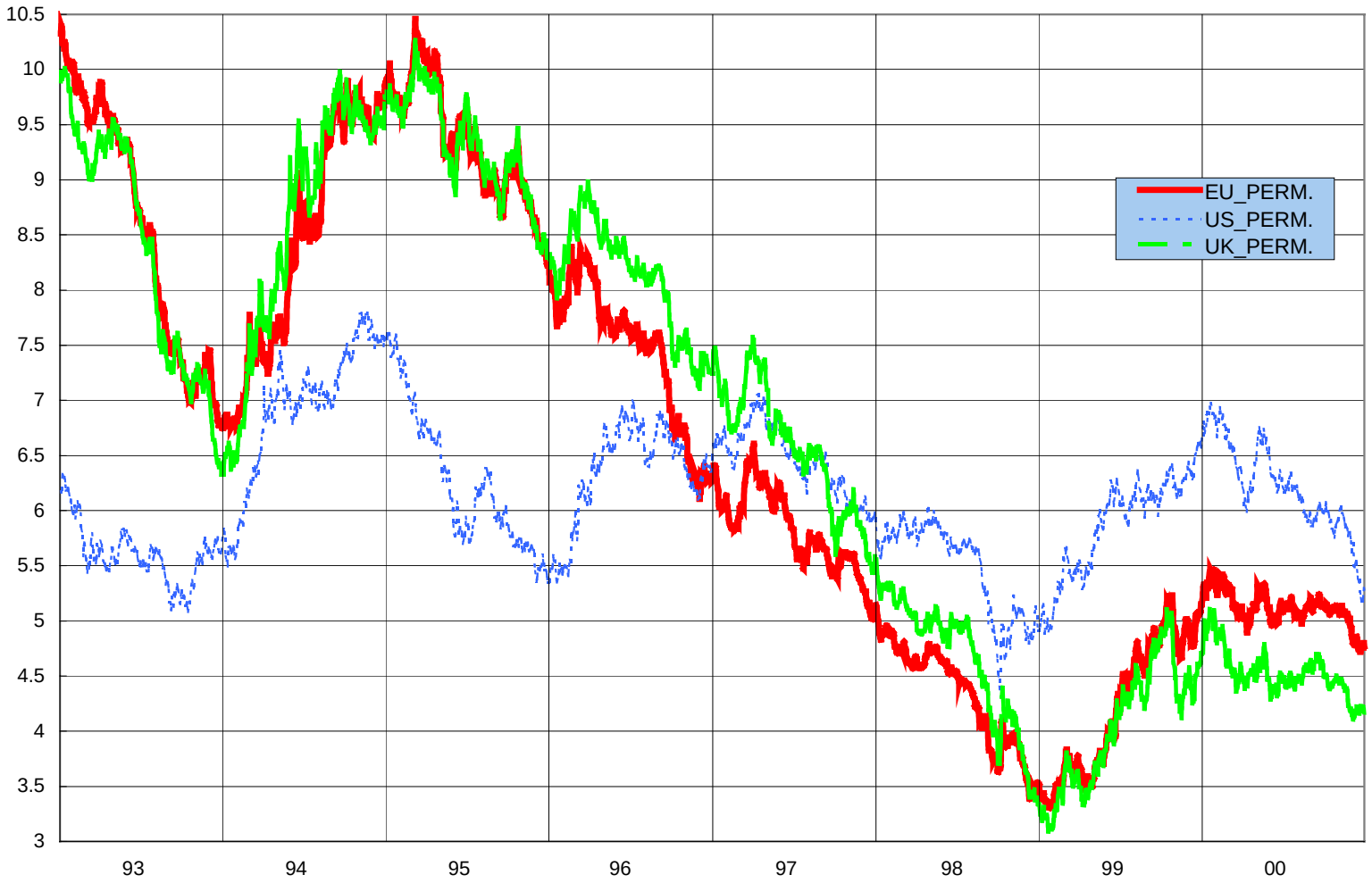


Chart 6

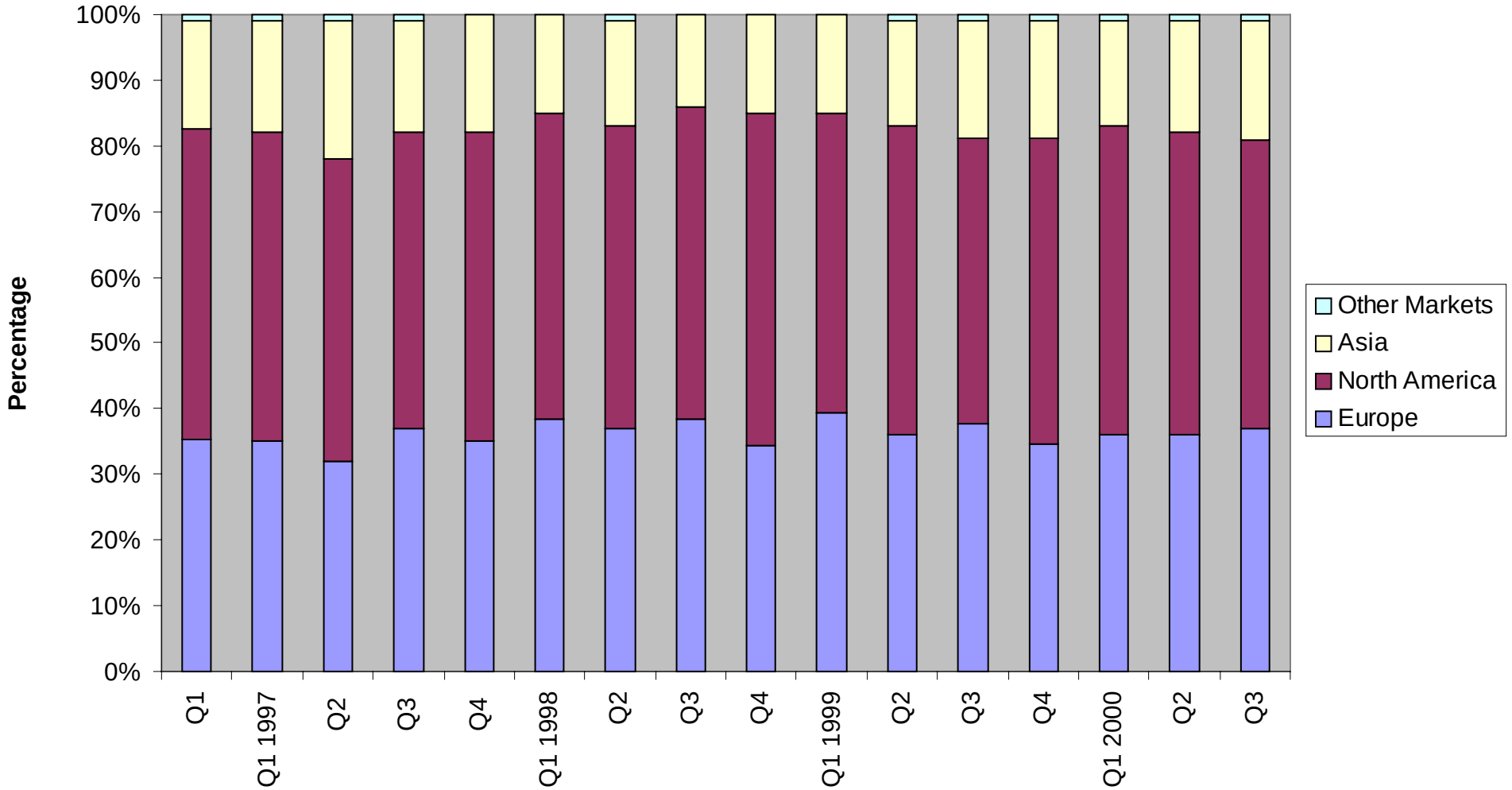
US, UK and euro area (France, Germany and Italy) 10-year government bond yield: fundamental (long-run) values

(daily data; in percentage points)



Annex 1

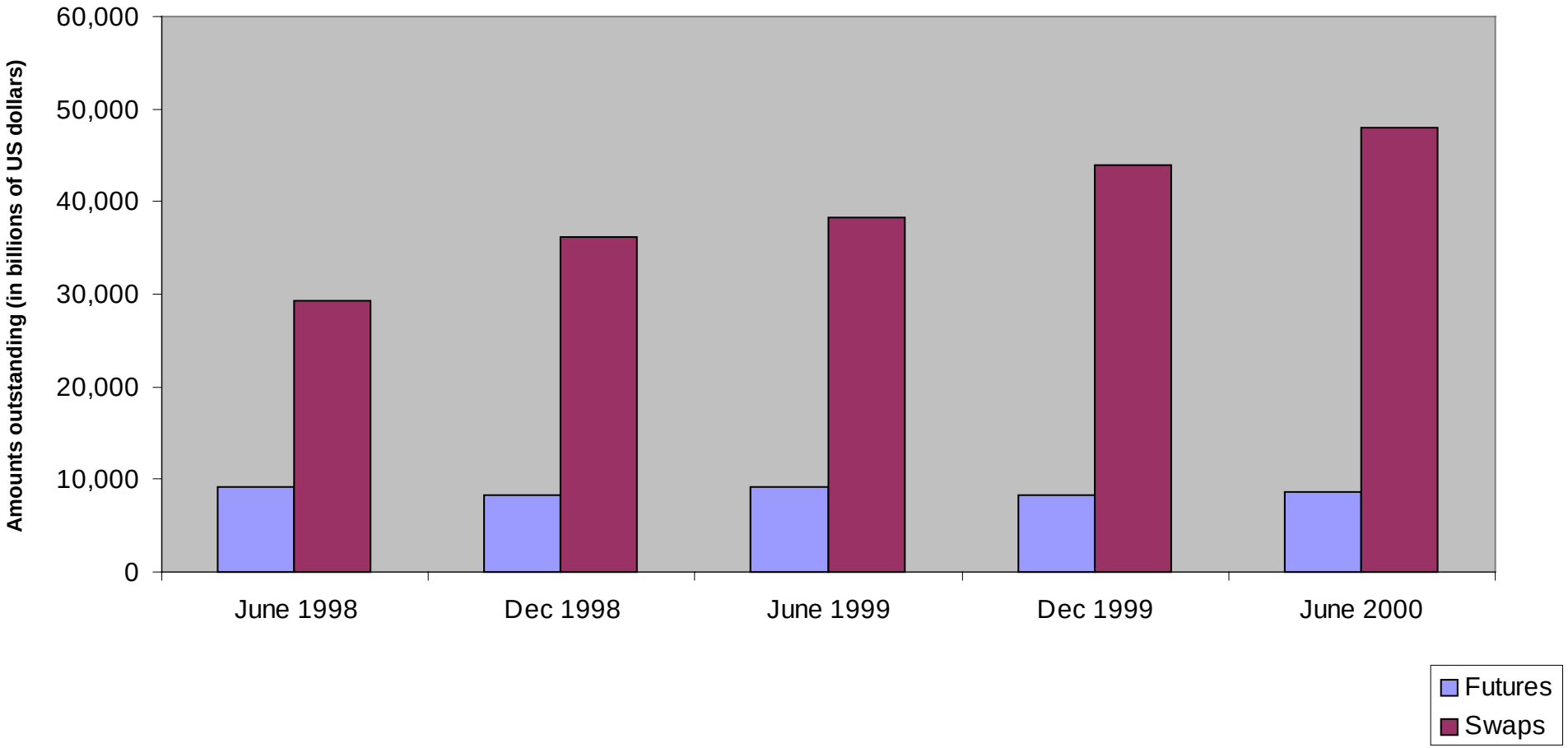
Turnover in exchange traded interest rate derivatives by location



Source: *BIS Quarterly Review.*

Annex 2

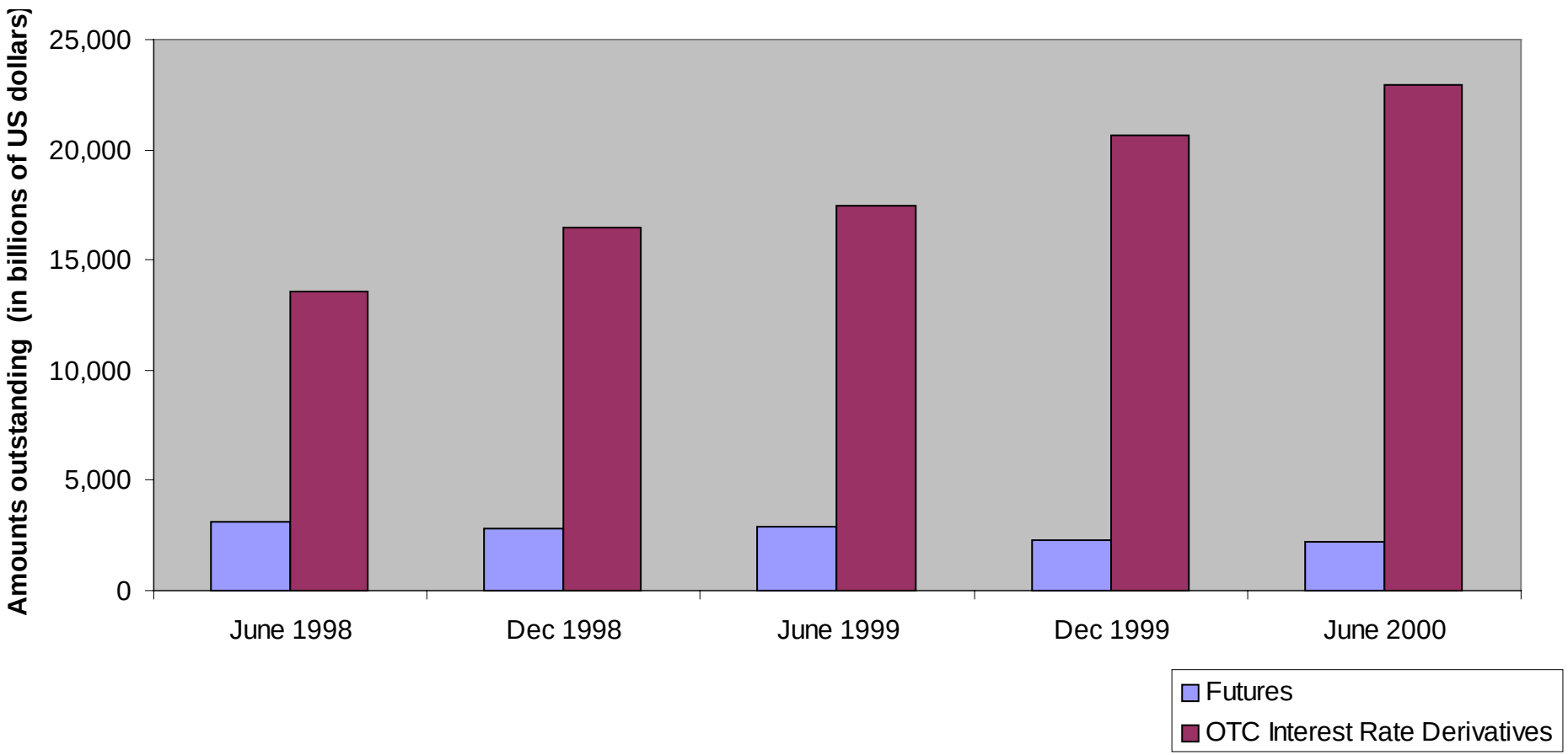
Amounts outstanding of OTC single currency interest rate swaps and exchange traded interest rate futures in all markets
(notional amounts in billions of US dollars)



Source: *BIS Quarterly Review.*

Annex 3

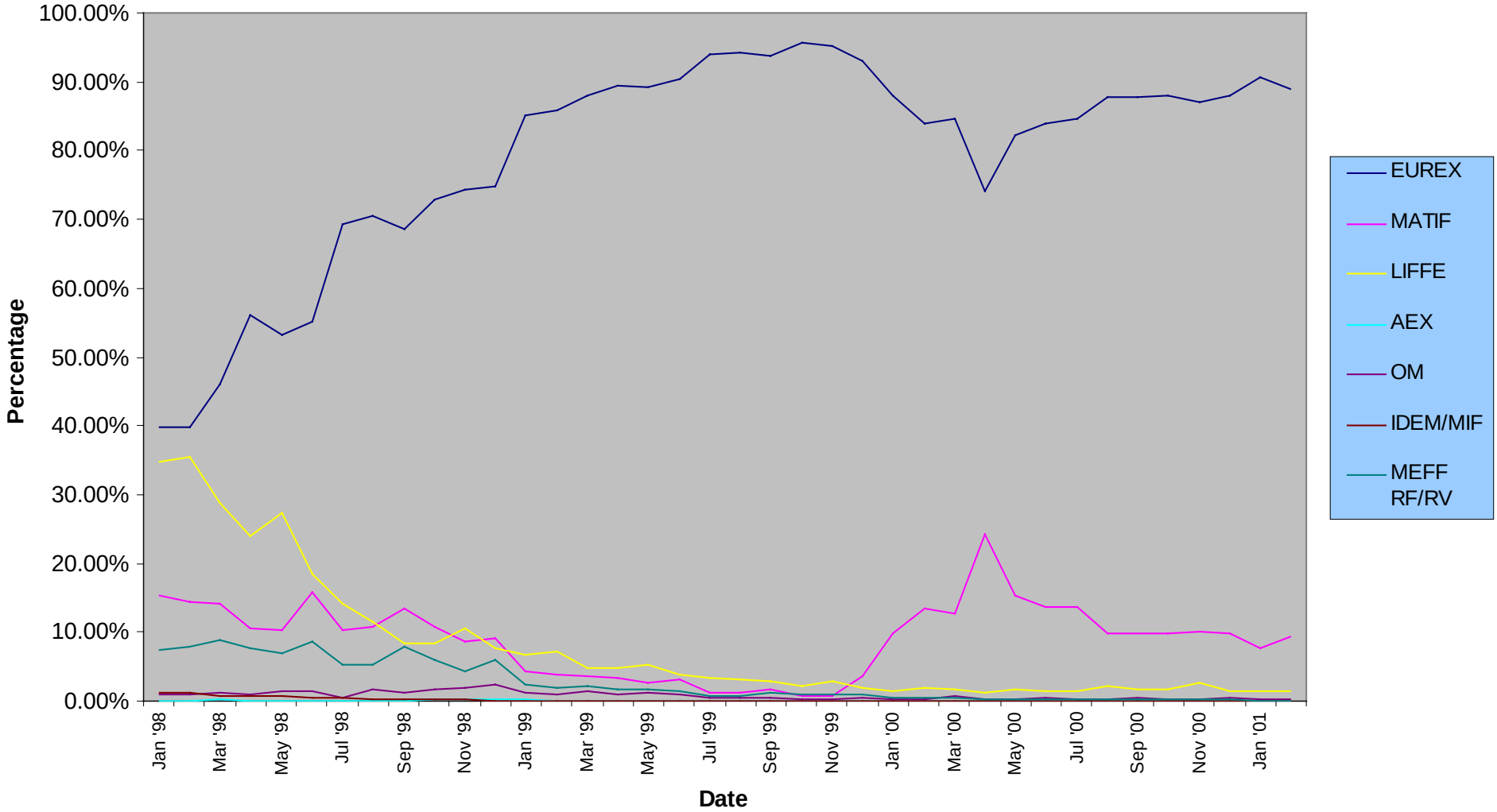
Amounts outstanding of OTC single currency interest rate derivatives and exchange traded interest rate futures in the euro area (notional amounts in billions of US dollars)



Source: *BIS Quarterly Review.*

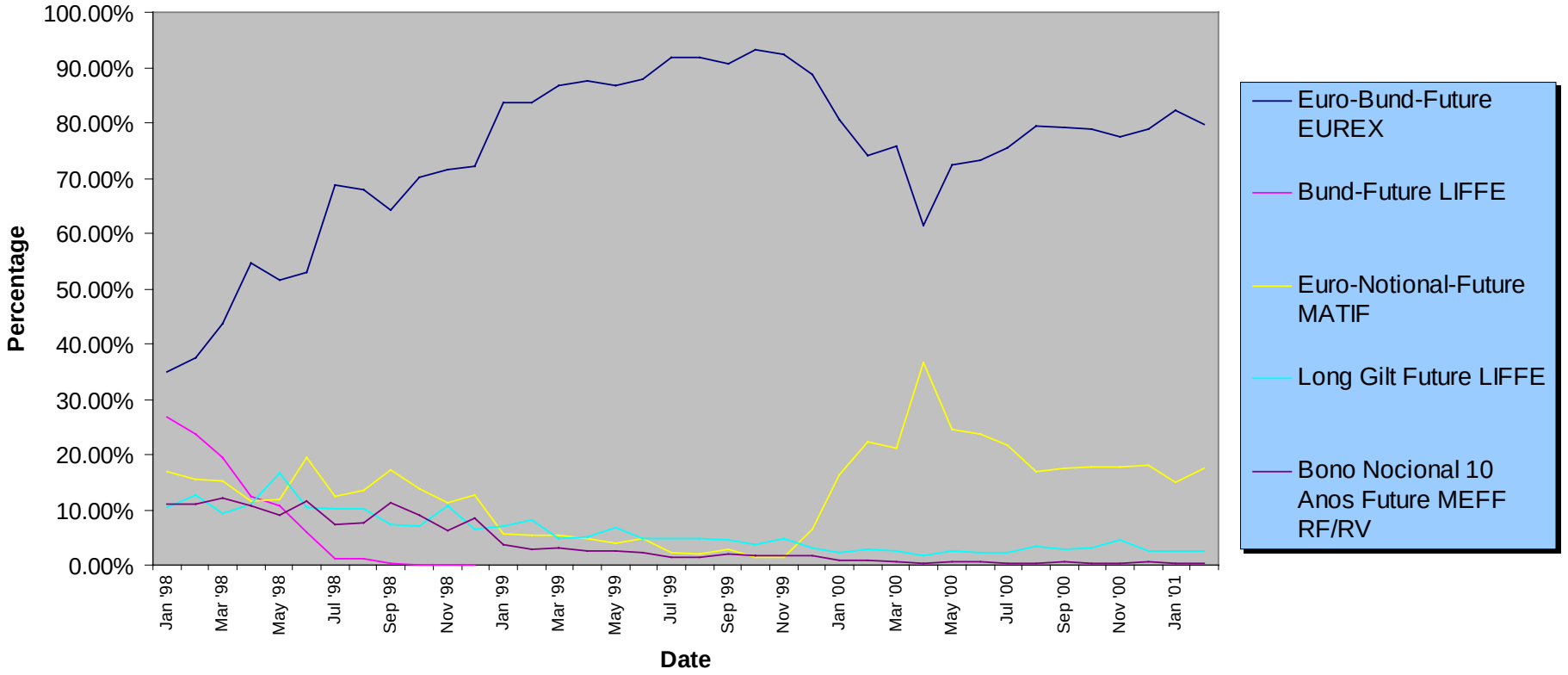
Annex 4

European futures exchanges - percentage of traded capital market products



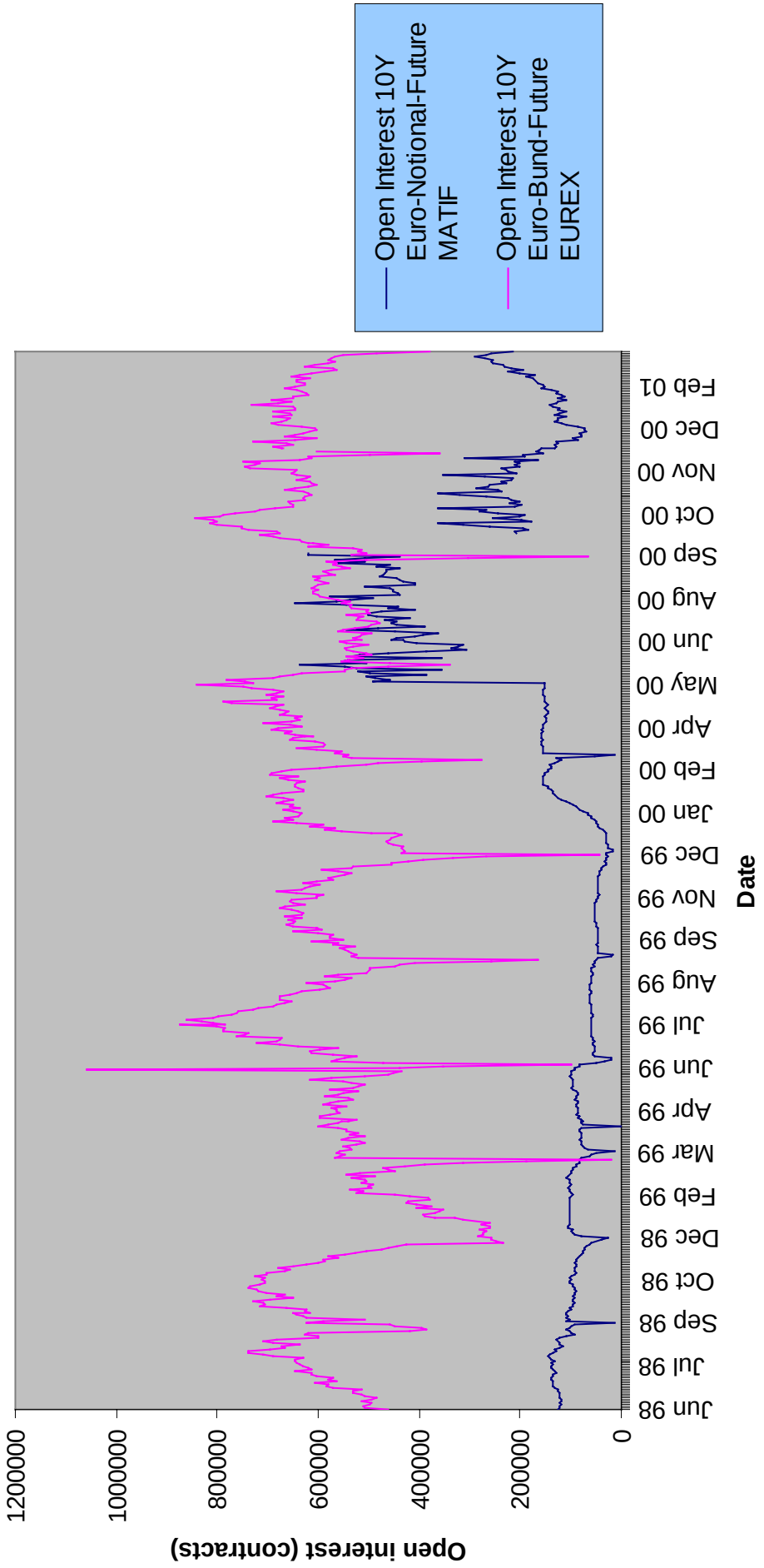
Annex 5

European 10Y capital market futures - traded contracts



Annex 6

Open interest 10Y futures EUREX/MATIF



Annex 7

Effect of a change in the notional contract coupon after the Euro Bund futures squeeze on the June 1999 delivery

Euro Bund futures contract: June 1999 delivery						
Contracts delivery date:	**10.06.1999**					
Bond No	113505	113507	113509	113510	113511	
Size (EUR millions)	15,339	8,692	13,805	14,000	11,000	
Coupon	5.25	4.75	4.125	3.75	4.00	
Maturity	04.01.2008	04.07.2008	04.07.2008	04.01.2009	04.07.2009	
Yield (ISMA in %)	6	6	6	6	6	
Duration	6.92	7.15	7.31	7.92	7.98	
Modified duration	6.52	6.75	6.90	7.47	7.53	Range: 1,01
Price	95.05	91.44	87.17	83.95	85.15	
Conversion factor (6%)	0.95049	0.914424	0.871737	0.839458	0.851507	
Converted price	***100.00***	***100.00***	***100.00***	***100.00***	***100.00***	Range: 0,00
Scenario1: Market yield level stays below the level of the notional contract coupon						
Yield (ISMA in %)	4	4	4	4	4	
Duration	7.05	7.32	7.47	8.07	8.18	
Modified duration	6.79	7.03	7.18	7.76	7.86	Range: 1,09
Price	108.90	105.61	100.93	98.03	99.96	
Converted price	***114.57***	115.49	115.78	116.77	117.39	Range: 2,82
Scenario 2: Relative yield change required to change the CTD bond						
Yield (ISMA in %)	***3.88***	4	4	4	4	
Duration	7.05	7.32	7.47	8.07	8.18	Range: 1,09
Modified duration	6.79	7.03	7.18	7.76	7.86	
Price	109.80	105.61	100.93	98.03	99.96	
Converted price	115.52	***115.49***	115.78	116.77	117.39	Range: 1,90
Scenario 3: The notional contract coupon is lowered to 4%, which was the market yield level on June 1999 delivery						
Conversion factor (4%)	1.088954	1.056048	1.009335	0.98027	0.999605	
Yield (ISMA in %)	4	4	4	4	4	
Duration	7.04	7.32	7.47	8.07	8.18	
Modified duration	6.77	7.03	7.18	7.76	7.86	Range: 1,09
Price	108.90	105.61	100.93	98.03	99.96	
Converted price	***100.00***	***100.00***	***100.00***	***100.00***	***100.00***	Range: 0,00
Scenario 4: Market yield level stays above the level of the adjusted notional contract coupon (4%)						
Yield (ISMA in %)	5	5	5	5	5	
Duration	6.98	7.23	7.39	8.00	8.08	
Modified duration	6.65	6.89	7.04	7.62	7.69	Range: 0,91
Price	101.68	98.21	93.74	90.65	92.19	
Converted price	93.37	92.99	92.88	92.48	***92.23***	Range: 1,14

The respective CTD bond is highlighted in each case.
The conversion factor for each deliverable bond is calculated according to the EUREX conversion factor formula; see EUREX circular 106/99 of 20 October 1999.

Annex 8.1

10Y Euro Bund futures contract (EUREX) vs 10Y Euro Notional futures contract (MATIF): September 1998 delivery

10Y Euro Bund futures contract September 1998 (09.06.98-08.09.98; delivery: 10.09.98)

Deliverable bonds	Start of accrued interest	Outstanding amount (Million Euro)	Coupon	Maturity	Conv. factor	Deliverable volume (Million Euro)	Open interest (high)	Days being CTD	Mod. duration	Yield
113503	25.04.1997	15.339	6	04.07.2007	0.999674	4,412.4 (29% of outst. amount)	738,281 (12.08.98)	63	6.85	4.275
113505	09.01.1998	15.339	5.25	04.01.2008	0.947629	25.4 (0.16% of outst. amount)		0	7.12	4.266
113507	10.07.1998	8.692	4.75	04.07.2008	0.909448			0	7.71	4.252
Total deliv. volume		39.370								

Nominal contract value: DEM 250,000

10Y Euro Notional futures contract September 1998 (16.06.98-14.09.98; delivery: 18.09.98)

Deliverable bonds	Start of accrued interest	Outstanding amount (Million Euro)	Coupon	Maturity	Conv. factor	Deliverable volume (Million Euro)	Open interest (high)	Days being CTD	Mod. duration	Yield
FR0000570665	25.10.1997	16,245	8.5	25.10.2008	1.227773	na	143,642 (10.08.98)	63	6.91	4.212
FR0000570574	25.04.1997	16,938	5.5	25.04.2007	0.99965			0	6.75	4.111
FR0000570590	25.10.1997	15,327	5.5	25.10.2007	0.999855			0	6.89	4.166
FR0000570632	25.04.1998	16,408	5.25	25.04.2008	0.981386			0	7.41	4.201
Total deliv. volume		64,918								

Nominal contract value: FRF 500,000

Sources: Bloomberg; Ministere de l'Economie des Finances et de l'Industrie: Monthly Report; Eurex: Monthly Report (Internet page: www.exchange.de); Clearnet: Bulletin for the delivery months.

Correlations (daily/weekly)

	Germany		France		Italy
	Benchmark bond	CTD bond	Benchmark bond	CTD bond	Benchmark bond
	113507	113503	570632	570665	
Bund future	0.847/0.805	0.880/0.948	0.898/0.886	0.889/0.884	0.593/0.379
Euro Notional future	0.879/0.920	0.895/0.972	0.919/0.960	0.920/0.955	0.690/0.621
DEM swaps	0.405/0.444	0.403/0.242	-	-	-
FRF swaps	-	-	0.665/0.608	0.676/0.606	-
ITL swaps	-	-	-	-	0.613/0.956

Daily period: 08.07.98-14.09.98. Weekly period: 17.07.98-11.09.98. Correlation is measured for futures by the effective daily/weekly price changes between futures and bonds, and for swaps by the effective daily/weekly yield changes between swaps and bonds.

Source: Bloomberg.

Annex 8.2

10Y Euro Bund futures contract (EUREX) vs 10Y Euro Notional futures contract (MATIF): December 1998 delivery

10Y Euro Bund futures contract December 1998 (09.09.98-08.12.98; delivery: 10.12.98)

Deliverable bonds	Start of accrued interest	Outstanding amount (Million Euro)	Coupon	Maturity	Conv. factor	Deliverable volume (Million Euro)	Open interest (high)	Days being CTD	Mod. duration	Yield
113503	25.04.1997	15.339	6	04.07.2007	0.999563	3,025.8 (19.7% of outst. amount)	767,452 (09.10.98)	63	6.66	3.895
113505	09.01.1998	15.339	5.25	04.01.2008	0.948987			0	6.94	3.854
113507	10.07.1998	8.692	4.75	04.07.2008	0.911092	3.19 (0.036% of outst. amount)		0	7.53	3.87
113509	30.10.1998	13,805	4.125	04.07.2008	0.866857			0	7.68	3.888
Total deliv. volume		53,175								

Nominal contract value: DEM 250,000

10Y Euro Notional futures contract December 1998 (15.09.98-14.12.98; delivery: 18.12.98)

Deliverable bonds	Start of accrued interest	Outstanding amount (Million Euro)	Coupon	Maturity	Conv. factor	Deliverable volume (Million Euro)	Open interest (high)	Days being CTD	Mod. duration	Yield
FR0000570665	25.10.1997	16,245	8.5	25.10.2008	1.223459	1,123.5 (6.92% of outst. amount)	109,367 (18.09.98)	64	7.16	3.862
FR0000570590	25.10.1997	15,327	5.5	25.10.2007	0.999824			0	7.03	3.824
FR0000570632	25.04.1998	24,703	5.25	25.04.2008	0.981761	50.5 (0.2% of outst. amount)		0	7.22	3.863
Total deliv. volume		56,275								

Nominal contract value: FRF 500,000

Sources: Bloomberg; Ministere de l'Economie des Finances et de l'Industrie: Monthly Report; Eurex: Monthly Report (Internet page: www.exchange.de); Clearnet: Bulletin for the delivery months.

Correlations (daily/weekly)

	Germany		France		Italy
	Benchmark bond	CTD bond	Benchmark bond	CTD bond	Benchmark bond
	113509	113503	571432	570665	
Bund future	0.821/0.917	0.854/0.952	0.849/0.961	0.849/0.966	0.600/0.871
Euro Notional future	0.674/0.921	0.722/0.922	0.799/0.923	0.772/0.920	0.534/0.709
DEM swaps	0.766/0.868	0.756/0.796	-	-	-
FRF swaps	-	-	0.792/0.951	0.820/0.963	-
ITL swaps	-	-	-	-	0.638/0.819

Daily period: 28.10.98-14.12.98. Weekly period: 06.11.98-11.12.98. Correlation is measured for futures by the effective daily/weekly price changes between futures and bonds, and for swaps by the effective daily/weekly yield changes between swaps and bonds.

Source: Bloomberg.

Annex 8.3

10Y Euro Bund futures contract (EUREX) vs 10Y Euro Notional futures contract (MATIF): March 1999 delivery

10Y Euro Bund futures contract March 1999 (09.12.98-08.03.99; delivery: 10.03.99)

Deliverable bonds	Start of accrued interest	Outstanding amount (Million Euro)	Coupon	Maturity	Conv. factor	Deliverable volume (Million Euro)	Open interest (high)	Days being CTD	Mod. duration	Yield
113505	09.01.1998	15.339	5.25	04.01.2008	0.949788	3,052.1 (19.9% of outst. amount)	591,424 (23.02.99)	58	7.01	4.089
113507	10.07.1998	8.692	4.75	04.07.2008	0.912935			0	7.26	4.077
113509	30.10.1998	13,805	4.125	04.07.2008	0.869567			0	7.41	4.094
113510	08.01.1999	14,000	3.750	04.01.2009	0.837267	11 (0.078% of outst. amount)		0	7.99	4.054
Total deliv. volume		37,836								

Delivered vol.: Bund future: 19,385 Contracts: 2,477.8 Mio Euro Nominal contract value: DEM 250,000
Euro ^Bund future: 5,743 Contracts: 574.3 Mio Euro Nominal contract value: Euro 100,000

10Y Euro Notional futures contract March 1999 (15.12.98-15.03.99; delivery: 19.03.99)

Deliverable bonds	Start of accrued interest	Outstanding amount (Million Euro)	Coupon	Maturity	Conv. factor	Deliverable volume (Million Euro)	Open interest (high)	Days being CTD	Mod. duration	Yield
FR0000570665	25.10.1997	16,245	8.5	25.10.2008	1.218868	1,125.7 (6.93% of outst. amount)	107,576 (19.02.99)	24	6.89	4.051
FR0000570590	25.10.1997	15,327	5.5	25.10.2007	0.999651			38	6.77	4.000
FR0000570632	25.04.1998	24,703	5.25	25.04.2008	0.982317			0	6.95	4.054
FR0000571432	25.04.1998	19,291	4	25.04.2009	0.885896				8.09	4.116
Total deliv. volume		75,566								

Nominal contract value: Euro 100,000

Sources: Bloomberg; Ministere de l'Economie des Finances et de l'Industrie: Monthly Report; Eurex: Monthly Report (Internet page: www.exchange.de); Clearnet: Bulletin for the delivery months.

Correlations (daily/weekly)

	Germany		France		Italy
	Benchmark bond	CTD bond	Benchmark bond	CTD bond	Benchmark bond
	113510	113505	571432	570665	
Bund future	0.850/0.777	0.865/0.837	0.862/0.825	0.851/0.845	0.824/0.618
Euro Notional future	0.951/0.955	0.958/0.966	0.966/0.961	0.964/0.978	0.910/0.878
Euro swaps	0.908/0.958	0.915/0.956	0.907/0.974	0.899/0.963	0.923/0.970

Daily period: 06.01.99-05.03.99. Weekly period: 15.01.99-05.03.99. Correlation is measured for futures by the effective daily/weekly price changes between futures and bonds, and for swaps by the effective daily/weekly yield changes between swaps and bonds.

Source: Bloomberg.

Annex 8.4

10Y Euro Bund futures contract (EUREX) vs 10Y Euro Notional futures contract (MATIF): June 1999 delivery

10Y Euro Bund futures contract June 1999 (09.03.99-08.06.99; delivery 10.06.99)

Deliverable bonds	Start of accrued interest	Outstanding amount (Million Euro)	Coupon	Maturity	Conv. factor	Deliverable volume (Million Euro)	Open interest (high)	Days being CTD	Mod. duration	Yield
113505	09.01.1998	15.339	5.25	04.01.2008	0.950792	5,441.3 (35.5% of outst. amount)	1,057,000 (01.06.99)	59	6.75	4.226
113507	10.07.1998	8.692	4.75	04.07.2008	0.914979			0	7	4.23
113509	30.10.1998	13,805	4.125	04.07.2008	0.872468			0	7.14	4.246
113510	08.01.1999	14,000	3.750	04.01.2009	0.840315			0	7.73	4.225
113511	26.03.1999	11,000	4.000	04.07.2009	0.852798				8.06	4.228
Total deliv. volume		62,836								

10Y Euro Notional futures contract June 1999 (16.03.99-14.06.99; delivery: 18.06.99)

Deliverable bonds	Start of accrued interest	Outstanding amount (Million Euro)	Coupon	Maturity	Conv. factor	Deliverable volume (Million Euro)	Open interest (high)	Days being CTD	Mod. duration	Yield
Bund 113505	09.01.1998	15,339	5.25	04.01.2008	1.127267		101,309 (26.05.99)	0	6.71	4.355
OAT FR0000570632	25.04.1998	25,292	5.25	25.04.2008	1.131264			6	7	4.375
Bund 113507	10.07.1998	8,692	4.75	04.07.2008	1.095524			0	6.96	4.358
OAT FR0000570665	25.10.1997	16,245	8.5	25.10.2008	1.393006			0	6.6	4.38
Bund 113509	30.10.1998	13,805	4.125	04.07.2008	1.047747			5	7.11	4.367
Bund 113510	08.01.1999	14,000	3.750	04.01.2009	1.019853			0	7.7	4.329
OAT FR0000571432	25.04.1998	22,522	4.000	25.04.2009	1.041014	1,251.1 (5.56% of outst. amount)		38	7.9	4.454
Bund 113511	26.03.1999	11,000	4.000	04.07.2009	1.041412			15	8.03	4.312
Total deliv. volume		126,895								

Basket of deliverable bonds changed by MATIF on June 1999 delivery: dual issuer basket with French and German issues. In addition, notional coupon lowered from 5.5% to 3.5%.

Sources: Bloomberg; Ministere de l'Economie des Finances et de l'Industrie: Monthly Report; Eurex: Monthly Report (Internet page: www.exchange.de); Clearnet: Bulletin for the delivery months.

Correlations (daily/weekly)

	Germany		France		Italy
	Benchmark bond	CTD bond	Benchmark bond	CTD bond	Benchmark bond
	113511	113505	571432	571432	
Euro Bund future	0.791/0.929	0.817/0.968	0.808/0.933	0.808/0.933	0.715/0.928
Euro Notional future	0.910/0.918	0.908/0.944	0.938/0.943	0.938/0.943	0.916/0.937
Euro swaps	0.715/0.866	0.720/0.884	0.732/0.897	0.732/0.897	0.667/0.897

Daily period: 23.03.99-14.06.99. Weekly period: 02.04.99-11.06.99. Correlation is measured for futures by the effective daily/weekly price changes between futures and bonds, and for swaps by the effective daily/weekly yield changes between swaps and bonds.

Source: Bloomberg.

Annex 8.5

10Y Euro Bund futures contract (EUREX) vs 10Y Euro Notional futures contract (MATIF): September 1999 delivery

10Y Euro Bund futures contract September 1999 (09.06.99-08.09.99; delivery: 10.09.99)

Deliverable bonds	Start of accrued interest	Outstanding amount (Million Euro)	Coupon	Maturity	Conv. factor	Deliverable volume (Million Euro)	Open interest (high)	Days being CTD	Mod. duration	Yield
113507	10.07.1998	8,692	4.75	04.07.2008	0.916530	1,050.3 (12.1% of outst. amount)	872,127 (13.07.99)	60	6.97	5.009
113509	30.10.1998	13,805	4.125	04.07.2008	0.874958	20 (0.14% of outst. amount)		4	7.1	5.016
113510	08.01.1999	14,000	3.750	04.01.2009	0.843546			0	7.37	5.005
113511	26.03.1999	11,000	4.000	04.07.2009	0.855312			0	7.7	4.992
113512	09.07.1999	20,000	4.500	04.07.2009	0.891403			0	7.65	5.008
Total deliv. volume		67,497								

10Y Euro Notional futures contract September 1999 (15.06.99-13.09.99; delivery: 17.09.99)

Deliverable bonds	Start of accrued interest	Outstanding amount (Million Euro)	Coupon	Maturity	Conv. factor	Deliverable volume (Million Euro)	Open interest (high)	Days being CTD	Mod. duration	Yield
OAT FR0000570632	25.04.1998	25,292	5.25	25.04.2008	1.127991		63,305 (03.08.99)	0	6.67	5.129
Bund 113507	10.07.1998	8,692	4.75	04.07.2008	1.093188			0	6.95	5.115
OAT FR0000570665	25.10.1997	16,245	8.5	25.10.2008	1.384281			0	6.24	5.112
Bund 113509	30.10.1998	13,805	4.125	04.07.2008	1.046547			0	7.08	5.118
Bund 113510	08.01.1999	14,000	3.750	04.01.2009	1.019432			0	7.35	5.109
OAT FR0000571432	25.04.1998	22,522	4.000	25.04.2009	1.040059			0	7.56	5.189
Bund 113511	26.03.1999	11,000	4.000	04.07.2009	1.040488			0	7.68	5.089
Bund 113512	09.07.1999	20,000	4.500	04.07.2009	1.081669			0	7.63	5.109
OAT FR0000186199	25.10.1999	13,697	4	25.10.2009	1.041905	1,685.6 (12.3% of outst. amount)		65	7.69	5.24
Total deliv. volume		145,253								

Sources: Bloomberg; Ministere de l'Economie des Finances et de l'Industrie: Monthly Report; Eurex: Monthly Report (Internet page: www.exchange.de); Clearnet: Bulletin for the delivery months.

Correlations (daily/weekly)

	Germany		France		Italy
	Benchmark bond	CTD bond	Benchmark bond	CTD bond	Benchmark bond
	113512	113507	186199	186199	
Euro Bund future	0.847/0.932	0.842/0.947	0.867/0.929	0.867/0.929	0.656/0.924
Euro Notional future	0.936/0.986	0.940/0.993	0.944/0.987	0.944/0.987	0.803/0.984
Euro swaps	0.834/0.943	0.827/0.936	0.863/0.950	0.863/0.950	0.627/0.942

Daily period: 07.07.99-13.09.99. Weekly period: 16.07.99-10.09.99. Correlation is measured for futures by the effective daily/weekly price changes between futures and bonds, and for swaps by the effective daily/weekly yield changes between swaps and bonds.

Source: Bloomberg.

Annex 8.6

10Y Euro Bund futures contract (EUREX) vs 10Y Euro Notional futures contract (MATIF): December 1999 delivery

10Y Euro Bund futures contract December 1999 (09.09.99-08.12.99; delivery: 10.12.99)

Deliverable bonds	Start of accrued interest	Outstanding amount (Million Euro)	Coupon	Maturity	Conv. factor	Deliverable volume (Million Euro)	Open interest (high)	Days being CTD	Mod. duration	Yield
113507	10.07.1998	8.692	4.75	04.07.2008	0.917801	748.2 (8.6% of outst. amount)	682,910 (05.11.99)	61	6.73	5.039
113509	30.10.1998	13,805	4.125	04.07.2008	0.876915	0.2 (0.001% of outst. amount)		2	6.86	5.042
113510	08.01.1999	14,000	3.750	04.01.2009	0.846008			0	7.13	5.034
113511	26.03.1999	11,000	4.000	04.07.2009	0.856929			0	7.46	5.033
113512	09.07.1999	20,000	4.500	04.07.2009	0.892856			0	7.4	5.07
113513	22.10.1999	11,000	5.375	04.01.2010	0.953223				7.62	5.063
Total deliv. volume		78,497								

10Y Euro Notional futures contract December 1999 (14.09.99-13.12.99; delivery: 17.12.99)

Deliverable bonds	Start of accrued interest	Outstanding amount (Million Euro)	Coupon	Maturity	Conv. factor	Deliverable volume (Million Euro)	Open interest (high)	Days being CTD	Mod. duration	Yield
Bund 113507	10.07.1998	8,692	4.75	04.07.2008	1.090849		53,975 (26.10.99)	0	6.73	4.989
OAT FR0000570665	25.10.1997	16,245	8.5	25.10.2008	1.375275			0	6.45	4.946
Bund 113509	30.10.1998	13,805	4.125	04.07.2008	1.045350			0	6.86	4.988
Bund 113510	08.01.1999	14,000	3.750	04.01.2009	1.019088			0	7.13	4.982
OAT FR0000571432	25.04.1998	22,522	4.000	25.04.2009	1.039181			0	7.34	5.066
Bund 113511	26.03.1999	11,000	4.000	04.07.2009	1.039643			0	7.46	4.983
Bund 113512	09.07.1999	20,000	4.500	04.07.2009	1.079848			0	7.41	5.015
OAT FR0000186199	25.10.1999	20,821	4	25.10.2009	1.041025	1,122 (5.39% of outst. amount)		65	7.81	5.12
Bund 113513	22.10.1999	11,000	5.375	04.01.2010	1.156354			0	7.62	5.015
Total deliv. volume		138,085								

Sources: Bloomberg; Ministere de l'Economie des Finances et de l'Industrie: Monthly Report; Eurex: Monthly Report (Internet page: www.exchange.de); Clearnet: Bulletin for the delivery months.

Correlations (daily/weekly)

	Germany		France		Italy
	Benchmark bond	CTD bond	Benchmark bond	CTD bond	Benchmark bond
	113513	113507	186199	186199	
Euro Bund future	0.939/0.985	0.938/0.979	0.931/0.978	0.931/0.978	0.835/0.965
Euro Notional future	0.965/0.982	0.971/0.978	0.973/0.987	0.973/0.987	0.930/0.972
Euro swaps	0.933/0.966	0.938/0.958	0.932/0.951	0.932/0.951	0.848/0.937

Daily period: 20.10.99-13.12.99. Weekly period: 29.10.99-10.12.99. Correlation is measured for futures by the effective daily/weekly price changes between futures and bonds, and for swaps by the effective daily/weekly yield changes between swaps and bonds.

Source: Bloomberg.

Annex 8.7

10Y Euro Bund futures contract (EUREX) vs 10Y Euro Notional futures contract (MATIF): March 2000 delivery

10Y Euro Bund futures contract March 2000 (09.12.99-08.03.00; delivery: 10.03.00)

Deliverable bonds	Start of accrued interest	Outstanding amount (Million Euro)	Coupon	Maturity	Conv. factor	Deliverable volume (Million Euro)	Open interest (high)	Days being CTD	Mod. duration	Yield
113510	08.01.1999	14,000	3.750	04.01.2009	0.849146	107.6 (0.77% of outst. amount)	703,749 (03.02.00)	2	7.13	5.443
113511	26.03.1999	11,000	4.000	04.07.2009	0.859902	5 (0.45% of outst. amount)		0	7.16	5.445
113512	09.07.1999	20,000	4.500	04.07.2009	0.894982	1,366 (6.83% of outst. amount)		59	7.11	5.46
113513	22.10.1999	20,000	5.375	04.01.2010	0.953876			0	7.32	5.449
Total deliv. volume		65,000								

10Y Euro Notional futures contract March 2000 (14.12.99-13.03.00; delivery: 17.03.00)

Deliverable bonds	Start of accrued interest	Outstanding amount (Million Euro)	Coupon	Maturity	Conv. factor	Deliverable volume (Million Euro)	Open interest (high)	Days being CTD	Mod. duration	Yield
OAT FR0000570665	25.10.1997	16,799	8.5	25.10.2008	1.366054		155,639 (14.02.00)	0	6.17	5.298
Bund 113510	08.01.1999	14,000	3.750	04.01.2009	1.018574			0	7.14	5.313
OAT FR0000571432	25.04.1998	22,522	4.000	25.04.2009	1.038381			0	7.06	5.395
Bund 113511	26.03.1999	11,000	4.000	04.07.2009	1.038875			0	7.17	5.319
Bund 113512	09.07.1999	20,000	4.500	04.07.2009	1.078107			0	7.12	5.331
OAT FR0000186199	25.10.1999	23,874	4	25.10.2009	1.040069	1,125.4 (4.71% of outst. amount)		64	7.53	5.421
Bund 113513	22.10.1999	11,000	5.375	04.01.2010	1.152988			0	7.34	5.321
Total deliv. volume		119,195								

Sources: Bloomberg; Ministere de l'Economie des Finances et de l'Industrie: Monthly Report; Eurex: Monthly Report (Internet page: www.exchange.de); Clearnet: Bulletin for the delivery months.

Correlations (daily/weekly)

	Germany		France		Italy
	Benchmark bond	CTD bond	Benchmark bond	CTD bond	Benchmark bond
	113513	113512	186199	186199	
Euro Bund future	0.839/0.895	0.897/0.906	0.903/0.928	0.903/0.928	0.807/0.804
Euro Notional future	0.877/0.962	0.961/0.966	0.956/0.960	0.956/0.960	0.898/0.899
Euro swaps	0.824/0.824	0.890/0.843	0.897/0.884	0.897/0.884	0.768/0.683

Daily period: 10.12.99-13.03.00. Weekly period: 17.12.99-10.03.00. Correlation is measured for futures by the effective daily/weekly price changes between futures and bonds, and for swaps by the effective daily/weekly yield changes between swaps and bonds.

Source: Bloomberg.

Annex 8.8

10Y Euro Bund futures contract (EUREX) vs 10Y Euro Notional futures contract (MATIF): June 2000 delivery

10Y Euro Bund futures contract June 2000 (09.03.00-08.06.00; delivery: 12.06.00)

Deliverable bonds	Start of accrued interest	Outstanding amount (Million Euro)	Coupon	Maturity	Conv. factor	Deliverable volume (Million Euro)	Open interest (high)	Days being CTD	Mod. duration	Yield
113510	08.01.1999	14,000	3.750	04.01.2009	0.852420	4,329.2 (30.9% of outst.amount)	842,199 (19.05.00)	36	6.92	5.233
113511	26.03.1999	11,000	4.000	04.07.2009	0.863172			0	6.95	5.221
113512	09.07.1999	20,000	4.500	04.07.2009	0.897383			25	6.9	5.222
113513	22.10.1999	20,000	5.375	04.01.2010	0.954764			0	7.12	5.196
113515	05.05.2000	8,000	5.250	04.07.2010	0.944136			0	7.64	5.178
Total deliv. volume		73,000								

10Y Euro Notional futures contract June 2000 (14.03.00-19.06.00; delivery: 23.06.00)

Deliverable bonds	Start of accrued interest	Outstanding amount (Million Euro)	Coupon	Maturity	Conv. factor	Deliverable volume (Million Euro)	Open interest (high)	Days being CTD	Mod. duration	Yield
Bund 113510	08.01.1999	14,000	3.750	04.01.2009	1.018025		159,373 (23.03.00)	0	6.91	5.145
OAT FR0000571432	25.04.1998	22,522	4.000	25.04.2009	1.037395	0.2 (0.0009% of outst. amount)	637,010 (06.06.00)	0	7.13	5.276
Bund 113511	26.03.1999	11,000	4.000	04.07.2009	1.038136			0	6.94	5.128
Bund 113512	09.07.1999	20,000	4.500	04.07.2009	1.076324			0	6.9	5.127
OAT FR0000186199	25.10.1999	23,874	4	25.10.2009	1.039126	867.5 (3.63% of outst. amount)		8	7.3	5.272
Bund 113513	22.10.1999	11,000	5.375	04.01.2010	1.149461			0	7.11	5.121
OAT FR0000186603	25.04.1999	13,201	5.5	25.04.2010	1.164066	0.1 (0.0008% of outst. amount)		58	7.42	5.271
Bund 113515	05.05.2000	8,000	5.250	04.07.2010	1.145740			1	7.63	5.104
Total deliv. volume		123,597								

Calculation of open interest changed by MATIF on 23.05.00 from net open interest to gross open interest; EUREX calculates net open interest.
Example: There are two clients for one member: First client: 10 long, 20 short, Second client: 50 long, 30 short, Sum: 60 long, 50 short; Net open interest: 10 long=10; Gross open interest: 10 short and 20 long=30.

Sources: Bloomberg; Ministere de l'Economie des Finances et de l'Industrie: Monthly Report; Eurex: Monthly Report (Internet page: www.exchange.de); Clearnet: Bulletin for the delivery months.

Correlations (daily/weekly)

	Germany		France		Italy
	Benchmark bond	CTD bond	Benchmark bond	CTD bond	Benchmark bond
	113515	113510	186603	186603	
Euro Bund future	0.946/0.999	0.956/0.995	0.926/0.995	0.926/0.995	0.908/0.952
Euro Notional future	0.971/0.995	0.976/0.997	0.970/0.999	0.970/0.999	0.959/0.968
Euro swaps	0.925/0.908	0.928/0.939	0.935/0.936	0.935/0.936	0.940/0.990

Daily period: 03.05.00-19.06.00. Weekly period: 12.05.00-16.06.00. Correlation is measured for futures by the effective daily/weekly price changes between futures and bonds, and for swaps by the effective daily/weekly yield changes between swaps and bonds.

Source: Bloomberg.

Annex 8.9

10Y Euro Bund futures contract (EUREX) vs 10Y Euro Notional futures contract (MATIF): September 2000 delivery

10Y Euro Bund futures contract September **2000 (09.06.00-07.09.00; delivery: 11.09.00)**

Deliverable bonds	Start of accrued interest	Outstanding amount (Million Euro)	Coupon	Maturity	Conv. factor	Deliverable volume (Million Euro)	Open interest (high)	Days being CTD	Mod. duration	Yield
113511	26.03.1999	11,000	4.000	04.07.2009	0.865974		614,649 (10.08.00)	1	7.09	5.306
113512	09.07.1999	20,000	4.500	04.07.2009	0.899414	2,127.7 (10.63% of outst. amount)		61	6.99	5.305
113513	22.10.1999	20,000	5.375	04.01.2010	0.955835			1	6.88	5.267
113515	05.05.2000	18,000	5.250	04.07.2010	0.944942			0	7.39	5.264
Total deliv. volume		69,000								

10Y Euro Notional futures contract September 2000 (20.06.00-18.09.00; delivery: 22.09.00)

Deliverable bonds	Start of accrued interest	Outstanding amount (Million Euro)	Coupon	Maturity	Conv. factor	Deliverable volume (Million Euro)	Open interest (high)	Days being CTD	Mod. duration	Yield
OAT FR0000571432	25.04.1998	22,522	4.000	25.04.2009	1.036411		644,715 (28.07.00)	0	6.87	5.474
Bund 113511	26.03.1999	11,000	4.000	04.07.2009	1.037161			0	7.06	5.372
Bund 113512	09.07.1999	20,000	4.500	04.07.2009	1.074422			0	6.95	5.369
OAT FR0000186199	25.10.1999	23,874	4.000	25.10.2009	1.038331	112.3 (0.47% of outst. amount)		19	7.03	5.495
Bund 113513	22.10.1999	20,000	5.375	04.01.2010	1.146277			0	6.84	5.341
OAT FR0000186603	25.04.1999	17,692	5.500	25.04.2010	1.160453	630.3 (3.56% of outst. amount)		46	7.15	5.495
Bund 113515	05.05.2000	18,000	5.250	04.07.2010	1.142579			0	7.35	5.344
Total deliv. volume		133,088								

Open interest is calculated by MATIF as gross open interest, by EUREX as net open interest.

Sources: Bloomberg; Ministere de l'Economie des Finances et de l'Industrie: Monthly Report; Eurex: Monthly Report (Internet page: www.exchange.de); Clearnet: Bulletin for the delivery months.

Correlations (daily/weekly)

	Germany		France		Italy
	Benchmark bond	CTD bond	Benchmark bond	CTD bond	Benchmark bond
	113515	113512	186603	186603	
Euro Bund future	0.888/0.931	0.888/0.941	0.894/0.95	0.894/0.95	0.894/0.943
Euro Notional future	0.943/0.975	0.942/0.981	0.956/0.998	0.956/0.998	0.946/0.975
Euro swaps	0.780/0.919	0.781/0.919	0.783/0.95	0.783/0.95	0.797/0.934

Daily period: 12.06.00-18.09.00. Weekly period: 16.06.00-15.09.00. Correlation is measured for futures by the effective daily/weekly price changes between futures and bonds, and for swaps by the effective daily/weekly yield changes between swaps and bonds.

Source: Bloomberg.

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Analysis of credit spread in Japan's corporate bond market

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Abstract

This paper analyses the determinants of variation in the yield spread (credit spread) between government bonds and corporate bonds in Japan's bond market after 1997. The authors conduct empirical tests on the relationship between credit spreads and several economic and financial variables. A key finding is that default risk and the overall financial situation in Japan were the most significant factors in explaining the credit spread. The ratio of corporate bond issuance to government bond issuance is also an important determinant of the spread, a result that preceding studies had been unable to either prove or disprove conclusively. Notably, some of the factors that market participants claim to focus on in their bond dealing activities, in particular duration risk and the crowding-out effects of higher government debt, did not appear to have a significant impact on credit spreads.

1. Introduction

This paper discusses the determinants of variation in the yield spread between government bonds and corporate bonds (hereafter credit spread) in Japan's bond market after 1997 (an overview of Japan's corporate bond market after 1997 is given in the Annex). When we discuss credit spread, the default risk of the issuer is the most important determinant of its value and variation. Hence, many studies have been undertaken seeking an appropriate definition of default risk and its relation to pricing bonds.

However, in the course of explaining the variation in credit spread in Japan's corporate bond market, we look for factors other than default risk. As a first step, the possible significance of each factor is conjectured either by observing the relation between the data in question and credit spread or by interviewing market participants regarding their practices. We conducted regression analyses to assess the degree of significance of each factor as a determinant of variation in credit spread by using the data from Japan's corporate bond market.[2] Despite the limited availability of appropriate data, we think the results of the regression analyses succeed to some degree in shedding light on the significance of those factors that have hitherto not been the focus of attention.

The organisation of this paper is as follows. In Section 2, the factors which we think would be influential are introduced and we attempt to explain the mechanism through which each contributes to variation. In Section 3, regression analyses including the factors as regressors for the variation in the credit spread are conducted. The results are given with some caveats. Section 4 contains concluding remarks.

[1] We wish to thank Mr Isao Hishikawa and Mr Keiichiro Inaba for their contribution to this paper.

[2] In this paper, we only deal with the data on corporate bonds issued in the domestic market.

2. Determinants of variation in credit spread

Concerning the relation between credit spread and default risk, Chart 2 depicts credit spread and the total liabilities of bankrupt firms. While they move in the same direction for most periods, as theoretically expected, they also show no correlation for some periods. For example, through 1999 the decrease in the total liabilities of bankrupt firms was not accompanied by a narrowing of credit spread. Another example is the most recent period. Despite the increasing trend and historical peak of the total liabilities of bankrupt firms,[3] credit spread does not show any strong sign of rising. The existence of such periods motivated us to explore other variables which might affect the variation in credit spread.

In this section, we explore possible determinates as determinants of credit spread in the secondary market referring to data from Japan's domestic corporate bond market. We use the indication rates announced by the Japan Securities Dealers Association (JSDA)[4] for the yield of corporate bonds, such rates being the average for bonds with the same credit rating. In the following examination we use monthly data for all variables in question. Volume and spread data are averages for end-of-day values through each month.

The variables whose explanatory power vis-à-vis variation in credit spread in the secondary market we examined were as follows:

(a) Total liabilities of bankrupt firms

(b) Spread between Tibor (Tokyo interbank offered rate) and Libor

(c) Monetary base

(d) Relative volume of corporate bond issues and government bond issues

(e) Value of government bonds outstanding

(f) Yield spread between five- and 10-year government bonds

(g) Lag of credit spread

Below we explain the mechanism which we believe gives each factor its explanatory power for the variation in credit spread.

(a) Total liabilities of bankrupt firms

An increase in the total liabilities of bankrupt firms would signal a rise in the default risk of issued bonds, which causes widening credit spread (Chart 2).

As already mentioned, there were some periods when a decoupling of credit spread and the total liabilities of bankrupt firms was observed. The following subsections introduce some candidates other than the total liabilities of bankrupt firms to explain the variation in credit spread.

(b) Spread between Tibor and Libor

In addition to the default risk attaching to individual bonds, financial uncertainty also seems to be of significance, which includes financial system uncertainty, distrust of government policy, etc. As a proxy, we chose the spread between Tibor and Libor (hereafter Tibor-Libor spread). Although the Tibor-Libor spread is an indication of the creditworthiness of Japanese banks, it is generally accepted that it expresses the "Japan premium", ie the overall financial condition of Japan.[5]

In Chart 3, the Tibor-Libor spread and credit spread are depicted. The shape of the humps in the Tibor-Libor spread look quite similar to those in the credit spread.

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[3] Sogo Group, one of Japan's biggest department stores, and related companies went bankrupt on 12 July 2000.

[4] The Japan Securities Dealers Association is a self-regulating body under the Securities Transaction Law.

[5] Strictly speaking, Tibor-Libor spread may not represent the "Japan premium" accurately, since Libor might also include Japanese banks' offered rate in London (and vice versa for Tibor) and the banks comprising the index occasionally change.

(c) Monetary base

When market participants have excess liquid assets, reflecting the Bank of Japan's easy monetary policy, they want to obtain less liquid assets to rebalance portfolios. This can be attributed to investors' appetite for risk assets including corporate bonds. Or, due to the increase in market liquidity, asset prices as collateral security rise. This can be attributed to a reduction in the exposure of investors to credit risk and greater capacity to purchase risk assets. Both cases could explain a narrowing credit spread. In any case, it seems that market liquidity is significant in explaining the variation in credit spread. To express market liquidity, it is believed that use of the monetary base is appropriate. The relationship between changes in credit spread and those in monetary base is not obvious as shown in Chart 4, but may exist loosely.

(d) Relative volume of corporate bond issues and government bond issues[6]

The issue volume of corporate bonds and government bonds is often referred to by market participants as an influential factor explaining the variation in credit spread.

The important point vis-à-vis their explanatory power is to understand the supply-demand balance within each bond market and the overall bond market. When supply in one bond market increases, the yield in that market rises. At the same time, yields on other bonds also rise because of the increase in supply in the bond market as a whole. If the supply of corporate bonds increases more than that of government bonds, the yield on corporate bonds usually rises more than that on government bonds. As a result, credit spread between corporate and government bond yields widens. In the next section, we try to examine whether or not the ratio of the volume of new corporate bond issues to that of government bonds (Chart 5) is significant for regression analyses.

(e) Value of government bonds outstanding

On the other hand, the value of government bonds outstanding is also pointed out by economists as an important factor in accounting for the variation in credit spread. It is supposed that the accumulation of government bonds reduces an investor's ability to purchase other bonds. Economists hold that this is one of the reasons behind a rising credit spread and term it "crowding-out".

Value of government bonds outstanding, which has been increasing month by month because the government has taken repeated measures to counter the recession. However, the credit spread has not risen much. We will examine this point in the next section.

(f) Yield spread between five- and 10-year government bonds

We conjecture that the yield spread between five- and 10-year government bonds (hereafter the five-10 year government bond spread)[7] moves in the opposite direction to the variation in credit spread. The market participants interviewed pointed out that this negative correlation between the two spreads was not constantly observed over the whole period but significantly determined the variation in credit spread in past phases. The mechanism linking the two spreads is market participant behaviour where they compare returns from shouldering the credit risk inherent in corporate bonds and the duration risk of long government bonds which are credit risk free. When rate rises are expected in the near future, investors hesitate to hold long bonds of any kind and try to find alternatives to obtain returns. Investing in corporate bonds of shorter maturity is one such alternative. By investing in such corporate bonds investors can avoid duration risk though they are exposed to credit risk. In this way a link between the two spreads would emerge.

In our study of bond market data (Chart 7), it is difficult to find a negative correlation between the credit spread of corporate bonds and yield spread on government bonds.

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[6] Excludes treasury bills and bonds purchased by the Bank of Japan and the Trust Fund Bureau of the Ministry of Finance.

[7] The five-10 year government bond spread is calculated as the yield on 10-year government bonds minus that on five-year government bonds.

(g) Lag of credit spread

It is observed in tracing credit spread that it tends to move with some degree of inertia unless there is a sudden shock, for example the sudden announcement of a large-scale bankruptcy.

The reasons behind this tendency can be explained by the following hypotheses. The first is that influential factors remain for some length of time. In other words, it is not realistic to think that a factor affecting credit spread in a certain period suddenly loses its influence in the next.

The second hypothesis is that movements in credit spread may convey information possessed by informed investors regarding the appropriate level of credit spread to uninformed investors who temporarily take a "wait -and -see" stance. The widening of spreads in one period reveals the perception of informed investors vis-à-vis credit spread and uninformed investors would then recognise the real state of market conditions and also start behaving like informed investors. This information spillover among investors may contribute to inertia in credit spread movements.

3. Regression analyses

In this section, we attempt regression analyses to examine the relation between variation in credit spread and the variables introduced in the last section.

3.1 Data descriptions

We assemble monthly yields of corporate bonds with five-year maturity and calculate corresponding credit spreads for three rating categories (Aa, A and Baa). We use the indication rates announced by the JSDA as yields for corporate bonds of five-year maturity and a particular credit rating.[8]

Other regressors in the regression equation are: total liabilities of bankrupt firms, Tibor-Libor spread, five-10 year government spread, relative volume of corporate bonds and government bonds outstanding, monetary base, and lag of credit spread.

3.2 Test methodology

We estimate regressions in the following form, which models the determination of variation in credit spread.

$$D(CS_t) = \alpha_1 \cdot (100 \cdot D(\ln DEB_t)) + \alpha_2 \cdot D(TLS_{t-1}) + \alpha_3 \cdot (100 \cdot D(\ln MB_t)) + \alpha_4 \cdot D(CGR_{t+1}) + \alpha_5 \cdot (100 \cdot D(\ln GBO_{t+1})) + \alpha_6 \cdot D(LMS_t) \cdot + \alpha_7 \cdot D(CS_{t-1}) + \varepsilon_t$$

$$\varepsilon_t \sim N(0, \sigma^2)$$

CS: credit spread (bp, monthly average)

DEB: total liabilities of bankrupt firms (million yen, monthly)

TLS: Tibor-Libor spread (bp, monthly average)

MB: monetary base (100 million yen, monthly average)

CGR: ratio of the volume of new corporate bond issues to that of new government bond issues (%, monthly)

GBO: value of government bonds outstanding (100 million yen, end of month)

LMS: five-10 year government bond spread (bp, monthly average)

D(•): the first differential of the variable in parentheses.

[8] The JSDA collects the data on issued corporate bonds and categorises them in terms of maturity and credit rating. The indication rates are the arithmetic mean of yields of corporate bonds in a certain maturity category and credit rating.

All variables including the dependent variable are averages for the latest three months. For example, CS_t is the average of the credit spread in months t, t-1 and t-2. By taking the first difference of all variables they are then transformed into the form of a three-month change.

The reason for this treatment is to smooth the relation between action and reaction and to adjust for quarterly seasonality. While it may cause multicollinearity, since this handling of data with a Koyck lag includes the same period between dependent and independent variables, we want to justify this transformation in our regression analyses because of smoothing needs.

3.3 Regression period

As mentioned, there are no corporate bond yield data sufficient for analyses before June 1997. Therefore, only 33 observations from November 1997 to July 2000 are efficient because of the transformation of three-month averages and adoption of the credit spread lag as the regressor. This limit to degree of freedom is the main problem throughout our regression analyses.

3.4 Regression results

The table below reports OLS estimates of the regression equation set in the last subsection for different credit ratings.

	α_1	α_2	α_3	α_4	α_5	α_6	α_7	Adj R^2	D-H
Aa	0.02	0.19	——	——	——	——	0.62	0.72	1.90
	(2.41)	(4.32)	(——)	(——)	(——)	(——)	(6.56)		
A	0.03	0.45	– 0.19	0.09	——	——	0.80	0.93	– 0.02
	(3.77)	(9.14)	(– 1.85)	(2.32)	(——)	(——)	(16.35)		
Baa	0.03	0.43	——	0.20	——	——	0.83	0.92	1.11
	(2.28)	(5.80)	(——)	(3.63)	(——)	(——)	(15.83)		

$$D(CS_t) = \alpha_1 \cdot (100 \cdot D(\ln DEB_t)) + \alpha_2 \cdot D(TLS_{t-1}) + \alpha_3 \cdot (100 \cdot D(\ln MB_t)) + \alpha_4 \cdot D(CGR_{t+1}) + \alpha_5 \cdot (100 \cdot D(\ln GBO_{t+1})) + \alpha_6 \cdot D(LMS_t) \cdot + \alpha_7 \cdot D(CS_{t-1}) + \varepsilon_t, \quad \varepsilon_t \sim N(0, \sigma^2)$$

Note: Figures in the upper rows of variables indicate coefficients, and figures in lower rows (in parentheses) indicate their t-values. Regression period: November 1997 to July 2000.

The table shows that all regression equations satisfactorily explain the credit spread, though it must be deduced that there is a problem in terms of the limit to degree of freedom. Following is a brief rationale for each explanatory factor.

The most significant variable in all credit rating categories is the Koyck lag (CS_{t-1}, the parameter is α_7), which indicates the existence of inertia in credit spread variation. To some extent it is natural because of including the same period between dependent and independent variables. Also there is some doubt about data stationarity as its coefficient is close to 1 and the t-value is large, especially for A and Baa ratings. However, we do not consider this problem here since there is no way to avoid it in such a short regression period.

The total liabilities of bankrupt firms (*DEB*, the parameter is α_1) is also statistically significant in all credit rating categories. The theoretical relation between default risk and credit spread is confirmed as we expected.

The Tibor-Libor spread (*TLS*, the parameter is α_2) is also one of the most influential factors in all credit rating categories. This shows, as we expected, that overall financial conditions in Japan cannot be neglected in explaining the variation in credit spread.

The regression results show that the coefficient of *CGR* (the parameter is α_4) has a positive sign and is statistically significant for A and Baa. This is supportive of our conjecture that the relative tightness

of supply-demand conditions in corporate and government bond markets affects credit spread. The result that the variable is significant for A and Baa ratings is attributable to the fact that these bonds are liable to be influenced by supply shocks because they may be bought marginally by investors.

The coefficient of monetary base (*MB*, the parameter is α_3) just managed to pass the *t*-test by 90% significance only in the case of A. This partly proves that the excess supply of money reduces credit spread. However, its explanatory power is weak.

The volume of government bonds outstanding (*GBO*, the parameter is α_5) does not explain credit spread. We suppose that the crowding-out effect has not existed for the three years under review. This might be because volume is increasing constantly but not rapidly. Though the result shows no evidence of crowding-out, we cannot say the situation will continue in the future.

The regression results also show that there is no compelling evidence that credit spread is affected by the five-10 year government bond spread (LMS, the parameter is α_6) from the perspective of statistical significance. Nevertheless, we think it is a little too hasty to conclude that this relation does not exist. According to some market participants, they actively conduct bond trading based on a comparison of return on duration risk in long government bonds and credit risk in corporate bonds with a shorter period to maturity from time to time. Although we could not statistically prove the significance of such a trading practice as a determinant of credit spread, we believe that its influence cannot be ignored.

The breakdown of the contribution of each regressor for the variation of A- and Baa-rated credit spread is shown in Charts 8 and 9. We see that the outline is explained by the Koyck lag term and that the slight changes and turning points are explained by the other variables. It is confirmed that this regression function succeeds in indicating the turning points with considerable accuracy in spite of the large size of the Koyck lag parameter. The result of the one-step forecast (Charts 10 and 11) evidences its forecasting ability.

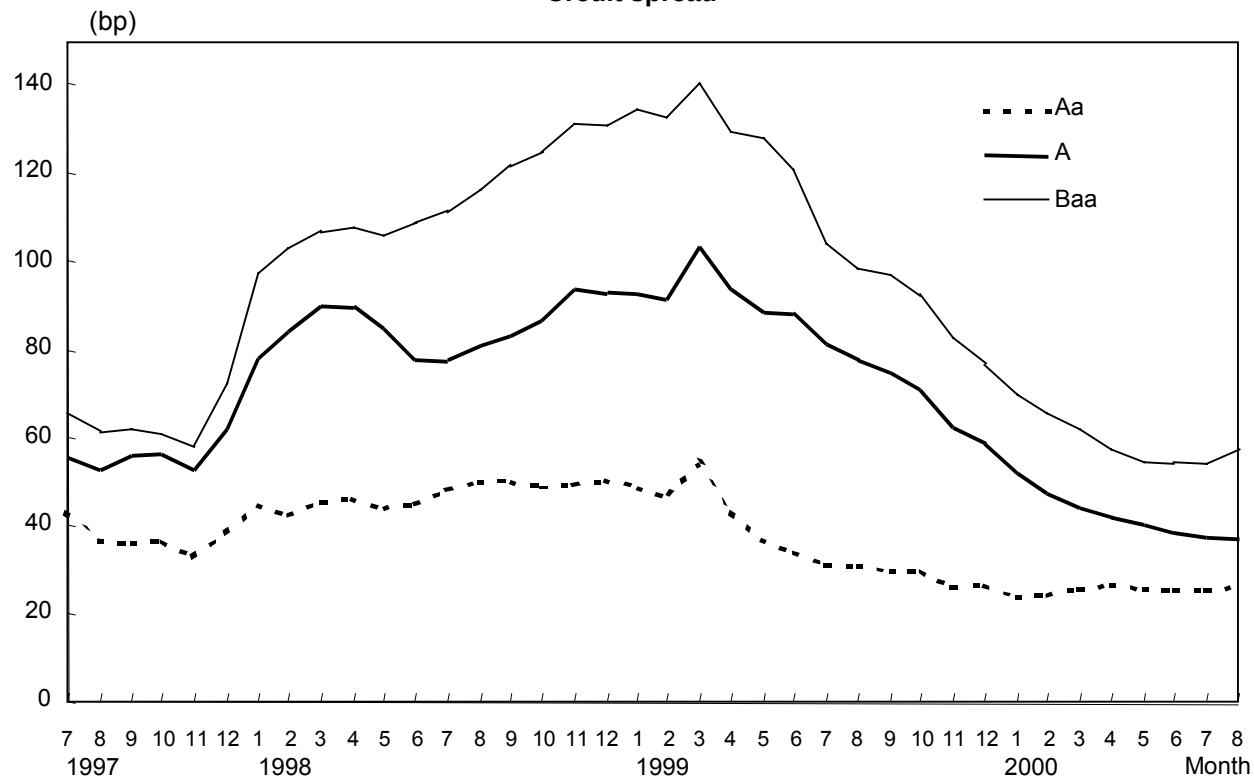
4. Concluding remarks

In this paper we showed that default risk, the overall financial situation in Japan, etc are the significant factors in explaining credit spread. In particular, it was fruitful to prove the importance of the ratio of corporate bond issue amounts to government bond issue amounts because preceding studies had not confirmed it conclusively. On the other hand, we could not prove the existence of the relative significance of credit risk to duration risk or the crowding-out effect that are monitored by market participants in their dealing. In addition, there still remain some problems which have not been solved because of the shortness of the regression period.[9] These are future studies to be undertaken.

[9] Especially for Aa class, it is desirable to add other variables to improve the performance of the equation because of the relatively low R^2 and high D-H. Though some variables on industrial attributes of each security would be important (eg the weighting of banks has been lower than before), we could not obtain such data in time series.

Chart 1

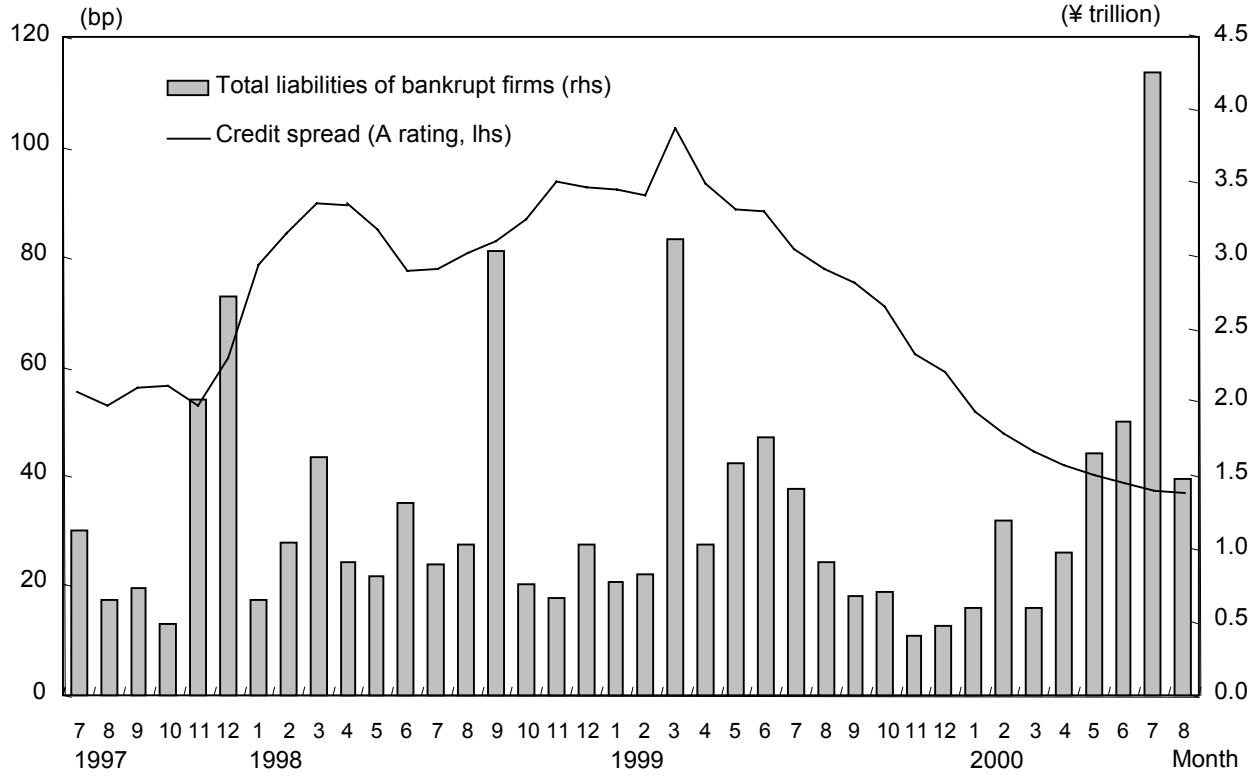
Credit spread



Source: Bank of Japan; Japan Securities Dealers Association.

Chart 2

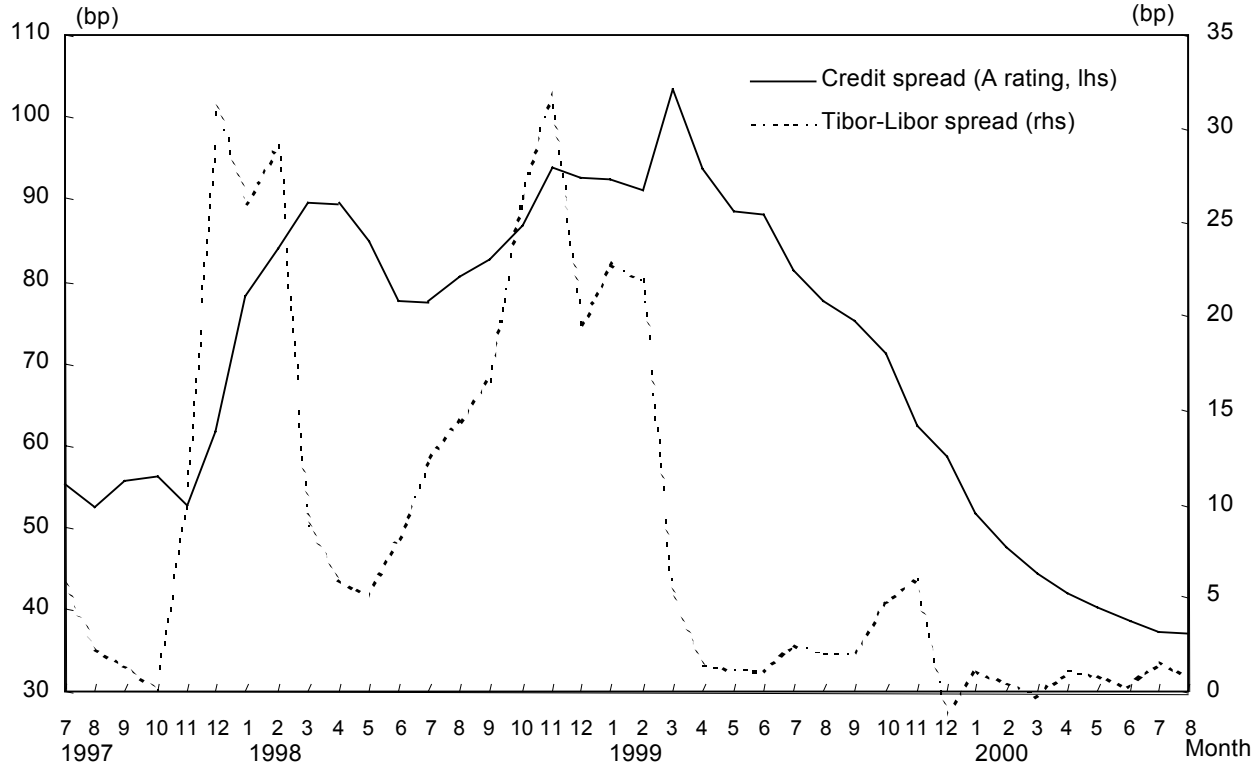
Credit spread and total liabilities of bankrupt firms



Sources: Japan Securities Dealers Association; Tokyo Shohkoh Research.

Chart 3

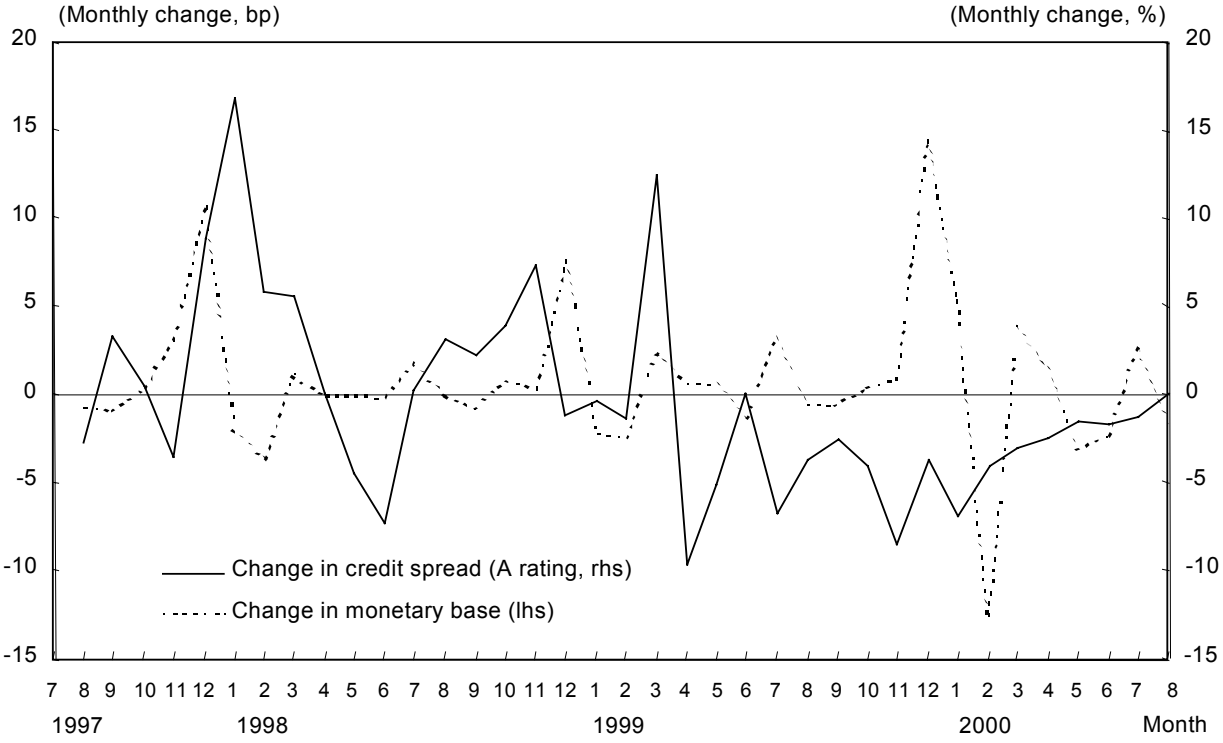
Credit spread and Tibor-Libor spread



Sources: Japanese Bankers Association; British Bankers Association.

Chart 4

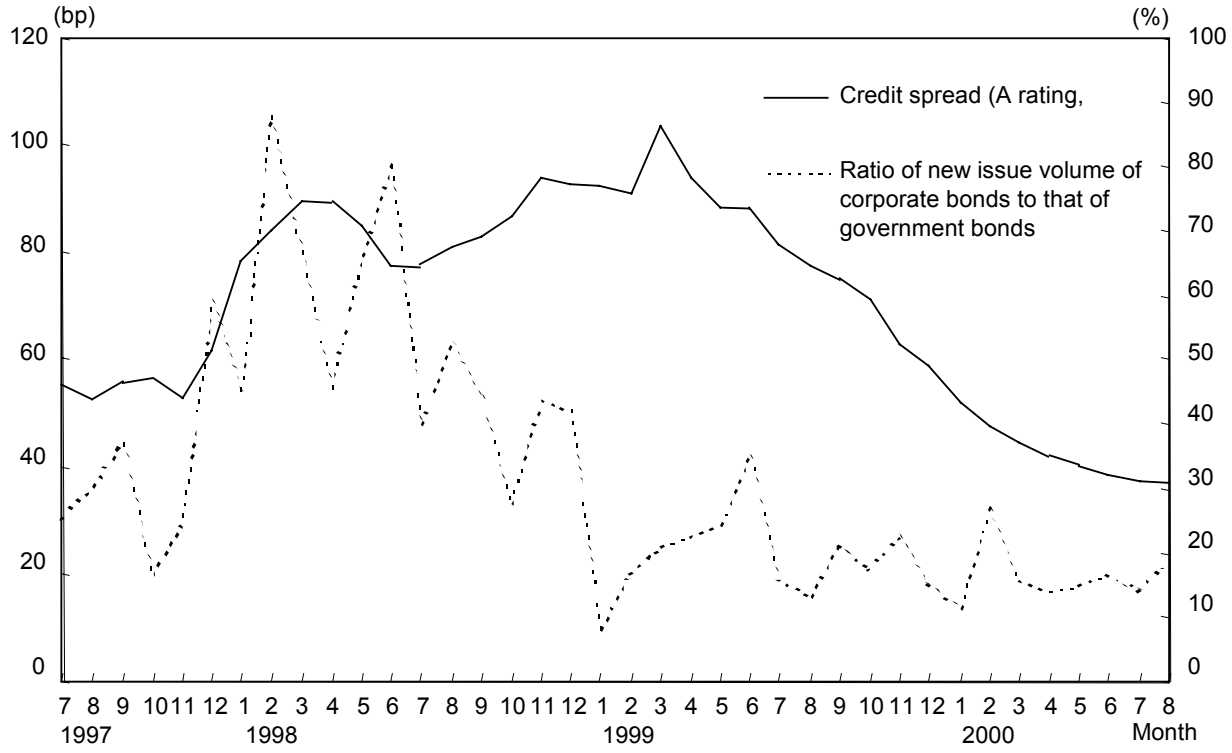
Changes in credit spread and monetary base



Source: Bank of Japan.

Chart 5

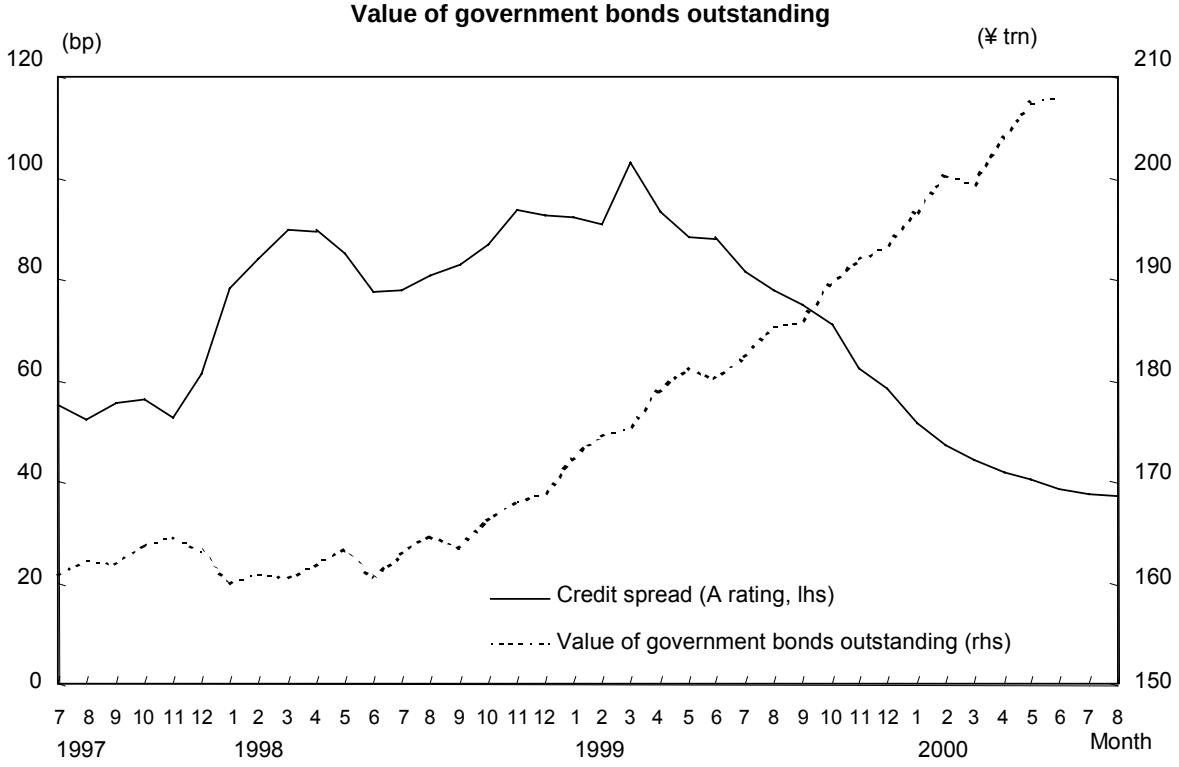
Credit spread and ratio of new issue volume of corporate bonds to that of government bonds



Sources: Bank of Japan; Japan Securities Dealers Association.

Chart 6

Value of government bonds outstanding

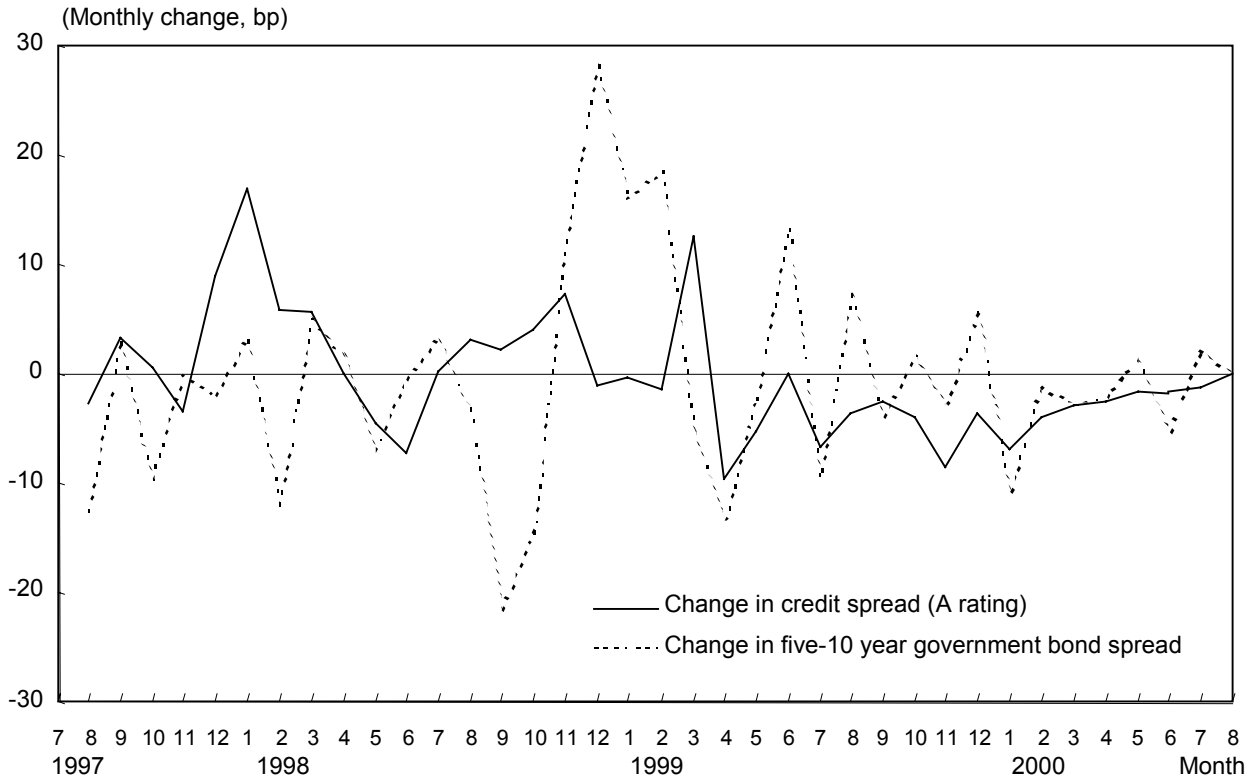


Note: Value of government bonds outstanding (public offering basis only).

Sources: Bank of Japan; Japan Securities Dealers Association.

Chart 7

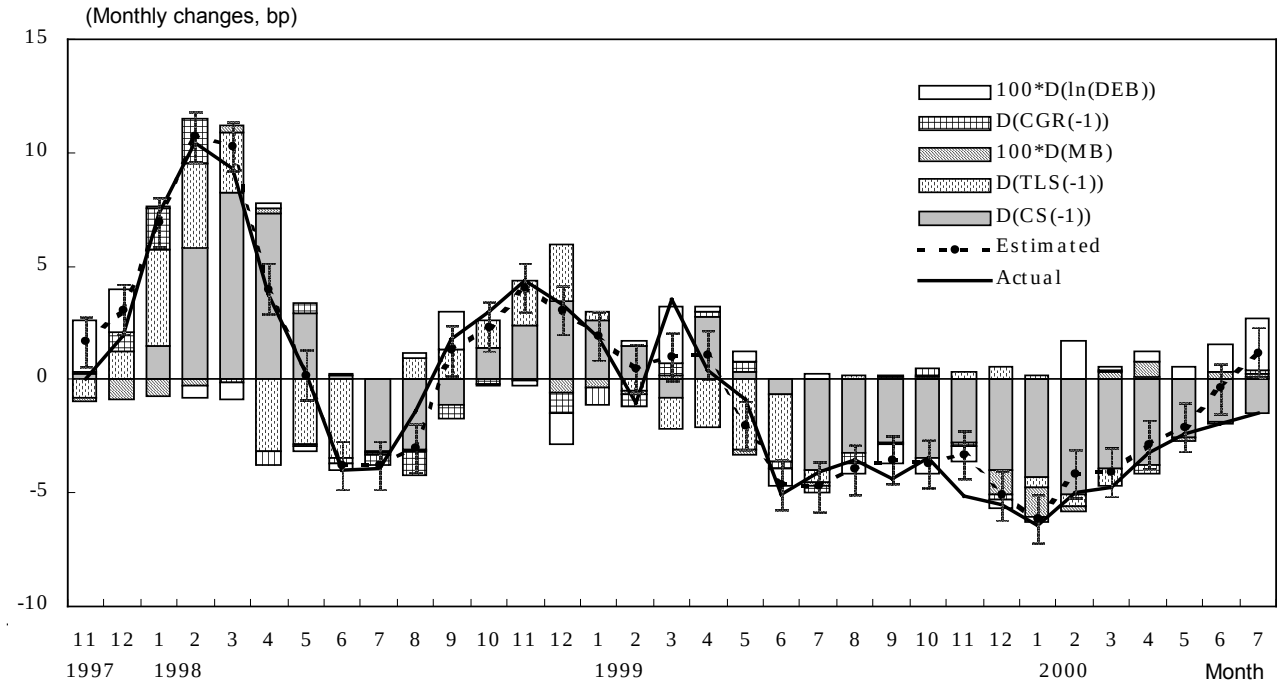
Changes in credit spread and five-10 year government bond spread



Sources: Bank of Japan; Japan Securities Dealers Association.

Chart 8

Contribution of each regressor to change in credit spread (A rating)

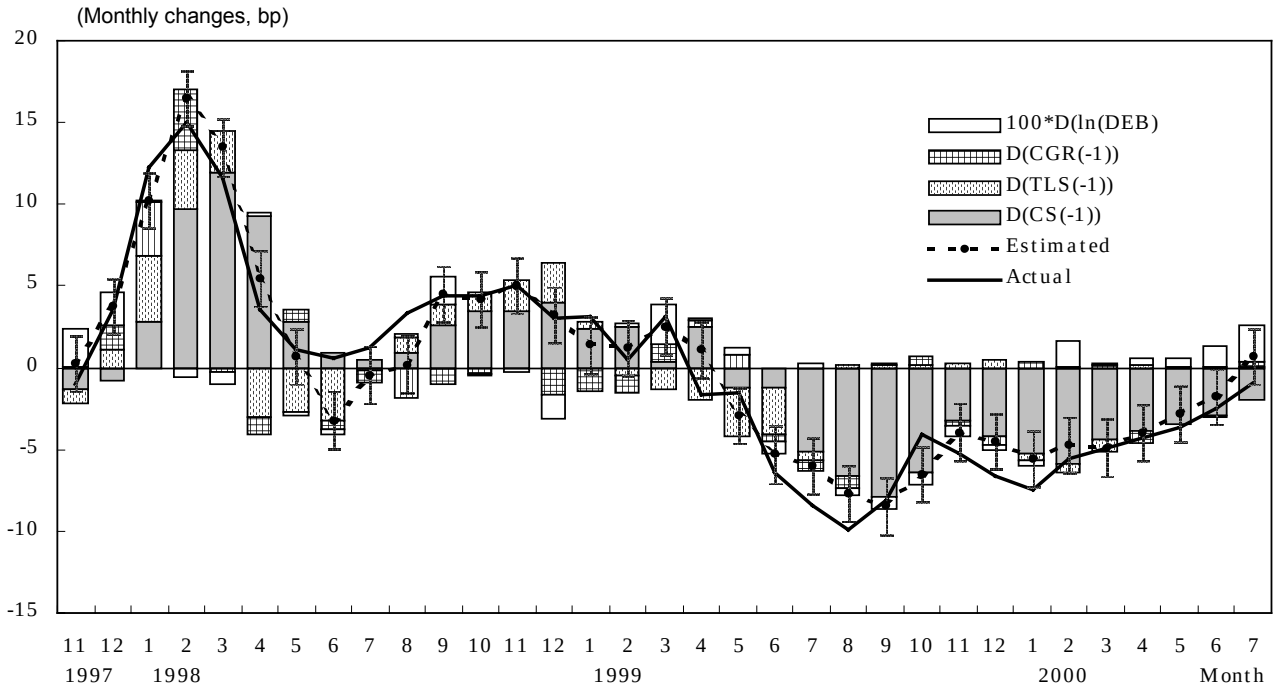


Notes: The error marks express 1 SE of estimation. Estimated line is the result of a one-step forecast. All variables are latest three-month averages.

Sources: Bank of Japan; Japan Securities Dealers Association.

Chart 9

Contribution of each regressor to change in credit spread (Baa rating)

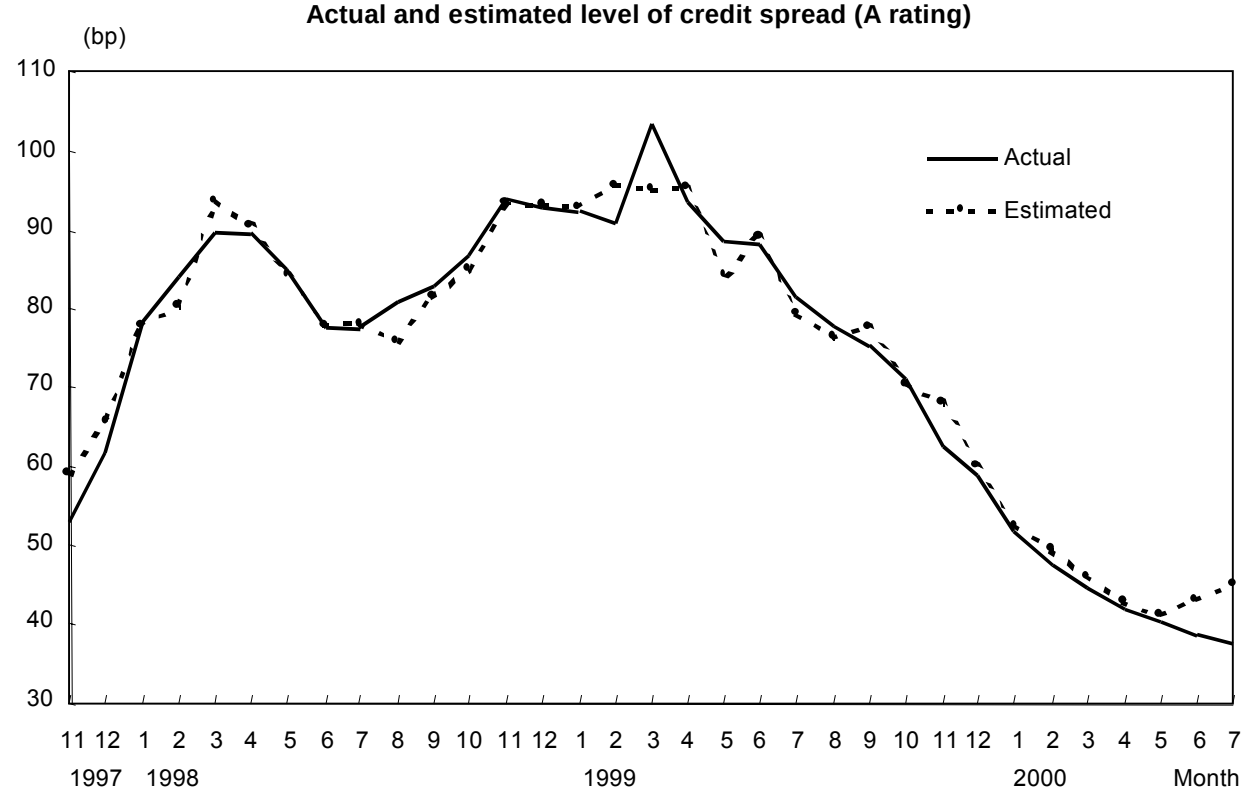


Notes: The error marks express 1 SE of estimation. Estimated line is the result of a one-step forecast. All variables are latest three-month averages.

Sources: Bank of Japan; Japan Securities Dealers Association.

Chart 10

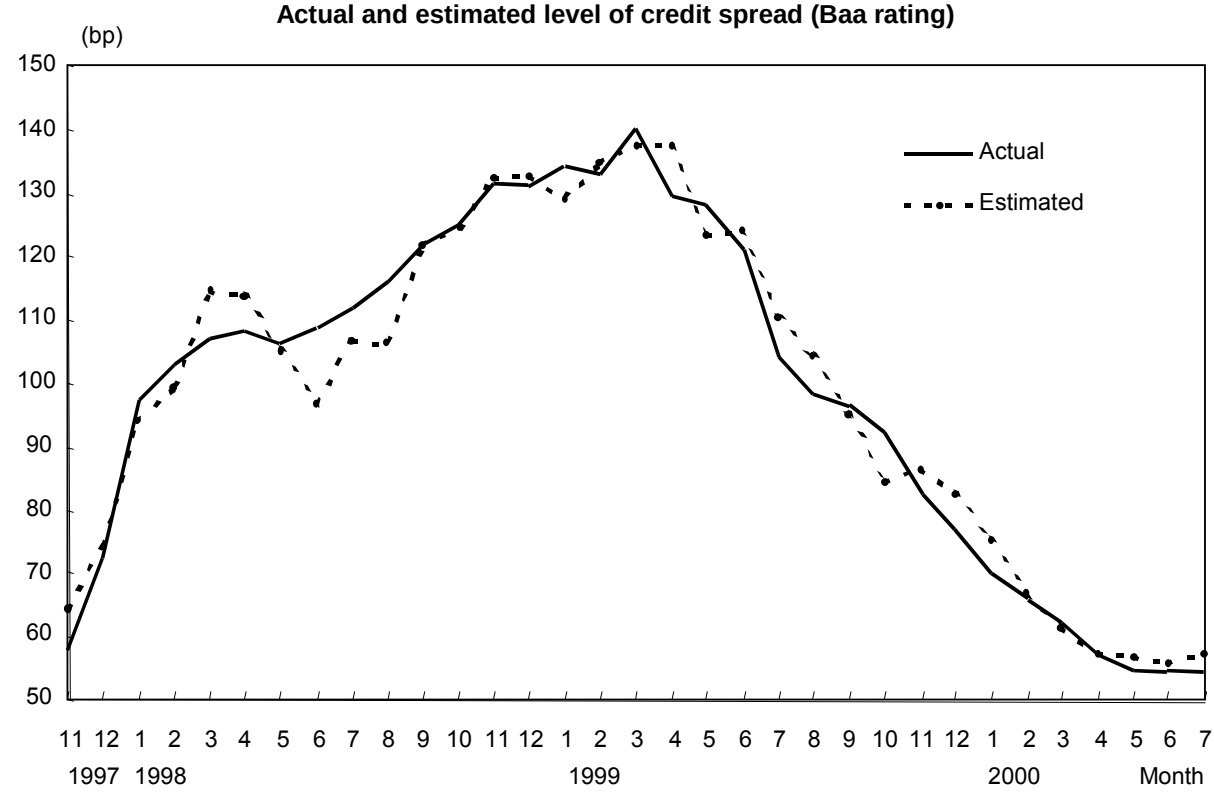
Actual and estimated level of credit spread (A rating)



Sources: Bank of Japan; Japan Securities Dealers Association.

Chart 11

Actual and estimated level of credit spread (Baa rating)



Sources: Bank of Japan; Japan Securities Dealers Association.

Annex:
Overview of Japan's corporate bond markets

A.1 Development after 1997

1997[10] was a big turning point for Japanese corporate bond markets.

Until then, there had been no case of the default of publicly issued bonds in Japan and market prices did not sufficiently reflect the credit risk of issuers.

This situation changed in 1997, when a severe financial environment surrounding Japanese financial institutions emerged. Specifically, at the beginning of 1997 credit concerns arose regarding *Nippon Credit Bank*, which led to a rapid widening in the spread on its debentures as shown in Chart A1. Then, in September 1997, the first default in Japan of publicly issued bonds was seen, namely the convertible bonds of retailer *Yaohan*.

In November 1997, several large and medium-sized banks and securities companies successively defaulted: *Sanyo Securities* (3 November) *Hokkaido Takushoku Bank* (17 November), *Yamaichi Securities* (24 November) and *Tokuyo City Bank* (26 November). These events saw the start of widening corporate bond spreads as shown in Chart A2.1.

In autumn 1998, Japan's financial system again experienced the collapse of large financial institutions: *The Long-Term Credit Bank of Japan* (October) and *Nippon Credit Bank* (November). The focus of market players in 1998 was mainly on 1) political debate in the Diet regarding the proposed framework to deal with the resolution of failed financial institutions, and 2) the downgrading of Japan's sovereign credit rating by Moody's.[11] Against this background, the spreads of both corporate bonds and bank debentures widened dramatically again in 1998 (Charts A1 and A2). Such widening of credit spreads after November 1997 may be interpreted as a manifestation of the decision of market participants to incorporate credit risk into the pricing of these bonds in a way which reflected the increase in default probability.

Meanwhile, the number of corporate bond issues for which quotations[12] were announced by the JSDA was expanded to all issues from April 1997. Also, restrictions on bond transaction price range (government bonds, corporate bonds, etc) were abolished in December 1998. These revisions contributed to price transparency and market liquidity.

After the "financial crisis", both corporate bond and bank debenture spreads tended to shrink as concern over financial turmoil calmed down (Chart A2.2). In particular, the Bank of Japan's zero interest rate policy and the injection of capital into banks by the government in the first quarter of 1999 were considered to have a big impact in reducing credit risk worries and in narrowing bond spreads.

Supply and demand factors in the corporate bond market also contributed to the narrowing. During the financial turmoil in 1998 the issuance of corporate bonds increased sharply (Chart A3), possibly boosted by large companies shifting fund-raising from bank loans to corporate bonds reflecting the tighter lending policies of banks. After the "financial crisis", firms had no more need to raise money by issuing bonds and had excessive liquidity. Thus, the volume of corporate bond issues declined from 1999. Because of this supply and demand factor, the shrinkage in the bond spread was conspicuous from the latter half of 1999 (Chart A2.2), which level did not seem to correspond properly to credit risk.

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[10] By then, most of the restrictions on corporate bond issues had already been relaxed. For example, in 1990, eligibility criteria based on accounting information were replaced by a single bond rating criterion. After that, other restrictions on corporate bond issues were gradually relaxed and in 1996 eligibility criteria were removed in the final stage of the liberalisation of Japanese corporate bond markets. At that time, with regard to primary markets, the institutional framework of Japanese corporate bond markets was already said to have been sufficiently improved so as to meet minimum global standards.

[11] Moody's placed its foreign currency country ceiling for Japan and the domestic currency rating of the government of Japan under review for possible downgrade on 23 July and eventually downgraded them from Aaa to Aa1 on 17 November 1998. Incidentally, the domestic currency rating of the government of Japan was further downgraded on 8 September 2000.

[12] Quotations for corporate bonds are reported by securities firms and banks. These quotations are used for reference in OTC bond transactions.

A.2 Characteristics of Japan's corporate bond market

This section discusses characteristics of Japan's corporate bond market compared with the United States market.

A.2.1 Size

Chart A4, drawn from OECD's *Financial Statistics*, shows the issuance of corporate bonds in Japan and the United States. Issuance in Japan's corporate bond market (including bonds issued outside Japan) totalled US$ 64 billion in 1997, less than half the figure in the United States corporate bond market. As a proportion of GDP, the figure for Japan is 1.5%, which is smaller than that for the United States. Also, in terms of the fixed income market the proportion of corporate bond issuance to government bond issuance is quite different between the two countries.

When comparing the size of the yen-denominated corporate bond market (domestic[13]) with other currency counterpart markets, the yen market ranks second (as of end-1998; Chart A6). However, that share seems to be declining compared with figures in 1994 (Chart A7).

A.2.2 Categories

Next, ratings and maturities of corporate bonds between the United States and Japan are compared.

AAA- and AA-rated corporate bonds account for more than 50% of the total in Japan, but less than 30% in the United States (Chart A8). In other words, the United States corporate bond market has more heterogeneity than its Japanese counterpart. It is considered that corporate bond pricing reflects credit risk more properly in the United States, where credit risk management is developed and issuers with various ratings can more easily issue bonds.

Chart A9 compares United States and Japanese spreads based on OTC bond quotations as of the beginning of June 2000. In the mature United States dollar bond market, the spread of Ba bonds (similar to Japanese BBB) is 0.47X the yield on United States Treasuries of the same maturity. In the domestic yen bond market, the spread of Japanese BBB bonds (Ba2 bonds in the United States) reached 1.3X before taking off. Thus, spreads of bonds below the BBB level are extremely wide vis-à-vis Japanese Government Security (JGS) yields compared with the United States counterpart. This is attributable to the fact that Japanese institutional investors remain conservative in their preferences and tend to focus on bonds graded A and above, which results in a thin market below the BBB level.

Also, the United States corporate bond market has more heterogeneity in terms of maturity (Chart A10). There is little volume in long-term maturities of over 11 years in Japan's corporate bond markets. In Japan, it is difficult to effect pricing in such long-term corporate bonds because of a liquidity shortage in the maturity-matched government bond market, which is the base rate for corporate bond pricing.

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[13] The bond issuance of Japanese firms became larger in domestic markets than in overseas markets after FY 1993 (Chart A5). Formerly, at the time of the stock market boom of the late 1980s, many firms issued, in particular, equity-related bond instruments (convertible bonds and warrant bonds) which were mainly issued in the euro market. As shown in Chart A5, from FY 1983 until FY 1992, except for a few brief periods from FY 1986 to FY 1988, the volume of bonds issued by Japanese firms was larger in overseas markets than in domestic markets.

At that time, the Ministry of Finance applied essentially the same criteria to overseas bond issues as domestic bond issues, so that there was virtually no case of a euro issue of a corporate bond by a domestically ineligible firm. Euro issues did, however, offer institutional advantages: (1) in contrast to the domestic market, where collateral is normally required, the euro market did not require collateral; and therefore (2) bond trustee administration fees for euro issues were much lower than for domestic ones.

A.2.3 Market liquidity

A large, efficient and liquid secondary bond market is highly desirable from the perspective of issuers, investors and dealers that trade and sell corporate bonds.

When comparing trading volume and turnover between Japan and the United States, the turnover ratio of the United States corporate bond market is about five times bigger than that of Japan's market (Chart A11), evidencing that the United States corporate bond market is more liquid and active with heterogeneous investors.

Why is Japan's corporate bond market not as well developed and less liquid than its United States counterpart? The lack of a reliable JGS yield curve across maturities can be cited as one reason, since the yield curve of government securities in a liquid market serves as the benchmark for pricing other financial products including corporate bonds.

According to the report of a study group on market liquidity under the Committee on the Global Financial System (CGFS), liquidity in the JGS market is the lowest among major countries in that bid-ask spreads are the widest in Japan and the turnover ratio the lowest among Group of Seven countries (charts A12 and A13).[14]

Having said that, some progress has been seen in JGS markets. In fiscal 1999, the government started issuing one-year Treasury bills and five- and 30-year coupon bearing bonds. As a result, the line-up of original maturities now covers most investment horizons, although issuance volume is still heavily skewed to 10-year bonds.

Another reason why Japan's corporate bond market is less liquid than its United States counterpart may come from the lack of a corporate bond lending market in Japan. Bond lending is necessary to enable dealers to conduct market-making temporarily without owning bonds or buying from accounts. In the United States, the borrowing or repo market, which is a well established feature of most bond and equity markets, enables dealers to sell bonds they do not own. This allows dealers to manage their inventory of bonds more effectively, reduce their overall risk exposure and serve a large customer base. Thus, in the United States, the repo market results in greater competition, lower transaction costs, and improved liquidity in the corporate bond market.

In contrast, in Japan, the repo market is less developed, which makes shorting corporate bonds difficult. One big reason for this is a lack of consensus on the level of haircut among market players when conducting a repo transaction in the corporate bond market. As mentioned, in Japan investors in corporate bonds do not effect sufficient credit analysis, and the market has not really imposed a credit spread which is properly linked to the credit of the firm issuing bonds. This is also the case of the haircut rate in the corporate bond market.

The absence of allowing "failure" can also be considered one reason why the development of the corporate bond repo market in Japan is in marked contrast to that in the United States. There, if a dealer cannot generate bonds outright or through the repo market by the settlement date, he will "fail", ie, be unable to deliver bonds on the settlement date. This is a necessary feature of the market in that it provides a safety relief valve that gives the dealer some level of comfort in making active markets in bonds he does not have in his inventory.

In Japan, market practice did not permit failure to deliver bonds on the settlement date. However, regarding the JGS market alone, allowing "failure" was introduced at the beginning of this year when the Bank of Japan started to settle almost all JGSs on a real-time gross settlement (RTGS) basis. The introduction of "failure" to the corporate bond market remains a future task in terms of activating corporate bond repo markets.

A.2.4 Pricing

As the benchmark for the pricing of corporate bonds, most corporate bond dealers in Japan traditionally use interest rate swaps for less creditworthy issues (rated below A) and JGSs for highly creditworthy issues (above AA).

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[14] BIS (1999).

The turmoil following the Russian crisis saw a change in the pricing of corporate bonds by some dealers. The stable correlation between corporate bonds and the benchmark[15] (JGS) was broken during the flight to quality wave to JGSs. Then, some dealers also used interest rate swaps for highly rated issues. Currently, pricing practice has reverted to pre-turmoil times, and JGSs have come to again be widely used as the benchmark for the pricing of highly rated corporate bond issues (above AA), which account for more than half of total corporate bond issues in Japan as shown in Chart A8. This is in contrast to recent developments in other markets and might be partly due to the difference in trend of JGSs outstanding between Japan and other developed countries.

In any event, dealers have come to choose the benchmark for the pricing of corporate bonds more flexibly according to the correlation between corporate bonds and the benchmark. Such practices are expected to gradually contribute to the development of the corporate bond market in Japan (for an overview of the yen interest rate swap market, see Appendix).

Settlement system and market practices

We can point to the regulatory environment and market practices as important ingredients for the success of a financial market. A settlement system is one such important ingredient in considering market design.

In the United States, the creation of an impartial depository such as the Depository Trust Company (DTC) has simplified the handling of securities and reduced barriers to participating in this market. This encourages more trading, better distribution and tighter margins. In Japan, the settlement of corporate bonds is handled in a decentralised way by about 160 banks with whom corporate bonds are registered. Currently, there are discussions under way as to the possibility of the creation of a centralised depository like the DTC for the more efficient settlement of corporate bonds.

Regarding market practices, one of the most important differences between Japan and the United States lies in the role of the trustee. In the absence of financial distress, a United States trustee's function is limited to managing the ownership records and acting as paying agent. In Japan, the trustee banks are traditionally involved in the formative stages of bond deals, offering financial advice to the issuers and negotiating indenture terms. They monitor the financial condition of companies and are involved in distress situations to avoid default. In particular, before default of the convertible bonds of retailer *Yaohan*, there was a general practice that trustee banks should even purchase distressed bonds so that no investor lost money.[16] Thus, the trustee banks that structure bonds have, to some extent, implicitly provided a guarantee of performance which is considered one reason why good credit analysis has been comparatively weak in Japan. Also, high trustee fees are considered to have held back the development of Japanese domestic bond issuances.

This is in marked contrast to the United States, although the concept of the trustee as implicit guarantor in Japan weakened considerably after financial turmoil in 1997 and 1998. In the United States, investors bear credit risk and are paid a premium coupon for taking on such an obligation. The rating agencies, bond research departments at investment banks and other private services provide information and analysis of the credit quality of companies as well as market trends bearing on valuation.

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[15] Incidentally, until the large-scale flotation of government bonds after 1975, there were times when benchmark issues in Japan's secondary bond markets were interest bearing telegraph and telephone bonds (long-term interest rates) and bank debentures (medium-term interest rates). Chart A14 compares interest rates and price fluctuations with respect to the former. As the chart shows, before the large-scale flotation of government bonds, interest rates on interest-bearing telegraph and telephone bonds were determined freely to a considerable degree, reflecting inflationary expectations, and already played the role of supplying information regarding market expectations of interest rates.

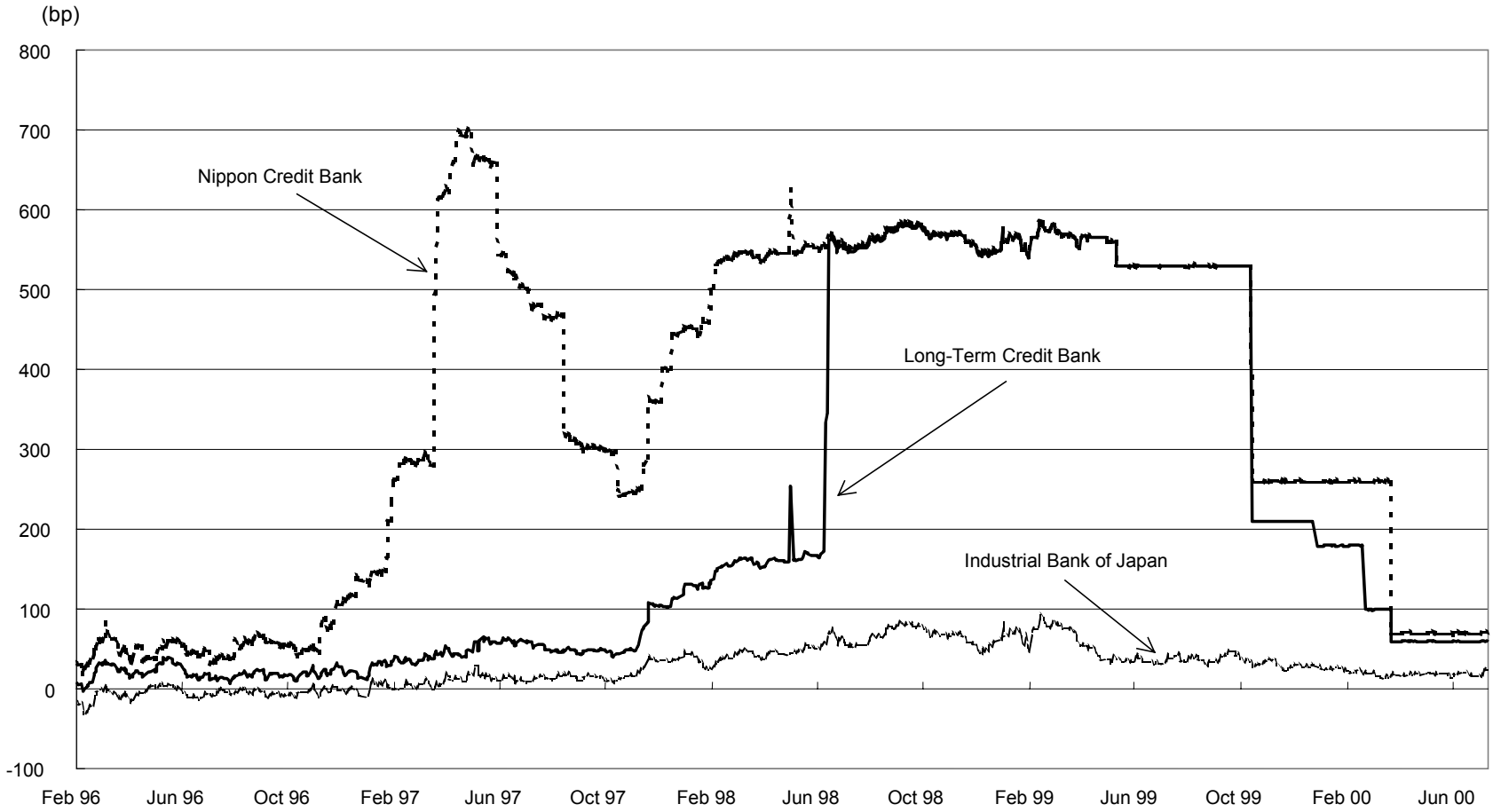
[16] Traditionally, corporate bond issuers had close connections with financial institutions. For example, in the 1950s and 1960s, the Bond Issue Arrangement Committee, which was composed of representatives from big banks and major securities firms, adjusted corporate bond financing at rigidly set low interest rates for newly issued bonds. Under this artificial low interest rate policy the only firms that were able to issue bonds were those that had close connections with financial institutions, and it was these financial institutions that bought the bonds. In a sense, corporate bonds were really just another form of bank loan.

A.3 Conclusion

The Japanese corporate bond market has improved, particularly in the 1990s. However, there remains room for further improvement in several areas, such as market design, market practice and credit analysis, compared with the United States counterpart. In the United States, the corporate bond market has opened up to less creditworthy firms, and regular issuers can float bonds nearly at will in large volume. Investors' preferences are increasingly being met with customised products that best accommodate their portfolio requirements and views. Fund intermediation can be achieved at lower cost through the bond market than through bank loans. In these respects, when the Japanese corporate bond market nears the level of its United States counterpart, trading volume will probably increase and market liquidity be enhanced.

Chart A1

Spread of five-year bank debentures over maturity-matched JGSs



Sources: Japan Securities Dealers Association; Bloomberg.

Chart A2

Spread of five-year corporate bonds by rating over maturity-matched JGSs

Chart A2.1

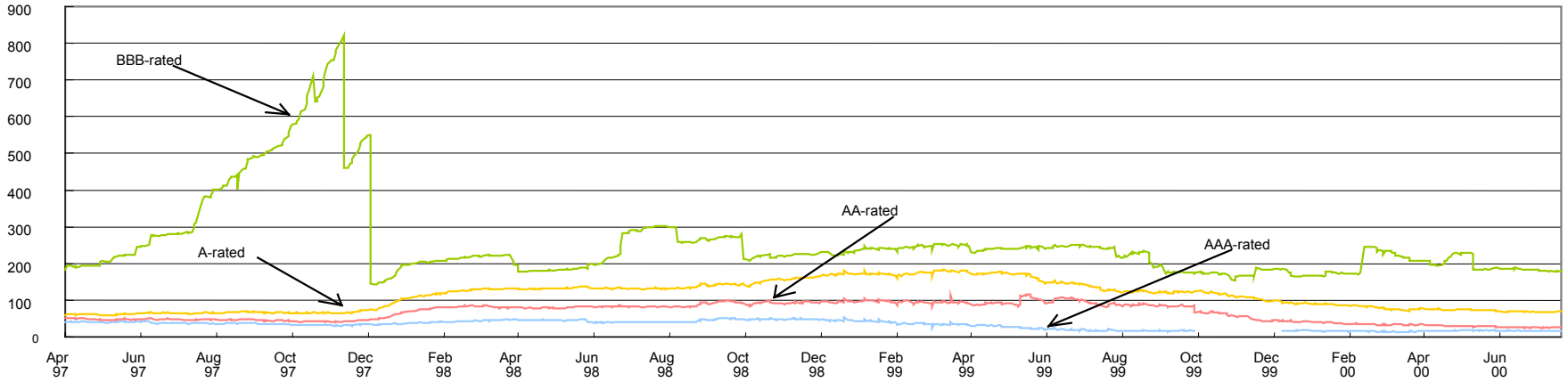
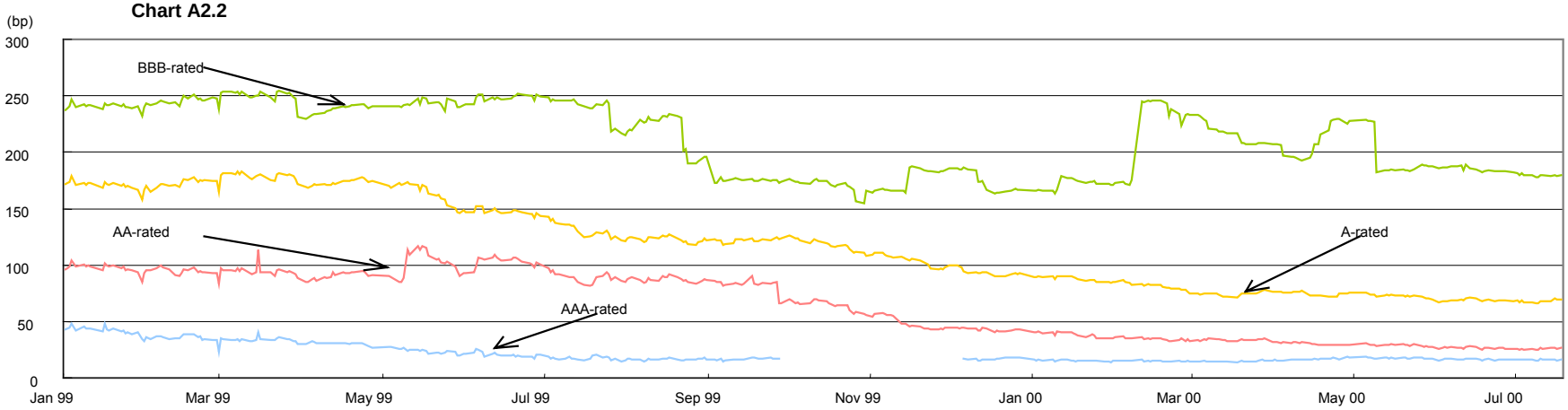


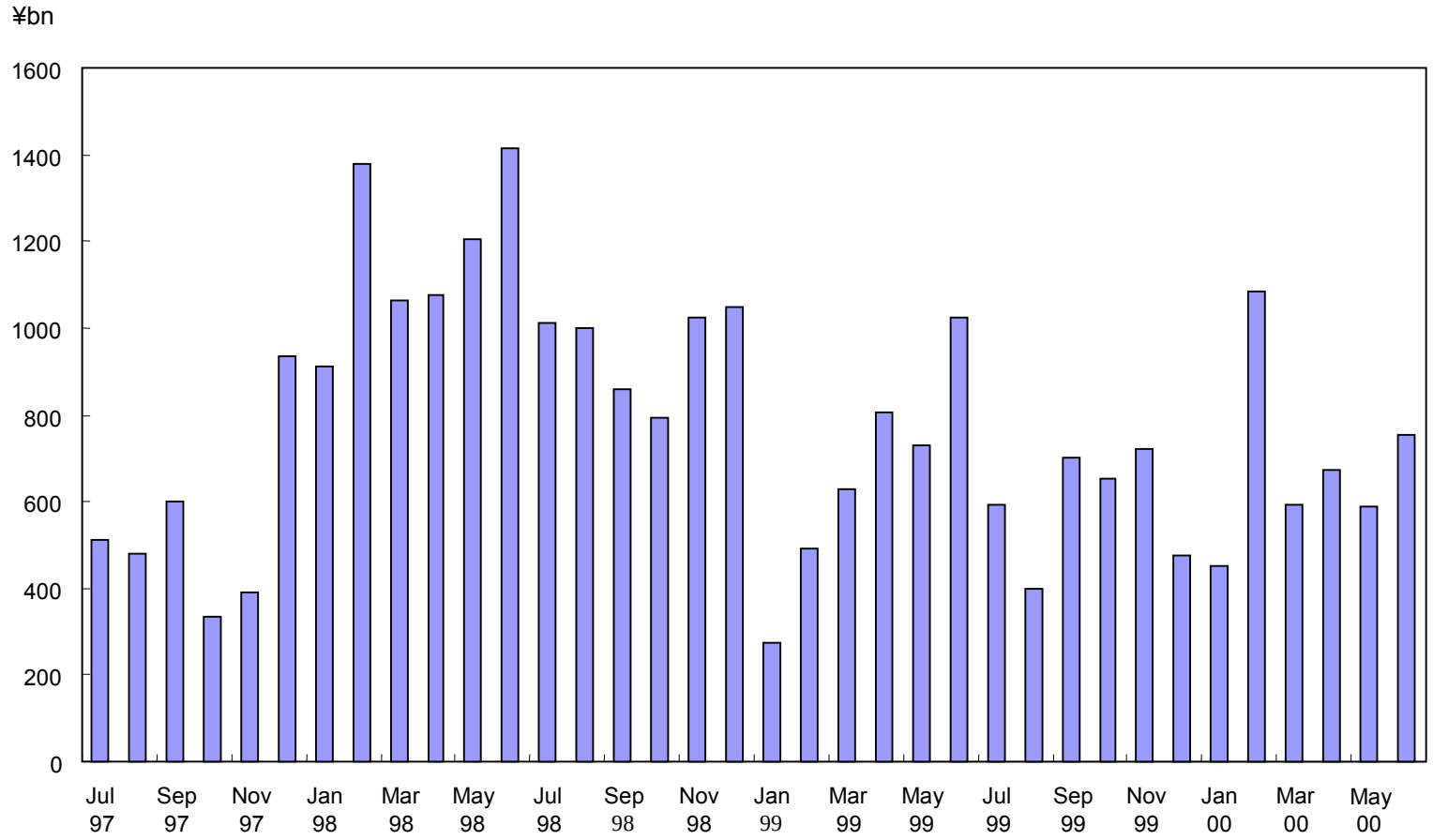
Chart A2.2



Sources: Japan Securities Dealers Association; Bloomberg.

Chart A3

Corporate bond issuance (straight bonds and asset-backed securities)



Source: Japan Securities Dealers Association.

Chart A4

Comparison of corporate bond issuance (1997)

in billions of US dollars and percentages

	Corporate bond issuance (A)	Government bond issuance (B)	Porportion of government bond issuance (A)/(B)	Nominal GDP (C)	Proportion of nominal GDP (A)/(C)
Japan	64	505	12.7	4,190	1.5
United States	168	567	29.6	8,080	2.1

Source: OECD, *Financial Statistics Monthly*, Part 1, Section 2: Domestic Markets, March 1998.

Chart A5.1

Bonds issued by Japanese firms in Japan

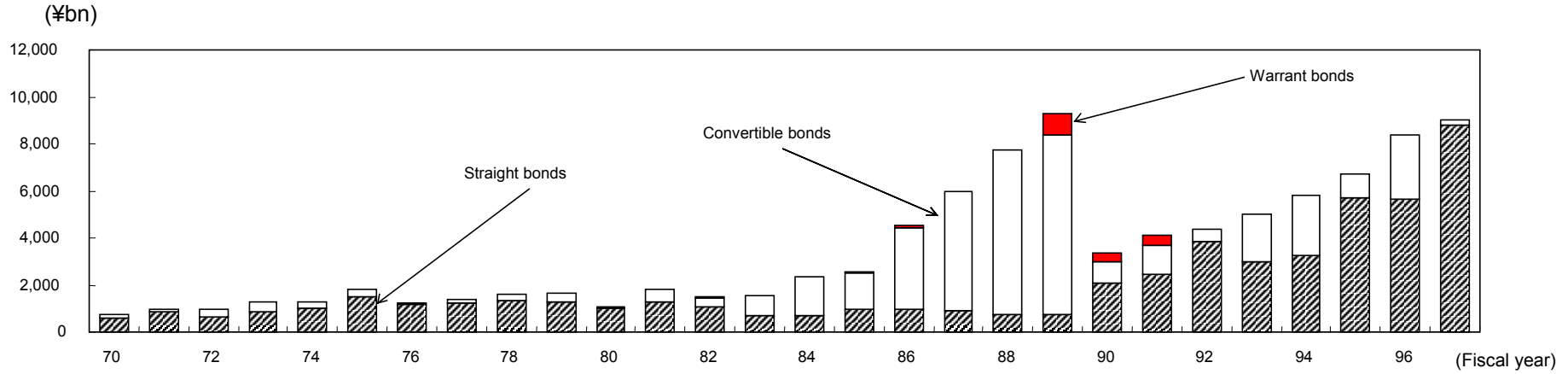
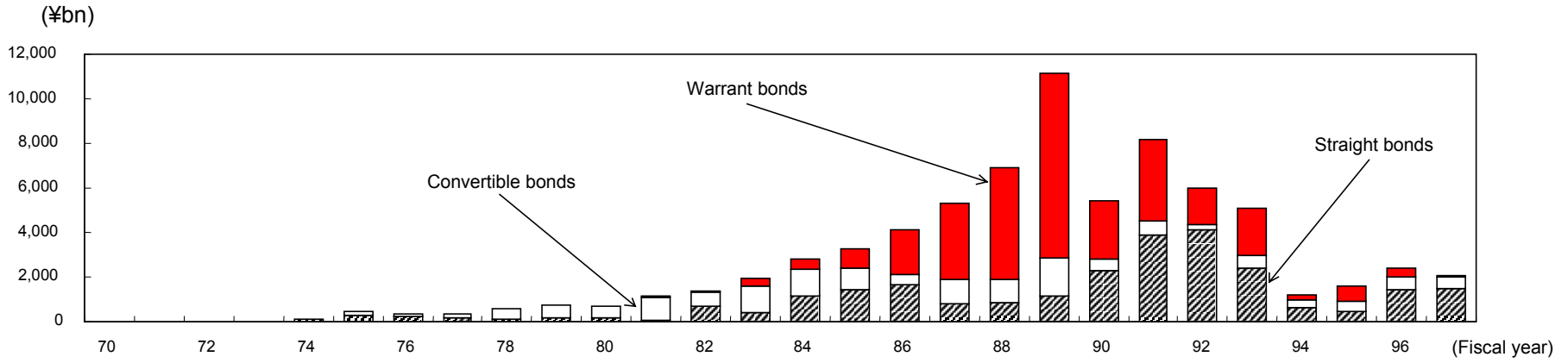


Chart A5.2

Bonds issued by Japanese firms outside Japan



Source: Japan Securities Dealers Association.

Chart A6

Size of major bond markets at year-end 1998 (nominal value outstanding)

in billions of US dollars

	Total publicly issued		Domestic bonds		Corporate bonds		International bonds	
		% of total		% of total		% of total		% of total
US dollar	12,476	(49)	10,791	(49)	3,675	(50)	1,685	(47)
Japanese	3,924	(15)	3,575	(16)	990	(13)	349	(10)
Deutsche mark	2,579	(10)	2,208	(10)	1,353	(18)	370	(10)
Italian lira	1,462	(6)	1,331	(6)	270	(4)	131	(4)
French franc	1,075	(4)	864	(4)	139	(2)	211	(6)
Pound sterling	790	(3)	507	(2)	55	(1)	283	(8)
Dutch	442	(2)	339	(2)	153	(2)	103	(3)
Canadian	432	(2)	382	(2)	73	(1)	50	(1)
Others	2,306	(9)	1,895	(9)	679	(9)	412	(11)
Total	25,484	(100)	21,891	(100)	7,370	(100)	3,594	(100)

Source: Salomon Brothers, *International Bond Market Analysis; How Big is the World Bond Market?* August 1999, Figure 1.

Chart A7

Size of major bond markets at year-end 1994 (nominal value outstanding)

in billions of US dollars

	Total publicly issued		Domestic bonds		Corporate bonds		International bonds	
		% of total		% of total		% of total		% of total
US dollar	8,023	(43)	7,266	(44)	1,509	(66)	757	(38)
Japanese	3,699	(20)	3,362	(20)	383	(17)	308	(15)
Deutsche mark	1,964	(11)	1,722	(10)	2	(0)	242	(12)
Italian lira	956	(5)	909	(6)	4	(0)	47	(2)
French franc	894	(5)	766	(5)	144	(6)	125	(6)
Pound sterling	502	(3)	360	(2)	29	(1)	142	(7)
Canadian	404	(2)	326	(2)	52	(2)	78	(4)
Others	2,073	(11)	1,760	(11)	177	(8)	312	(16)
Total	18,515	(100)	16,471	(100)	2,299	(100)	2,011	(100)

Source: Salomon Brothers, *International Bond Market Analysis; How Big is the World Bond Market?* August 1995, Figure 1.

Chart A8

Comparison of corporate bonds outstanding by rating[1]

in billions of US dollars and percentages

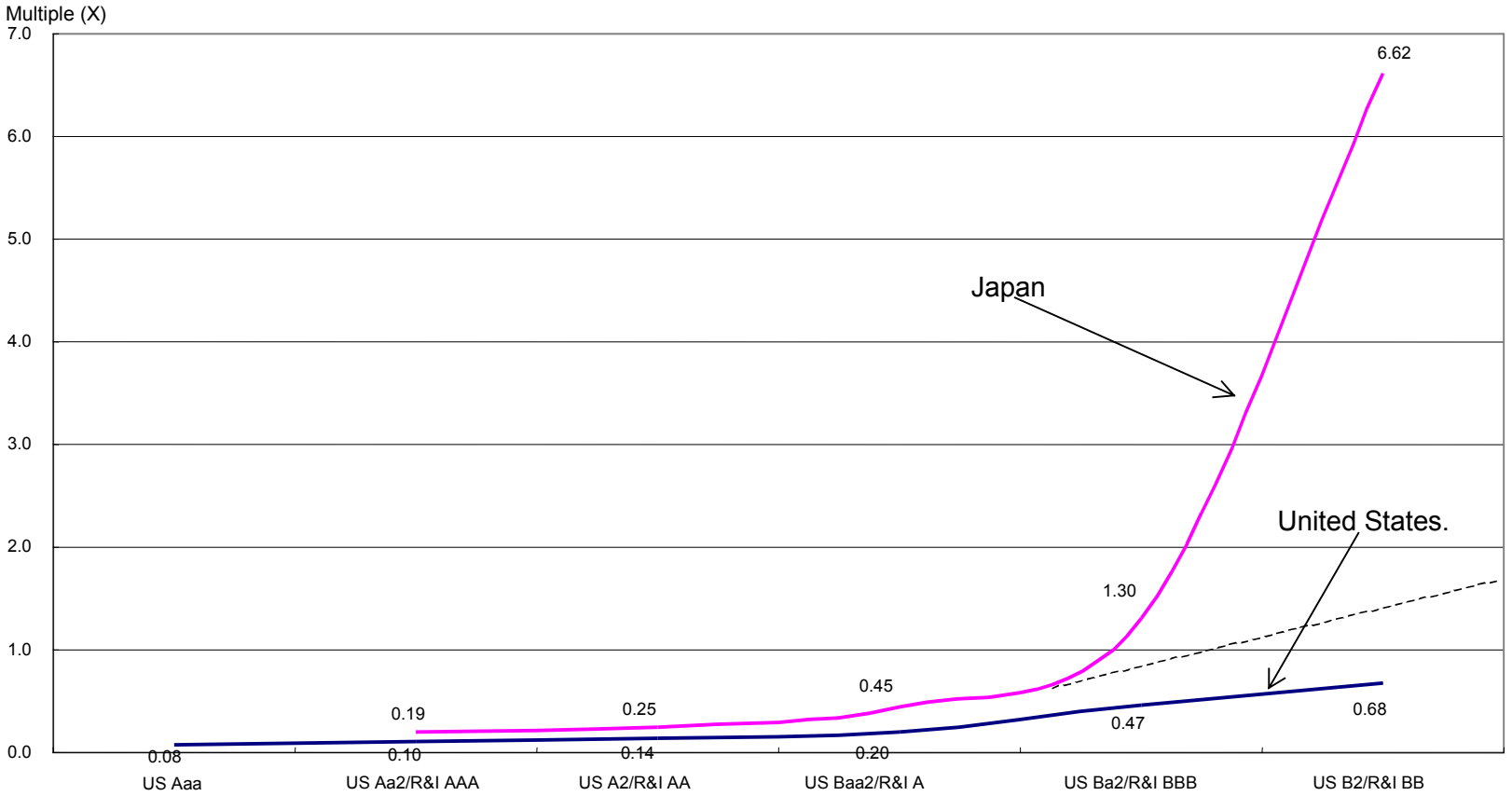
		AAA (Aaa)	AA (Aa)	A (A)	BBB (Baa)	Total
Japan	1997	30.2	42.1	26.3	1.4	100.0
	1998	30.4	40.3	29.1	0.2	100.0
	1999	33.6	25.4	34.6	6.4	100.0
United States	1997	7.7	19.2	43.9	29.3	100.0
	1998	7.8	18.0	43.4	30.8	100.0
	1999	7.4	17.2	43.5	31.9	100.0

[1] Japan: Rated by Japan Credit Rating Agency or Rating and Investment Information (R&I). United States: Rated by Moody's or S&P.

Sources: Japan: Japan Securities Dealers Association; United States: Corporate bonds in Salomon Smith Barney's BIG (broad investment grade) index (the index follows design criteria including a screen for a minimum amount outstanding of US$ 100 million for corporate issues, and a minimum quality of BBB-/Baa3 by S&P/Moody's).

Chart A9

United States-Japan comparison (multiples of spread/Treasury bonds, JGS yields) as of beginning of June 2000



Note: Maturity of three years as of early June: US$ market: T+Spread (industrials) / Treasury bond yields. JPY market: T+Spread[1]/JGS yields.

[1] Adjusted from the JSDA's October bond (Standard) quotation, Moody's ratings and one category higher R&I ratings.

Sources: Japan Securities Dealers Association; Bloomberg; Deutsche Securities.

Chart A10

Comparison of corporate bonds outstanding by maturity

		Short-term (one to three years)	Medium-term (four to 10 years)	Long-term (over 11 years)	Total
Japan	1997	3.3	67.5	29.2	100.0
	1998	12.2	75.4	12.4	100.0
	1999	12.2	77.1	10.8	100.0
United States	1997	14.3	50.3	35.4	100.0
	1998	15.3	48.8	36.0	100.0
	1999	16.2	51.8	32.0	100.0

Sources: Japan: Japan Securities Dealers Association. United States: Corporate bonds in Salomon Smith Barney's BIG (broad investment grade) index (the index follows design criteria including a screen for a minimum amount outstanding of US$ 100 million for corporate issues, and a minimum quality of BBB-/Baa3 by S&P/Moody's).

Chart A11

Trading volume and turnover ratio in the corporate bond market as of Q1 2000

in billions of US dollars

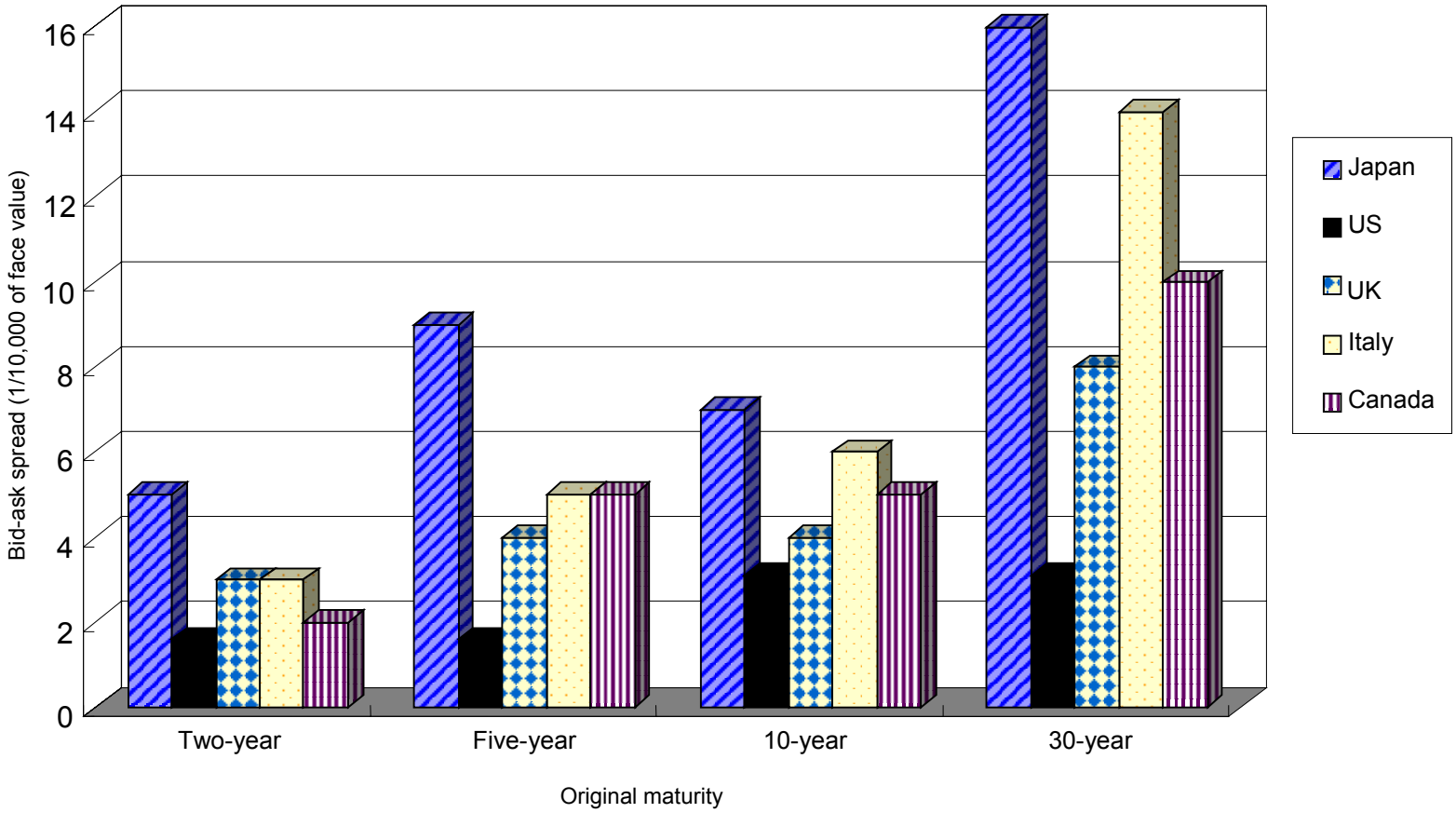
	Trading volume (A)	Outstanding volume (B)	Turnover ratio (A)/(B)
Japan	151	968	0.16
United States	2,500	3,100	0.81

Note: Turnover ratio = Trading volume/Outstanding volume (trading volume estimated by annualising daily data).

Sources: Japan: Japan Securities Dealers Association. United States: Bond Market Association.

Chart A12

Comparison of bid-ask spread

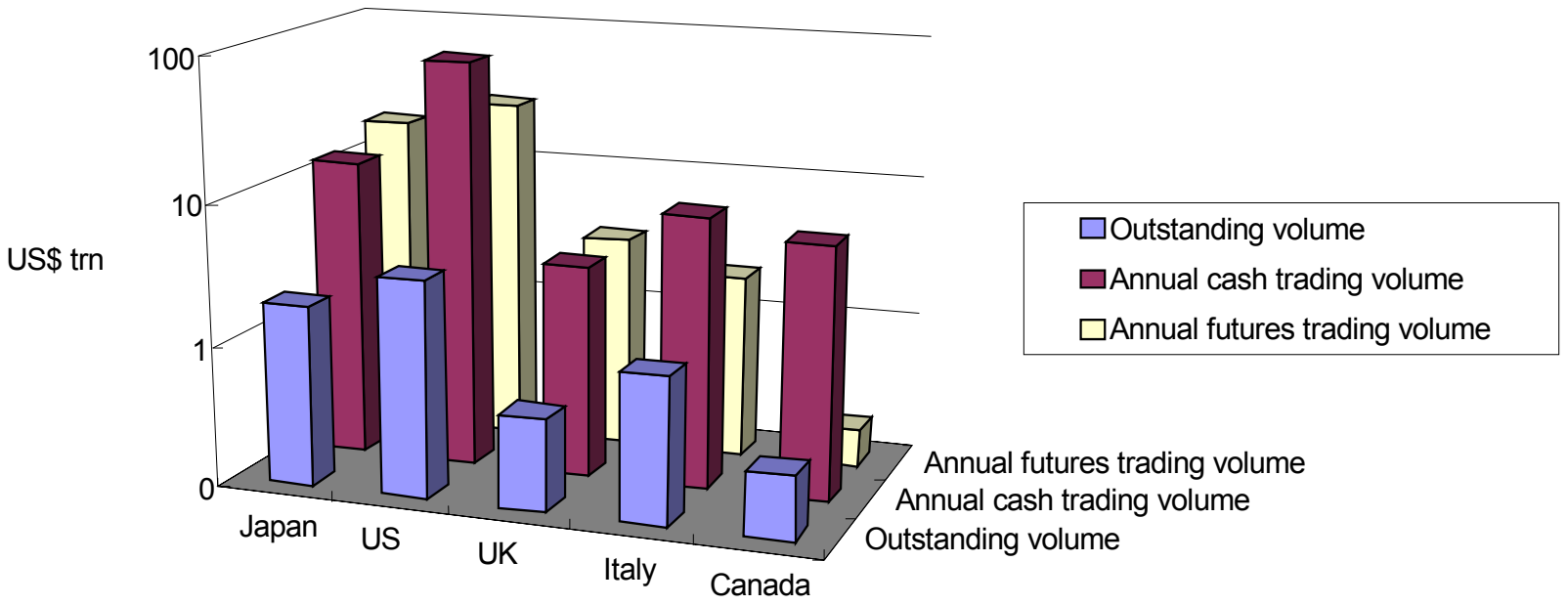


Note: The spreads for five- and 30-year JGSs are those of six- and 20-year bonds.

Source: BIS, *Market liquidity: research findings and selected policy implications*, 1999.

Chart A13

Turnover ratios



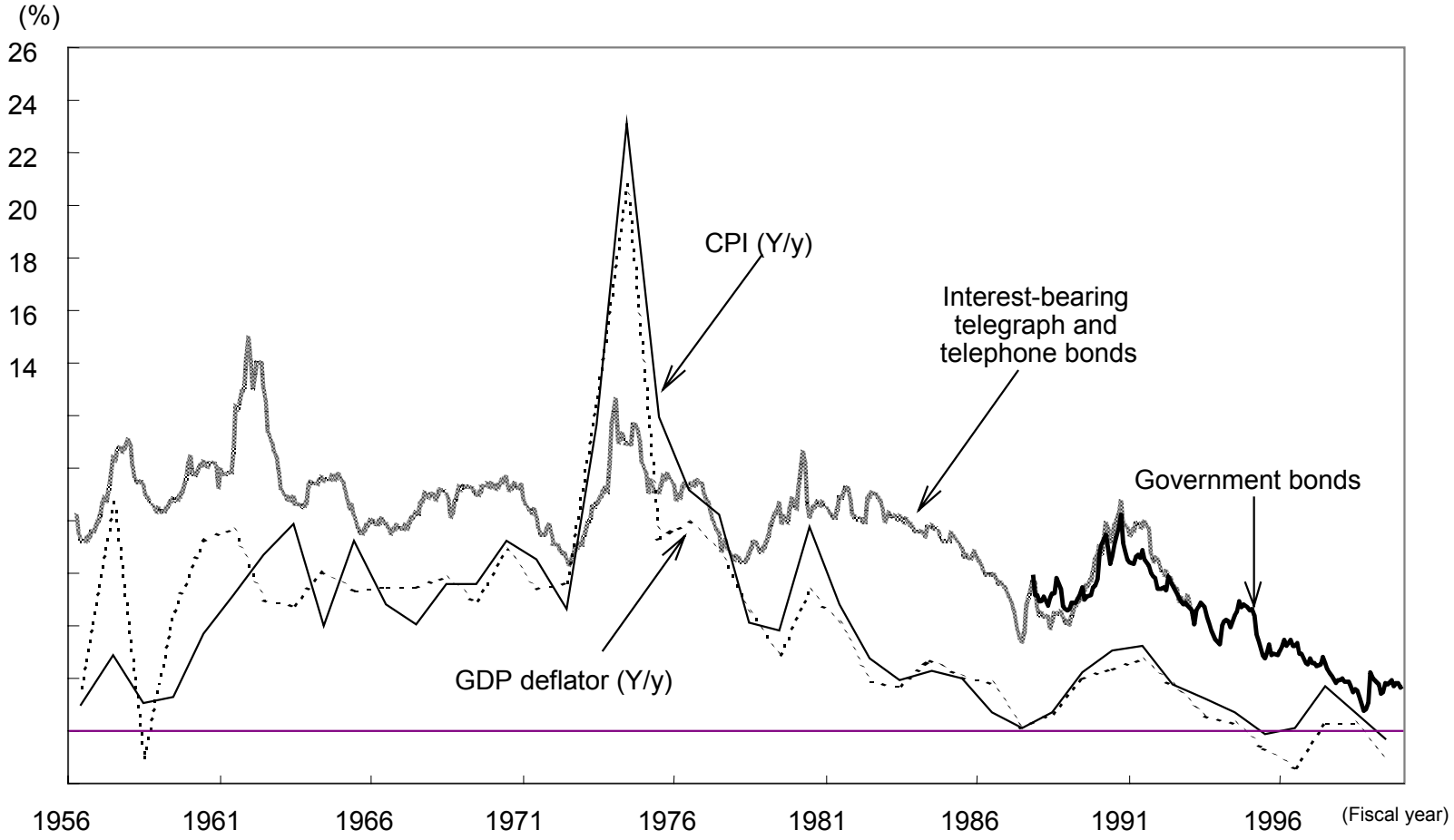
	Japan	United States	United Kingdom	Italy	Canada
Cash turnover ratio	6.9	22.0	7.0	7.7	21.9
Cash/futures ratio	0.7	2.7	1.0	4.1	33.7

Note: As of 1997. Cash turnover ratio = Trading volume (two-way basis)/Outstanding volume; Cash/futures ratio = Cash trading volume/Futures trading volume.

Source: BIS, *Market liquidity: research findings and selected policy implications*, 1999.

Chart A14

Japanese long-term interest rates and inflation rates

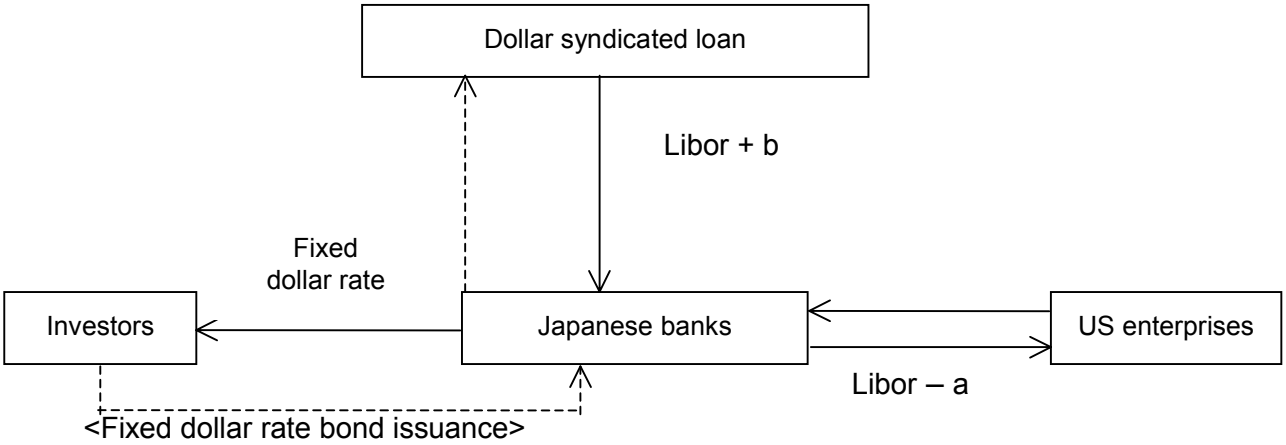


Sources: CPI: Management and Coordination Agency. GDP: Economic Planning Agency. Other: Japan Securities Dealers Association.

Appendix:
Overview of the yen interest rate swap market

Currency swap market transactions started in the Tokyo market around 1980 when the Foreign Exchange and Foreign Trade Control Law was revised. About two years later, interest rate swap transactions started in the Tokyo market when Japanese banks conducted dollar interest rate swaps with United States enterprises in order to raise floating rate funds using the following scheme (Figure 1).

Figure 1



Yen swap transactions started several years later, around 1986. At that time, most swap transactions were closely connected with the foreign bond issuance of Japanese enterprises or yen bond issuance by foreign enterprises via the following schemes (Figures 2, 3).

Figure 2

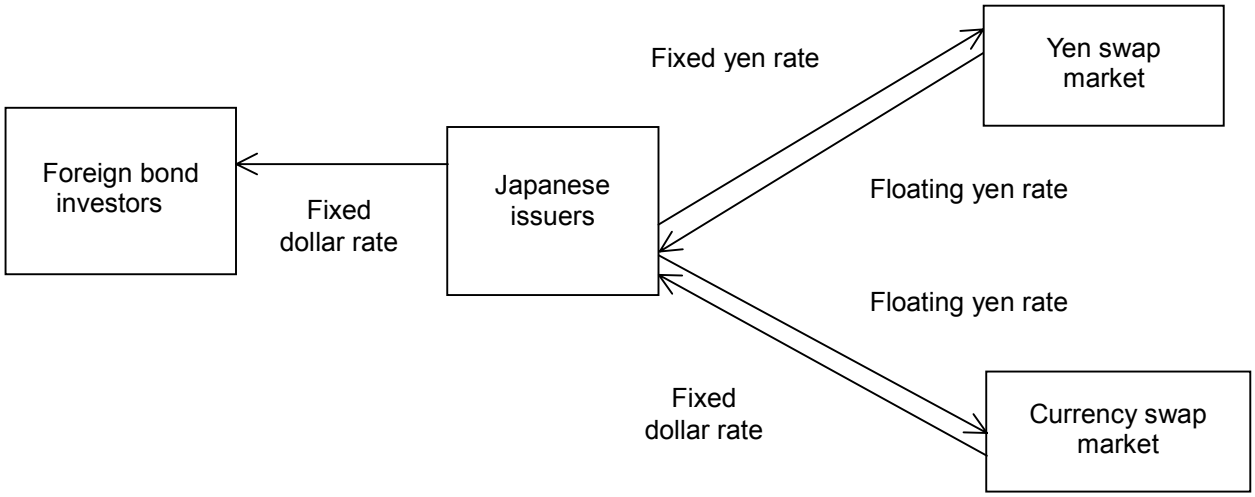
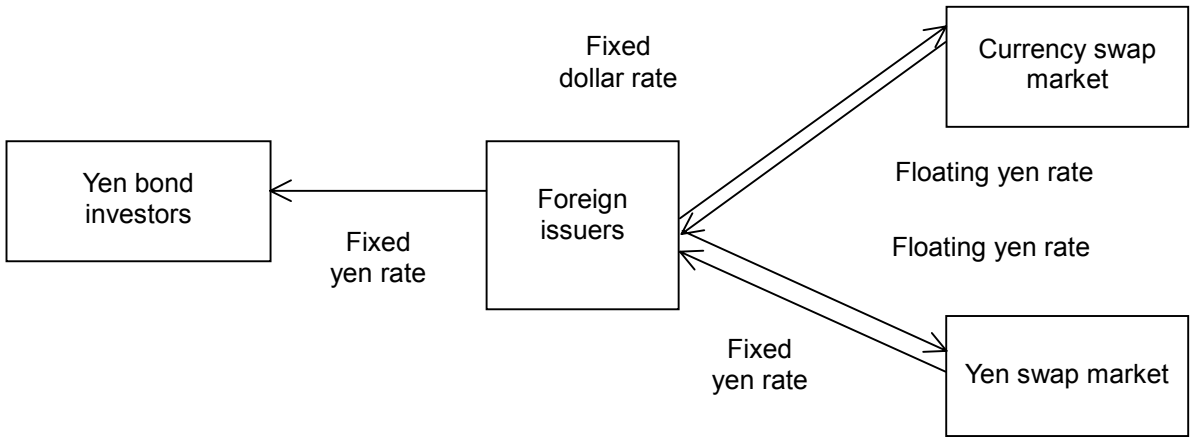


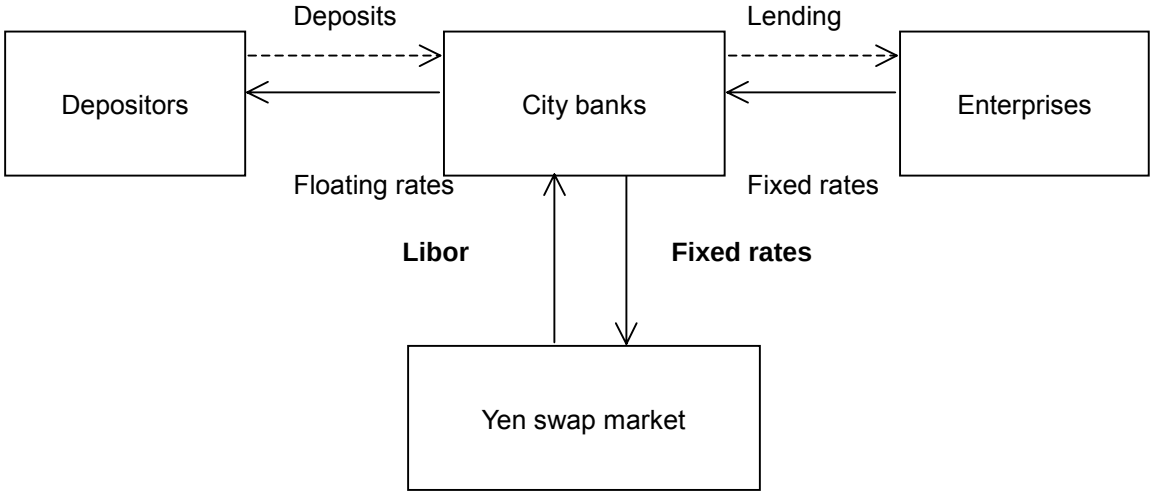
Figure 3



When Japan's interest rates rose under tight monetary policy after 1989, the need to hedge interest rate risk increased among city banks. As city banks' hedging needs increased, yen swap transactions became more prevalent.

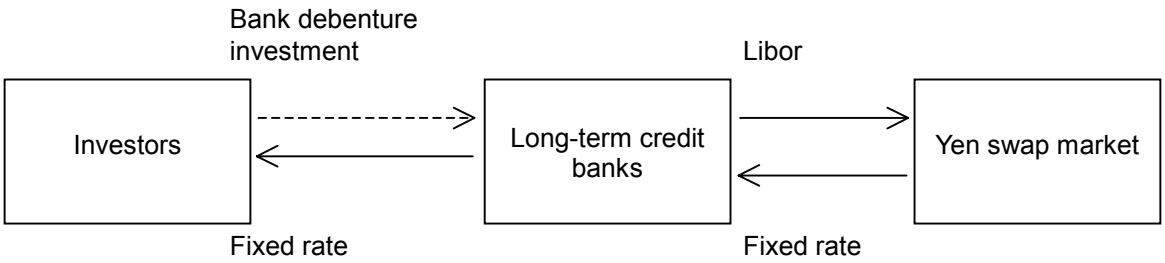
City banks have paid fixed/received floating positions using yen swap transactions as follows (Figure 4).

Figure 4



Also, other main players such as long-term credit banks, which receive fixed so as to hedge bank debenture issuance, became active in the yen swap market (Figure 5).

Figure 5

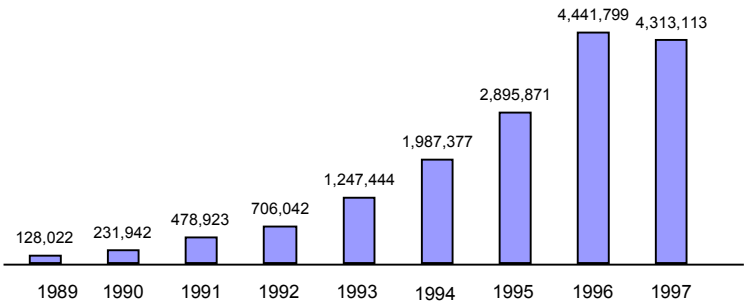


In addition, large Japanese banks, securities houses and foreign investment banks actively effected yen swaps in the Tokyo market in the 1990s. Thus, transaction volume of the yen swap market increased remarkably as shown in Figure 6.

Figure 6

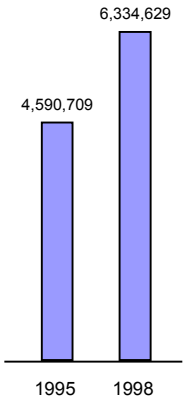
Notional yen interest rate swap amounts outstanding at year-end

(US$ equivalent in millions of United States dollars)



Source: ISDA.

(US$ equivalent in millions of United States dollars)



Source: Central bank survey of foreign exchange and derivatives market activity.

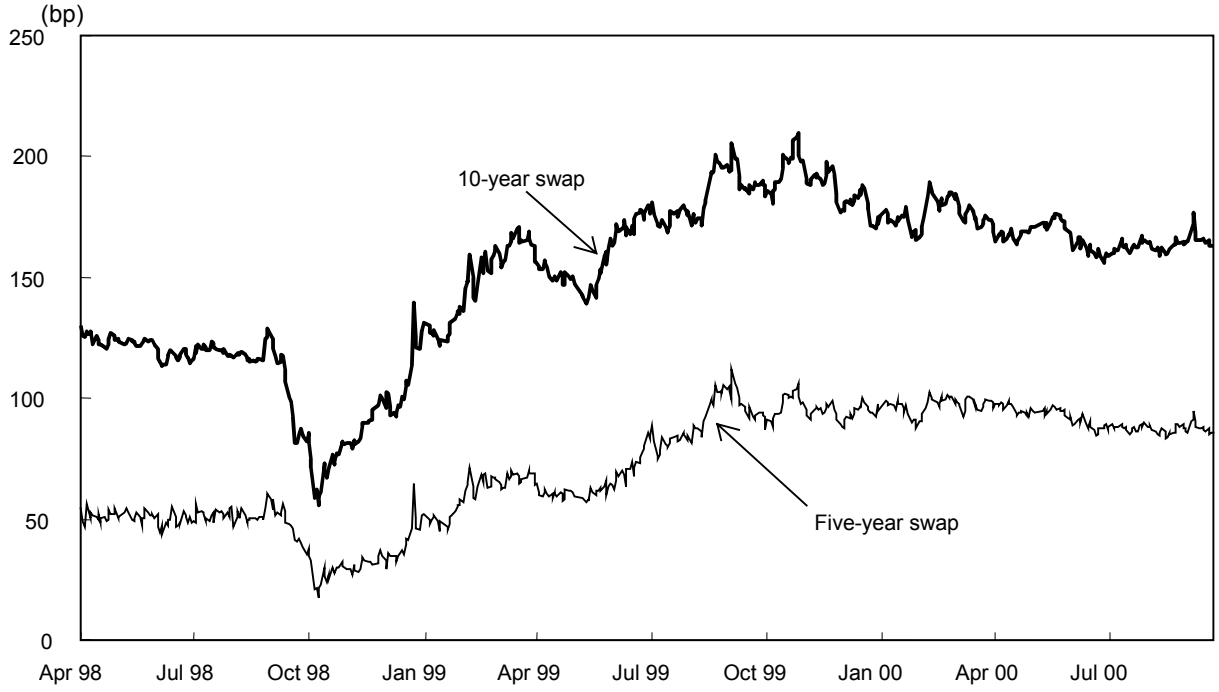
With the increased transaction volume in yen interest rate swaps, yen swap rates have become more prevalent as the benchmark for long-term interest rates in the Tokyo market. As a result, the yen swap market and bond market have become more closely connected.

A typical example was the effect of some disruption in the JGS market in mid-August 1999, which was reported to be due to Y2K concerns.

Concretely, the JGS futures market did not function as a hedging tool because of a malfunction in repo transactions for cheapest to deliver issues. Reports surfaced of the hoarding of the desired securities by some Japanese institutions. This turbulence in the JGS market also affected the yen swap market. During the turbulence, JGS market players switched hedging tools for JGS cash transactions from JGS futures to yen swaps, which resulted in a widening yen swap spread as shown in Figure 7.

Figure 7

Spread of Japanese yen interest rate swaps over the JGS benchmark



Source: Bloomberg.

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Government bond market valuations in an era of dwindling supply

Neil Cooper and Cedric Scholtes, Bank of England[1]

Abstract

This paper considers whether diminishing government bond supply has driven government bond prices above levels consistent with economic fundamentals. By assuming the swap market is unaffected by supply side considerations and by developing an expression for the fair value for the swap spread, we use swap spreads as a measure of the possible divergence between government yields and true risk-free rates. By investigating swap spreads across currencies and maturities, we find evidence that, in both the United Kingdom and the United States, government bond yields have been depressed below risk-free rates. Although this bias has corresponded with reductions in net issuance, it is difficult to identify a robust statistical relationship between issuance and the swap spread.

This paper also examines two specific issues which arise when government bonds cease to accurately reflect risk-free rates: (i) how policymakers should measure the risk-free term structure in the presence of distortions to the yield curve; and (ii) how bond market participants price non-government bonds in the absence of a risk-free benchmark.

1. Introduction

In the past two years there has been growing concern amongst market participants about the impact on government bond prices of the decreasing issuance of government securities by several of the G7 governments. This has been most pronounced in the United States, where the value of outstanding federal government debt held by the public has already declined from nearly 50% of GDP in the mid-1990s to 30.5% of GDP in 2001 and is forecast to fall to only 4.8% of GDP by 2011.[2] Reductions in the size of sovereign debt stocks are an important issue because government debt is central to the implementation of monetary policy and to fixed income markets more broadly. Government securities are the main asset class held by central banks, and are also used as benchmarks for monitoring risk-free interest rates and monetary conditions more generally, as well as providing pricing reference points and serving as hedging vehicles for other fixed income securities. Indeed, so widespread is the use of government securities and their derivatives that Friedman (1999) has claimed that "the entire risk management business as we know it today would have been impossible before the mid-1970s change in debt management policy [that re-enabled the US Treasury to issue long term debt]".[3]

Although the outstanding stock of government debt in the United Kingdom and the United States is still large, we will show that there is already some evidence that the falling net supply of government bonds in these countries has depressed their yields below "true" nominal risk-free rates and diminished their use as benchmarks. But while there has been a great deal of discussion of the impact on financial markets of reduced issuance and the corresponding depression of government bond yields, much of this has been in qualitative terms. This paper provides quantitative estimates of the size of these effects.

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[1] The views expressed are those of the authors and do not necessarily reflect those of the Bank of England. The authors would like to thank Martin Brooke, Roger Clews, Mark Salmon and participants in the Study group on fixed income markets for helpful advice and comments. All errors are, of course, the authors'.

[2] See Congressional Budget Office (2001).

[3] In the mid-1970s the US Treasury was effectively banned from issuing long-term debt with coupons equal to current long-term interest rates by a legal prohibition on the issuance of Treasury securities with a coupon greater than 4.25%. As pointed out by Friedman, this meant that by the mid-1970s the mean maturity of US government debt was only 2.5 years.

In the United Kingdom there has been concern among the authorities for much of the postwar period that changes in the supply of government bonds affect gilt prices. Goodhart (1999) explains that the worry of the Bank of England was that an excessive supply of gilts would increase gilt market yields. Reflecting this concern, during the 1950s to 1970s the Bank acted in the gilt market to attempt to stabilise prices - it sold in a rising market and, until a change of policy in 1971, made net purchases to support the market when prices were falling. In particular, the Bank waited for environments in which yields were falling before undertaking sizeable gilt sales.

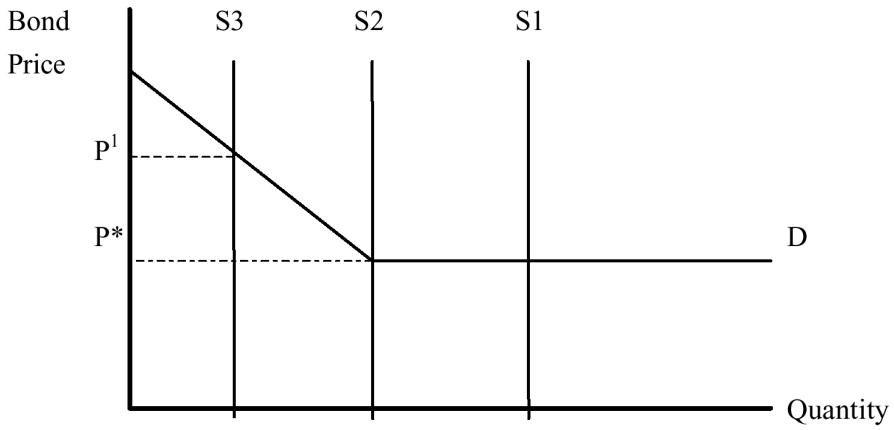
To test whether supply does matter in determining gilt prices, Goodhart and Gowland (1978) use monthly data on gilt sales from 1954 to 1972 and estimate cross autocorrelations between 20-year yields and net sales of long gilts. They find no support for the hypothesis that increased gilt sales push up gilt yields. Later work by Eggington and Hall (1993) examines the effect of gilt issuance on the slope of the yield curve. They first derive a measure of the slope of the yield curve by using principal component analysis (PCA). PCA enables movements in the yield curve to be decomposed into a limited number of underlying factors. In almost all applications of PCA to the yield curve, three factors are found: a parallel shift factor, a tilt factor (ie a change in the slope) and a twist factor (ie a change in curvature). Employing daily data on outstanding stocks of UK gilts, Eggington and Hall model the time series properties of the tilt factor and find that the supply of bonds has a significant impact on the shape of the yield curve. In particular, they find that an increase in the proportion of bonds with maturity greater than 10 years causes a steepening of the yield curve. This they take as evidence for a rejection of the expectations hypothesis in favour of a market segmentation view of the determination of the yield curve.

So previous central bank concern has been associated with the ill effects on the bond market of issuing too much debt too quickly. The current policy concern is effectively the opposite of this. It is that by repurchasing government debt the yields of government bonds will cease to act as a benchmark measure of the risk-free term structure of interest rates and that this will impose costs on the remainder of the economy. Of course, many mainstream financial economists would be uncomfortable with the idea that merely changing the supply of government bonds could have an impact on yields. In theory nominal yields on default risk-free bonds should depend on current and expected real risk-free interest rates, inflation expectations and appropriate risk premia. Just changing the supply of government bonds should not in theory cause a change in bond yields unless it changes one of these underlying drivers, such as a change in inflation expectations if investors perceived there to be a greater risk of the monetisation of government debt. And yet when market practitioners sought to explain much of the fall in UK and US long-term nominal bond yields during 1999 and early 2000, their explanations were generally in terms of the change in current and projected supply of government bonds, rather than these more theoretical considerations.

Under what conditions might we expect to see changes in the supply of government bonds result in their yields ceasing to be an accurate measure of the risk-free term structure of interest rates? There are two requirements: first, that there could exist a subset of investors with price-inelastic demand for government bonds; and, second, that the supply of bonds should fall sufficiently that these investors become the marginal and hence dominant investors that dictate the bond price. This is illustrated in Chart 1.

Chart 1

The effect of diminishing supply on government bond prices



In this highly simplified description of the world, there are two types of investor: the unconstrained marginal investor and the investor with a price-inelastic demand for government bonds. The unconstrained investor has a perfectly elastic demand for the bond at the equilibrium price P*. The constrained type would hold the bond even if its yield were lower (ie if its price were higher). Why would she do this? One reason is that she may be constrained (or strongly encouraged) by some form of regulation to hold a government bond even when its yield falls below the theoretical fair value. A second possibility is that the investor is an institutional fund manager whose performance may be closely measured against a government bond benchmark. Her incentives may be to hold government bonds even though they provide a poor total return so that the performance of the fund does not stray far from the performance benchmark. Price inelasticity of demand from constrained investors is the reason the demand curve slopes downwards at first. If the price falls to the risk-free yield, additional demand comes from the unconstrained investors. Chart 1 makes clear that we could observe a large reduction in supply of government bonds from S1 to S2 in the diagram without incurring any effect on price. This happens when there is sufficient supply, even after the debt buyback, to satisfy the demand of the constrained investors. As supply is cut further from S2 to S3, the bond price rises above P* to P1 as constrained investors bid up prices and yields drop below the risk-free curve. Bond prices become overvalued in the sense that their yields are no longer reflective of default risk-free interest rates.

Is this what we see in practice? In some markets, such as the UK index-linked gilts market, the observed yields do appear to be surprisingly low and the bonds are held almost exclusively by investors with strong incentives to hold them, notably pension funds and life assurance companies. For other markets, such as the UK conventional gilt and US Treasury markets, practitioners have also argued that negative net issuance of bonds has caused yields to fall below true risk-free rates. One problem with these arguments is that in practice we continue to observe a remaining subset of investors who hold these securities but who do not seem to be constrained in any way to do so. This observation leads Grinblatt (1995) to argue that either these investors are behaving irrationally or they may be holding these bonds for other reasons. Grinblatt suggests that because government bonds can be used as collateral to obtain cheap short-term funding (sometimes very cheap when a bond goes “special”), this liquidity “convenience yield” is reflected in prices, pushing yields below the risk-free curve.

The main purpose of this paper is to try and generate a measure of the extent to which government bond yields may have been pushed below true risk-free rates. We use interest rate swap spreads to measure the impact of the reduced supply on government bond yields. Financial market practitioners have regularly pointed to widening swap spreads in the US dollar and sterling fixed income markets as evidence that the corresponding government bonds are becoming overvalued as issuance declines. We develop the intuition behind these arguments by first developing a simple framework to measure the fair value of swap spreads and then use the excess of the observed swap spread over this fair value as our measure of the overvaluation of government bonds in alternative markets. This framework also allows us to consider how policymakers should adjust forward curves estimated from government bonds when trying to assess expectations of future short-term interest rates. Finally, we also examine whether the swap market is currently acting as the de facto benchmark for very high-quality bond issues.

The rest of this paper is organised as follows. In Section 2 we set out the main argument for using swap spreads as a measure of misvaluation in government bond markets. Section 3 examines empirically the behaviour of swap spreads, relating them in particular to net issuance of government debt. Section 4 examines two specific issues that arise if government bond markets cease to be an accurate measure of riskless interest rates: (i) how policymakers should measure the risk-free term structure in the presence of distortions to the yield curve; and (ii) how market practitioners price non-government debt in the absence of government bond market benchmarks. Section 5 concludes.

2. Using swap spreads as a measure of relative valuation

How can we measure whether government bond yields are artificially depressed? An obvious way would be to examine long bond yields or the slope of the yield curve. If long government bond yields are falling and/or the yield curve is inverting during a time of dwindling supply, then this might be taken as evidence that the bond market is becoming overvalued as a result. However, the obvious

alternative to this explanation is that the bond market remains fair value but that the underlying fundamental economic drivers of long nominal bond yields - expected real interest rates, inflation and risk premia - have changed.

What we need is a way of disentangling movements in yields caused by reductions in supply from those that are caused by fundamental determinants. One way of doing this is to examine the movements in spreads between government bonds and other fixed income securities that are close comparators. If we assume that the latter securities remain fairly valued against the "true" (but unobservable) default risk-free yield curve, then we would expect the spreads between their yields and those of government bonds to widen as government bond yields become depressed. Here again, though, we are faced with the difficulty of disentangling changes in the spread due to changes in the fair value of credit spreads over risk-free rates and the movements due to government bond overvaluation. So to do this, we need to use a comparator instrument for which we have a very good idea of what the fair value of the spread between its yield and the true risk-free rate should be.

The instrument we use is the interest rate swap. An interest rate swap is an over-the-counter contractual agreement between two parties to exchange cash flow streams denominated in the same currency but calculated on different bases. The most common type of swap is the "plain vanilla" fixed-for-floating swap. This is an agreement that binds each party to make periodic interest payments to the other on a predetermined set of dates in the future, based on a notional principal amount denominated in the same currency. One party is the fixed rate payer - the fixed rate being agreed at the inception of the swap. The other party is the floating rate payer - the floating rate being determined during the lifetime of the swap by reference to a specific market rate.[4] Note that there is no exchange of principal at any time - there are only exchanges of (net) interest payments.

A par swap is a plain vanilla interest rate swap with zero initial premium (ie where the swap rate is set such that the fixed and floating "legs" of the swap have equal present value, so that it costs nothing to enter into the swap). One can think of the cash flows on a par swap as a combination of a fixed rate bond that pays a coupon equal to the agreed swap rate and a floating rate bond with coupon equal to the reference Libor rate. At initiation of the contract, it can be shown that the floating-rate bond is worth the notional principal. For the contract to have zero net present value, the fixed side must therefore also be worth the notional principal. In other words, the fixed side of the swap can be thought of as a fixed rate bond that trades at par and pays a coupon equal to the swap rate. It follows from this that the swap rate is a par yield.

The difference between the swap rate and a government bond par yield with the same maturity is called the swap spread. We use the swap spread as a measure of overvaluation by assuming that the swap market is fairly valued and by using a model for calculating the fair value of the swap spread. If the swap spread is greater than the level suggested by this model, then we attribute it to overvaluation in the corresponding government bond market. Clearly, the assumption that the swap market is fairly valued at all times, while the government bond market is not, is debatable. But we think there are stronger reasons to believe that the government bond markets may become overvalued than there are to suggest that swaps are mispriced: the swap market is now huge in terms of outstanding notional principal, there are no supply constraints as for the government bond market, it is easy to take long or short positions using swap contracts, and there are no obvious regulatory distortions affecting swap pricing.

2.1 A fair value for the swap spread

In the following section we outline a methodology to determine the fair value for the swap spread assuming the swap and the underlying government bond both pay their coupons semiannually. It is straightforward to rework this analysis for bonds and swaps with annual cash flows. We shall show that in theory the swap spread should be closely related to expectations of the future spread between six-month GC repo and six-month Libor. To see this, consider the following trade as an example:

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[4] For sterling fixed/floating rate swaps, the reference rate is by convention GBP six-month Libor with semiannual payment frequency on both legs. For euro fixed/floating swaps, the reference rate is generally EUR six-month Libor, with either *annual/semiannual* or *semiannual/semiannual* payment frequencies. US dollar swaps can commonly be referenced on an *annual/quarterly* basis on three-month USD Libor, or on an *annual/semiannual* basis on USD six-month Libor.

- short sell *$X* of 10-year government bonds trading at par and yielding *Y* (the fixed coupon rate);[5]
- invest the proceeds in six-month GC repo and roll over at each six-month interval over the 10-year life of the bond;
- simultaneously enter a 10-year swap contract (costing nothing) to receive fixed/pay six-month Libor at the current swap rate, R, on an $Xm notional principal.

This portfolio costs nothing to set up. Over the 10-year life of the bond, it pays a cash flow of:

*(((R - Y)/2) – ((6M Libor - 6M GC repo)/2)) * $X* (1)

every six months, where *R* and *Y* are the swap rate and the par yield on the bond at initiation of the trade. *(R–Y)* is the swap spread. The trader receives every six months *R/2* (half the initial swap rate) but has to pay out *Y/2* (half the coupon rate on the short bond position). He also has to pay out six-month Libor on the floating side of the swap, but receives the six-month GC repo rate on the invested proceeds from the short sold bond. The present value of this set of cash flows at initiation of the trade is given by:[6]

$$\sum_{i=1}^{20} \frac{(R-Y)X/2}{\left(1+\frac{r_i}{2}\right)^i} - E_0 \sum_{i=1}^{20} \frac{(6MLIBOR_i - 6MGCREPO_i)X/2}{\left(1+\frac{y_i}{2}\right)^i} \quad (2)$$

where r_i is the appropriate maturity riskless nominal zero coupon yield used to discount the cash flows in the first summation term, since these are known at the start of the trade. The second term represents the present value of the expected spreads between six-month Libor and six-month GC repo multiplied by *X*, the underlying principal. These cash flows are uncertain and depend on the spread between these two six-month rates at each of the semiannual payment dates at which swap cash flows are exchanged and the repo trade is rolled over. Since they are uncertain, their expected values are discounted at rate $y_i = r_i + \gamma$, where γ is a risk premium which reflects the anticipated risk of future movements in the Libor-repo spread. In equilibrium, under the CAPM, this spread will be determined by the covariance of innovations in the six-month Libor-repo spread with returns on the market portfolio.

If both the government bond and swap markets are fairly valued, then expression (2) should equal zero since the trade costs nothing to set up in the first place. Therefore:

$$\sum_{i=1}^{20} \frac{(R-Y)}{\left(1+\frac{r_i}{2}\right)^i} = E_0 \sum_{i=1}^{20} \frac{(6MLIBOR_i - 6MGCREPO_i)}{\left(1+\frac{y_i}{2}\right)^i} \quad (3)$$

Taking *(R-Y)* outside the summation term and rearranging provides an expression for the swap spread in terms of future expected spreads between six-month Libor and six-month GC repo:

[5] We are implicitly assuming it costs nothing to short the bond. But in practice it could go "special" in the repo market, so that the cost of reversing in the bond to sell could be non-negligible.

[6] This formula ignores the impact of counterparty default risk on the swap. This risk is very low since there are no transfers of principal and each side of the swap is effectively collateralised by the value of the other side. Using simulations of a theoretical model of default risk, Duffie and Huang (1996) show that this risk contributes less than three basis points to the swap spread. In practice this risk is further minimised by the use of margining and the fact that banks often use AAA-rated special purpose vehicles to conduct swap business.

$$R - Y = \frac{E_0 \sum_{i=1}^{20} \left[\left(6MLIBOR_i - 6MGCREPO_i \right) \Big/ \left(1 + \frac{y_i}{2} \right)^i \right]}{\sum_{i=1}^{20} \left[1 \Big/ \left(1 + \frac{r_i}{2} \right)^i \right]} \qquad (4)$$

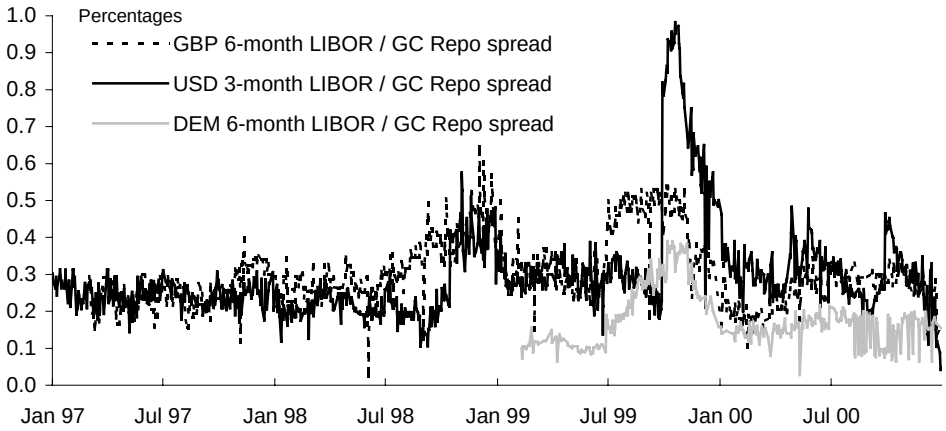
This equation demonstrates that the fair value of the swap spread is intimately related to expectations of the future spread between six-month Libor and six-month GC repo. If we assume the risk premium is zero, then the fair swap spread is simply a weighted average of future expectations of this spread over the life of the swap. By making assumptions about the expected future spreads between six-month Libor and GC repo and assumptions about the risk premium term, we can see what the swap spread ought in theory to be on the basis of equation (4).

Chart 2 shows time series for Libor-GC repo spreads for the US dollar, sterling and euro markets.[7] Although in the US dollar and sterling market these spreads have averaged around 30-40 basis points (bp), they have tended to widen during times of financial crisis such as the autumn of 1998. But they rarely move by more than 10-15 bp and appear to quickly revert back towards their mean levels. They were also much higher for the six months prior to the start of the year 2000. Given this behaviour, a simple rule for modelling expectations of the future spread is that they are flat at this historical average - we use 35 bp. In the euro markets the equivalent spread has historically been lower at 15-20 bp, so the appropriate rule should reflect this.

What is an appropriate level for the risk premium? We have done only a very limited amount of work on this. Using a simple CAPM framework, for the sterling market we regressed innovations in the Libor-repo spread against returns on the FTSE-100 as a proxy for the market portfolio. This yielded a beta estimate that was negative, but not statistically significantly different from zero. So our best guess at this stage is that the risk premium is small but negative. This makes sense since the spread is generally larger in times of financial crisis, when equity market returns tend to be negative. An asset which pays a higher return when the rest of the market is depressed should attract a negative risk premium. A zero risk premium, γ, gives a measure of the fair value of the swap spread of 35 bp using equation (4) and our simple expectation of the future Libor-repo spread. Using a –2% risk premium as an extreme case, we obtain an upper bound on the size of the fair value of the swap spread of 50-55 bp. All this suggests an estimate of the fair value for swap spreads in the sterling and US dollar markets of 40-50 bp, with perhaps 30 bp in the euro market.

Chart 2

Libor-GC repo spreads for USD, GBP and EUR (DEM)



[7] We only have data for the three-month GC repo-Libor spread for the United States.

2.2 Recent developments in swap spreads

How does this square with reality? Chart 3 plots 10-year swap spreads over government benchmark yields since 1987 for the dollar, sterling and euro (we use Deutsche mark swaps prior to 1999). What is clear is that for the middle part of the 1990s these swap spreads were close to what we would have expected given our simple model. Prior to this, swap spreads were wider, particularly in the United States and United Kingdom, though the swap markets were much less developed during the late 1980s than they are now. In mid-1997 swap spreads began to widen in the sterling and dollar markets. This continued through 1998 until in the autumn the spreads widened sharply in the dollar and in particular the sterling fixed income markets. Note, however, that the response was far more muted in the German swap market. This increase in spreads resulted from the flight to UK and US government bonds (particularly on-the-run issues) that followed the Russian debt crisis and subsequent near collapse of Long-Term Capital Management (LTCM). A further reason why swap spreads in the sterling market widened so much during this period was that LTCM and other leveraged institutions were forced to unwind positions in which they were short of UK gilts and receiving fixed on similar maturity swaps. In fact these trades were originally initiated to take advantage of swap spreads which looked too wide on the basis of the sort of argument we have described in Section 2. But as government bond prices were bid up, these positions began to rapidly lose money and were unwound in what were at the time illiquid markets. The effect was to cause a temporary widening in the swap spread.

Chart 3

Ten-year swap spreads USD, GBP and EUR (DEM)

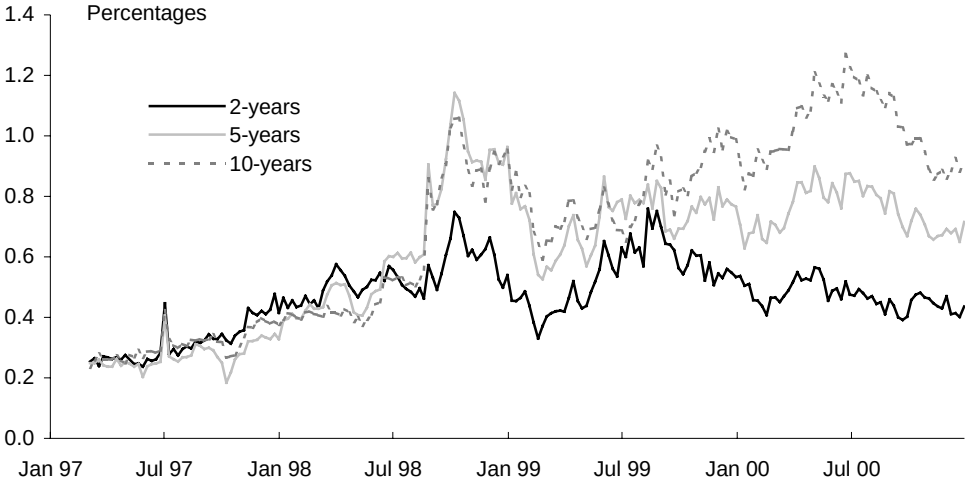


Chart 4

Two, five and 10-year GBP swap spreads

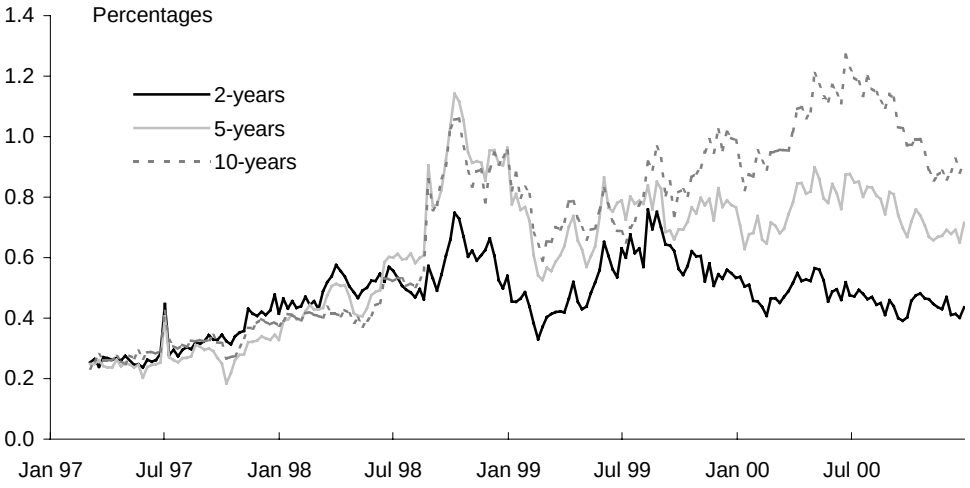


Chart 5

Two, five and 10-year USD swap spreads

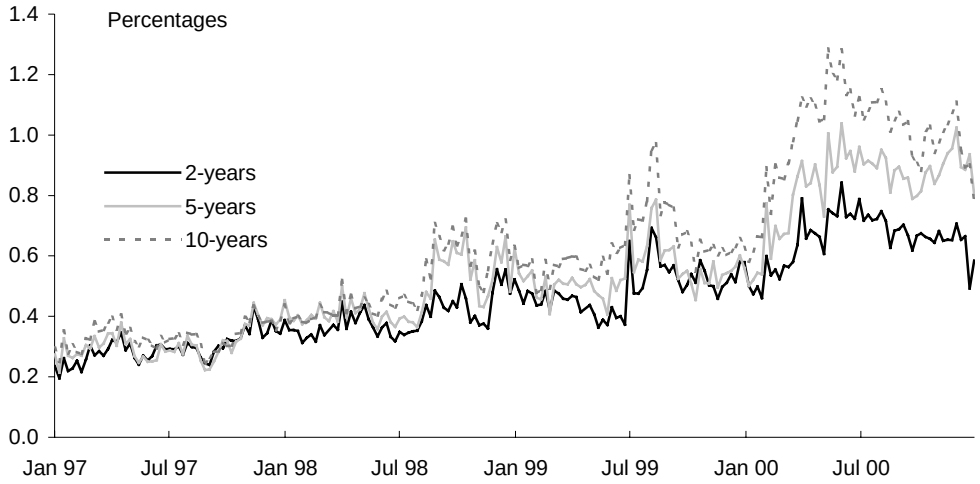
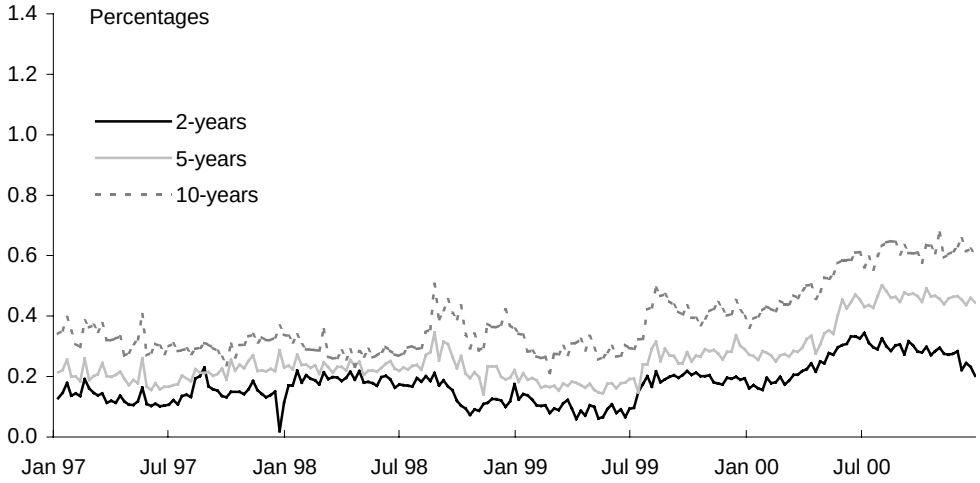


Chart 6

Two, five and 10-year EUR (DEM) swap spreads



Charts 4, 5 and 6 plot two, five and 10-year swap spreads for the sterling, dollar and Deutsche mark (euro after January 1999) markets. Two things are worth noting: (i) swap spreads widened far more for long-term swaps; and (ii) German swap spreads widened far less than sterling and dollar spreads. Had the events of autumn 1998 increased the perceived risk of interbank default over the short- to medium-term horizon, one would have expected to see increased forward spreads of Libor over collateralised debt over a short- to medium-term horizon. But this did not happen - 10-year swap spreads moved far more than two-year swap spreads. In addition, it should be recognised that the Libor bank pools for each currency have similar and overlapping memberships. Consequently, an increase in future expected interbank credit risk should have widened swap spreads in *all* currencies. But German swap spreads were far less affected than sterling and dollar spreads. All this suggests that movements in swap spreads during this period were not driven exclusively by credit risk considerations, but rather by the large flows to benchmark government bonds from interest rate swap positions receiving fixed in what had become illiquid markets.

In late 1998 swap spreads fell partially back to lower levels. But this development proved to be temporary, and the uptrend in swap spreads in the UK and US markets continued during 1999. This persistent widening in swap spreads was attributed by many to the reduction in the net supply of government bonds in both the UK and US markets. Indeed, dollar swap spreads widened dramatically in the first quarter of 2000 as the Treasury buyback schedule gathered momentum and projections started to indicate that the United States would be in a position to repay its national debt by the

beginning of the next decade.[8] Our interpretation of the US and UK 10-year swap spread time series is that the Russian debt/LTCM crisis caused a spike in a series which was in any case on an upward trend as a result of a growing perception in the markets that the net supply of UK and US government bonds would be much lower looking forward. Fears of a worsening scarcity of UK and US sovereign debt caused yields on these bonds to decline relative to true risk-free rates.

So how overvalued is sterling and dollar sovereign debt? Recall that our estimate of the fair value of the swap spread in the United Kingdom and the United States was 40-50 bp. By comparison, during much of 2000, swap spreads in the sterling and dollar markets were around 110 and 100 bp respectively. If we make the crucial assumption that the swap market is fairly valued, then swap spreads at these levels suggest that yields on 10-year gilts and Treasuries were at the time depressed by around 60-70 bp. So it appears that even though the outstanding stock of debt in both countries remains large, the effect of currently negative net supply (and perhaps more importantly expectations that the stock of debt would continue to shrink) was to significantly depress bond yields in both countries.

3. Empirical behaviour of swap spreads

In this section we examine whether it is possible to identify an empirical relationship between swap spreads and the net supply of government bonds. A limited number of studies have already examined the empirical properties of swap rates and swap spreads. Early studies such as Sun et al (1993) and Minton (1997) sought to examine the equivalence between swap *rates* and the Libor yield curve using data on long-term Libor borrowing rates and eurodollar futures rates respectively. This was motivated by the recognition that the fixed side of a swap can be interpreted as a par yield. These studies found that, typically, the swap curve was close to, but not exactly the same as, the Libor par curve. Other studies such as Cooper and Mello (1991), Sorensen and Bollier (1994) and Duffie and Huang (1996) examined the value of the risk of counterparty default on an interest rate swap and how this was factored into the swap spread. As we pointed out in Section 2, Duffie and Huang showed via simulations that the value of counterparty default risk could not contribute more than a very small number of basis points to the swap spread. Furthermore, the collateralisation and margining practices between swap market participants that have become widespread since the mid-1990s now mean that counterparty default risk is not really a serious issue and so cannot explain swap spreads.

Grinblatt's (1995) work is closer to our own in that he attributes the size of the swap spread not to default risk but rather to the underlying government bond yield lying below risk-free rates. Grinblatt argues that this is because government bonds also yield a liquidity-based convenience yield, the present value of which is reflected within the bond price, pushing government bond yields below the risk-free equivalent. The origin of this convenience yield is not necessarily lower bid-ask spreads on government bonds, but rather, as explained in Duffie (1996), that holding government bonds can grant access to cheap short-term financing via the repo market if the bond goes "special". This is likely to be particularly relevant for newly issued *on-the-run* US Treasuries. Krishnamurthy (2001) has shown that much of the spread between the yield of *on-the-run* and "old" 30-year Treasury bonds can be explained by relative financing costs in the repo market - ie the present value of the cheap funding via specific repo offered by newly issued benchmark bonds. So part of the spread between a swap rate and an *on-the-run* government bond is likely to reflect this factor. But because "specialness" tends to be concentrated amongst the most recently issued bonds, it is difficult to explain much of the spread between swap rates and the yield on *off-the-run* bonds in this way.

Baz et al (1999) employ similar arguments to those in Section 2 to show that the swap spread is equal to a weighted average of forward Libor-Treasury spreads. They then model swap spreads econometrically, employing daily data with factors such as the slope of the yield curve, the level of interest rates, the GC repo-Libor spread, returns on the equity market and corporate bond spreads. They find that equity market returns, changes in credit spreads, and the slope of the yield curve have

[8] In January 2000, assuming unchanged taxation and spending plans, the Congressional Budget Office (CBO) projected that total federal surpluses would be sufficient to pay off all publicly held debt available for redemption by 2006 (source: US Congressional Budget Office, www.cbo.gov).

highly significant effects on UK and US swap spreads over the period 1994-99. The link between equity prices and swap spreads is attributed to changes in risk appetite amongst investors in response to sharp falls in equity prices. As risk appetite declines, investors find government bonds more attractive and so their prices are bid up, depressing yields and causing a widening in swap spreads. This phenomenon seems to have been particularly strong in the UK and US markets during the autumn of 1998. Such a phenomenon may also explain why there is a strong contemporaneous link between credit spreads and swap spreads: an isolated downward move in the government bond yield as a result of a "flight to quality" will cause all spreads over that yield to widen together. Finally, under the Baz et al model, a steepening of the yield curve causes a narrowing in the swap spread. They provide two potential explanations for this: first, that in a steep yield curve environment corporates issue long-term fixed rate debt but are keen to swap to floating rate debt with a lower current interest rate via receiving fixed on a swap; they argue this bias to receiving fixed in the swap market tends to narrow the swap spread; second, that the slope of the yield curve contains information on the future macroeconomic outlook and hence on credit conditions. So if the yield curve inverts and is indicative of a worsening of future credit conditions, then these authors suggest there should be a widening of the swap spread. We discuss the plausibility of this argument later.

It is worth stating at this stage that if supply considerations do impact on government bond yields, and thereby on swap spreads, one would expect the appropriate measure of supply to be the anticipated future profile of outstanding government stock. Unfortunately, we do not have a measure of the market's expectations of the future outstanding stock. Perhaps the best we can do is measure how swap spreads react to concurrent supply shocks - namely current net debt issuance.

Charts 7 to 11 plot time series of the 10-year swap spread versus current net government issuance (as a proportion of GDP) for the UK, US, German, Japanese and Canadian markets respectively. In the German market net issuance has been low and stable,[9] whereas in Japan net issuance of government debt has been very substantial over the last few years.[10] The simple demand and supply analysis in Section 1 would suggest that bond market yields should lie on the default risk-free yield curve and swap spreads should remain close to their fair value. Charts 9 and 10 show that in Japan and Germany this has been the case. In the Canadian market, net issuance has become negative over the last three years, mirroring developments in the United States. But Canadian dollar swap spreads have remained close to our estimate of fair value at 30-40 bp. Nevertheless, our earlier analysis also suggested that reduced supply need not have an impact on bond yields either if there is no "constrained" subset of investors or if supply does not drop sufficiently. Perhaps these conditions have simply not been met in the Canadian markets. Given that there does not appear to be any obvious link between government bond supply and the swap spread in these three markets, we have not attempted to estimate any econometric link here.

In the United Kingdom and the United States there appears to be a stronger link. Chart 7 in particular suggests a negative correlation between net issuance of UK government debt and the level of 10-year sterling swap spreads. In the late 1980s/early 1990s the emergence of negative net issuance of UK government bonds was associated with widening of swap spreads and has been again since 1997. In the United States the reductions in outstanding government debt since 1997 have also been accompanied by widening 10-year swap spreads, although it is difficult to explain on these grounds why swap spreads were so wide in the early 1990s.

[9] We acknowledge that after 1999 one should look to euro area rather than German federal government net issuance as a driver of euro swap spreads.

[10] The Japanese government is now the world's biggest debtor, with the dollar value of outstanding JGBs now greater than the stock of outstanding US Treasuries.

Chart 7

UK government net issuance vs 10-year GBP swap spreads

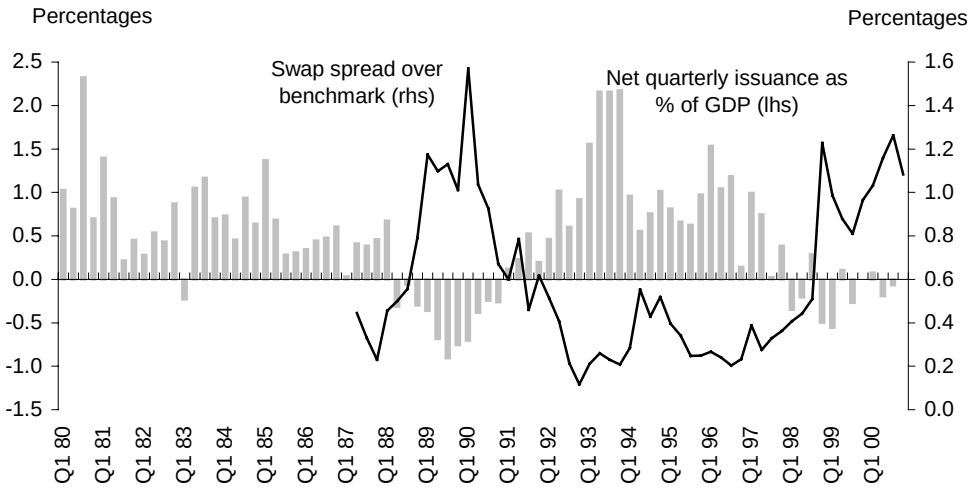


Chart 8

US government net issuance vs 10-year USD swap spreads

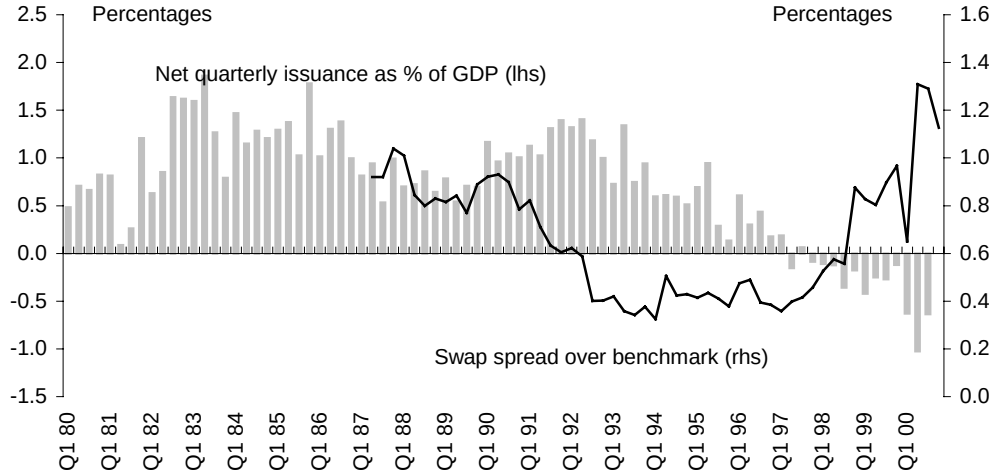


Chart 9

German government net issuance vs 10-year EUR (DEM) swap spreads

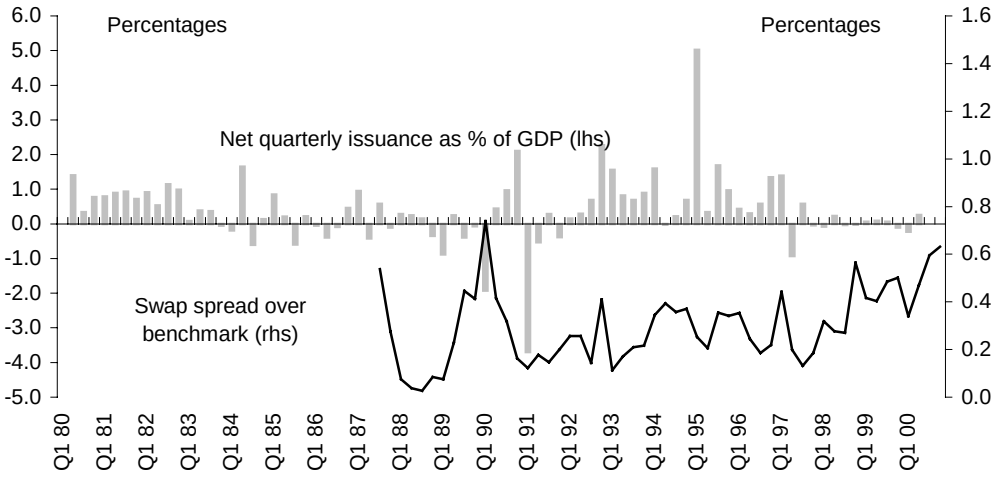


Chart 10

Japanese government net issuance vs 10-year JPY swap spreads

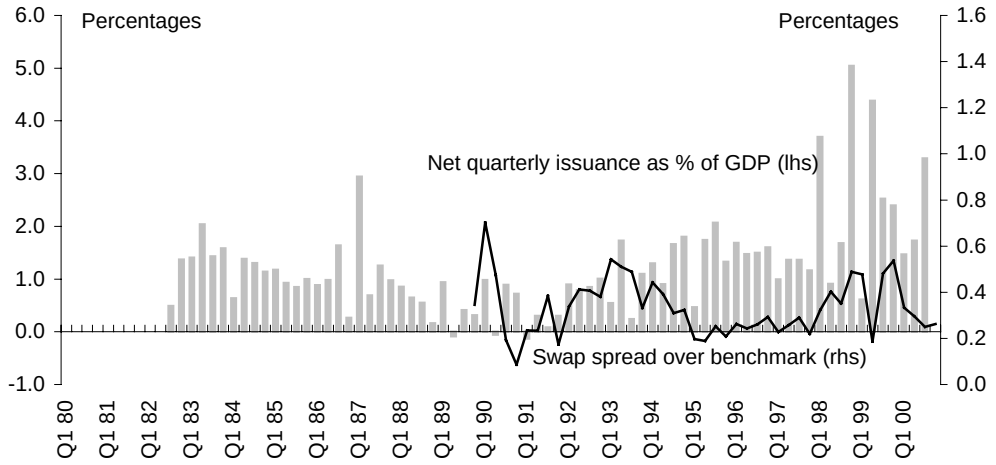
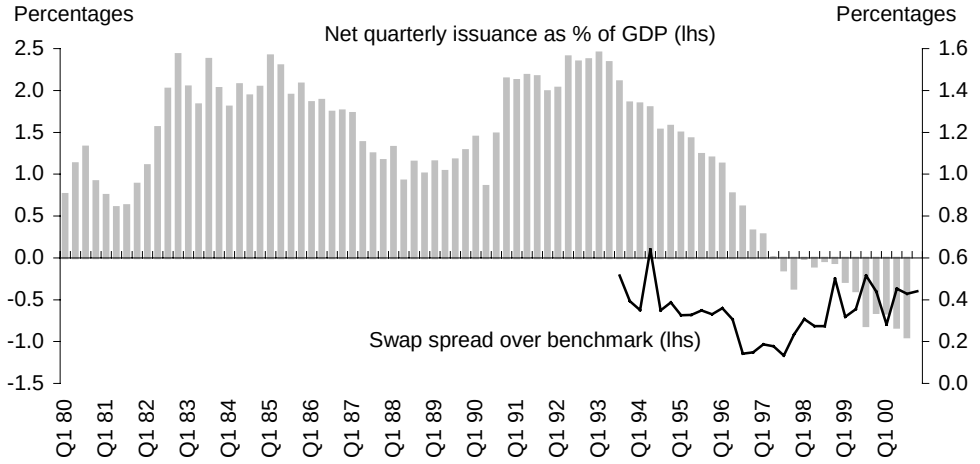


Chart 11

Canadian government net issuance vs 10-year CAD



To test for a statistical link between 10-year swap spreads and issuance in the UK and US markets, we regressed swap spreads, using quarterly data, against:

- **net issuance of government bonds as a proportion of GDP** - given by quarterly net issuance of government debt divided by GDP for the United Kingdom (not seasonally adjusted), and quarterly net federal government borrowing over GDP for the United States (seasonally adjusted because supply is seasonal);
- **the slope of the yield curve** - given by the difference between the appropriate 10-year government benchmark yield and the three or six-month T-bill rate;
- **short-term interest rates** - given by three-month sterling Libor and six-month US dollar Libor respectively;
- **the Libor-T-bill spread -** used as a proxy for the Libor-GC repo spread; and
- **quarterly equity returns** - given by the quarterly returns on the FTSE All-Share (UK) and S&P 500 (US) equity indices.

We estimated four different models for the United Kingdom and the United States covering the period 1989 Q3 to 2000 Q3. Results are provided in the statistical appendix. Model 1 simply regresses the swap spread against net issuance. In the United Kingdom the relationship is negative (as we

expected) and highly statistically significant. In the United States the sign is negative and again significant. In model 2 we introduce other variables that have been found to have explanatory power in other empirical studies of swap spreads. The lagged swap spread term is highly significant in both cases, suggesting that these spreads are highly persistent. Unlike in Baz et al (1996), we find that the equity return is not significant. This is likely to be due to the fact that we use quarterly rather than daily data, so that a shock from the equity market may unwind too quickly to be picked up in our dataset. Neither do we find the Libor-T-bill spread to be significant. In both the United Kingdom and the United States net issuance now loses it statistical significance but the slope of the yield curve is significant.

In model 3, we omit the equity return and the Libor-T-bill spread. The net issuance remains statistically insignificant in this model. Note, however, that in both the United Kingdom and the United States the net issuance and the slope of the yield curve are co-linear. The sample correlation between the two series is 0.73 in the United Kingdom and 0.59 in the United States. And because the slope is a less volatile series, it has a smaller standard error and hence a higher t-statistic. Our interpretation is that if changes to supply impact on long-maturity bond yields as argued by Eggington and Hall (1993), then this will change the slope of the yield curve. So the slope is a symptom of the same cause - changed government bond supply - of bond yields as the swap spread, not an explanatory factor of the swap spread per se.

So on a priori grounds we omit the slope of the yield curve in the final model. In this model 4, net issuance re-emerges as a statistically significant factor to explain swap spreads - our measure of the depression of bond yields below the risk-free curve. The negative coefficient matches our expectation that reduced supply tends to increase the swap spread.

4. Implications for policymakers

We have seen the evidence for overvaluation within the UK and US government bond markets. This phenomenon clearly has wide implications for financial market participants and policymakers, but here we focus on two particular questions:

(i) how should central banks infer and interpret expectations of future nominal risk-free interest rates from fixed income markets in the presence of known distortions?

(ii) what will financial market practitioners use as a benchmark for pricing non-government fixed income securities in the absence of default risk-free debt?

4.1 Assessing market interest rate expectations in the presence of known distortions

In Section 2, we developed a measure of the fair value of par swap spreads. Using estimates based on historical norms for Libor-GC repo spreads, we calculated the likely bias in gilt and US Treasury par yields versus risk-free rates. When we wish to infer expectations of future short-term interest rates, however, we use forward rates rather than par yields. So we need to calculate the corresponding biases in forward rates. We show here how to calculate the appropriate adjustments to forward curves using the swap market as a benchmark.

To do this, we employ an argument very similar to the one we developed in Section 2. The steps are as follows:

(i) assume the swap market is fairly valued - ie swap rates reflect market expectations of future short interest rates, appropriate term and credit premia and convexity effects only;

(ii) form a simple trading rule which relates the spread of forward swap rates over government forward rates - the forward swap spread - to future expected spreads between six-month Libor and six-month GC repo;

(iii) calculate the fair value for that trading rule and hence the fair value for the forward swap spread;

(iv) it then follows that the difference between the forward swap spread observed in the market and this fair value is a measure of the degree to which the government forward is biased downwards versus its fair value.

We can use this measure of the bias to adjust up our government forward to obtain a measure of the "true" risk-free forward curve. Or equivalently we can use the forward swap curve adjusted for the fair value of the forward swap spread.

The trading strategy in this case is a short forward position with maturity *m* in *$X* worth of a six-month government bond and a long forward position of the same maturity in a six-month swap with notional principal of *$X*. The first part locks in the yield on short selling a six-month government bond in *m* years time at rate *FY*. The forward swap position locks in a six-month swap starting in *m* years' time that swaps a fixed rate *FR* in *m* years' and six-months for six-month Libor at that time. These forward contracts cost nothing today. In *m* years' time, the six-month government bond is sold short at the price locked in by the forward rate agreed now and the proceeds are invested in six-month GC repo. The payoff to this strategy comes in *m* years and six-months and equals:

$$\left[\left(FR - FY\right)/2 - \left(6MLIBOR_m - 6MGCREPO_m\right)/2\right] * X \tag{5}$$

where $6MLIBOR_m$ and $6MGCREPO_m$ are the outturn values of six-month Libor and GC repo in *m* years' time. On the one hand, the trader receives the difference between the forward swap rate and the forward bond - the forward swap spread; on the other, he has to pay out the Libor-repo spread. The present value of this payoff is:

$$\left(\left(FR - FY\right)X/2\right)e^{-r\left(m+0.5\right)} - E\left(\left(6MLIBOR_m - 6MGCREPO_m\right)X/2\right)e^{-\left(r+\lambda\right)\left(m+0.5\right)} \tag{6}$$

where *r* is the continuously compounded *m*+0.5 maturity zero coupon rate and λ is the same risk premium as in equations (2) to (4) above. The first term is the present value of the forward swap spread payment received. Since this is known now, it is discounted at the risk-free rate. The second term is the present value of the expected payment made from the spread between six-month Libor and GC repo. Again, since this spread is unknown and uncertain until *m* years' time, its present value is its expectation discounted by *r* plus the risk premium term λ.

Now note that when setting up this strategy, there was no cost at the start of the trade since neither of the forward contracts cost anything to initiate. Nor is there a net cash flow at year *m*: the proceeds of shorting the gilt are entirely invested in GC repo, and entering the swap via the forward costs nothing. So since it costs nothing to follow this trading strategy, the present value of its payoff in equilibrium and when both the gilt and swap markets are fairly valued must be zero:

$$\left(\left(FR - FY\right)X/2\right)e^{-r\left(m+0.5\right)} - E\left(\left(6MLIBOR_m - 6MGCREPO_m\right)X/2\right)e^{-\left(r+\lambda\right)\left(m+0.5\right)} = 0 \tag{7}$$

Rearranging this equation and dividing through by exp(-r(m+0.5))*X/2, we obtain an expression for the fair value of the forward swap spread at maturity m:

$$FR - FY = E\left(6MLIBOR_m - 6MGCREPO_m\right)e^{-\lambda\left(m+0.5\right)} \tag{8}$$

So the fair value of the forward swap spread for maturity *m* is given by the current expectation of the spread between six-month Libor and GC repo but adjusted by a risk premium term which reflects the risk of this spread. Assuming the swap market is fairly valued, the difference between this measure and the observed forward swap spread measures how biased the gilt market forwards are as a result of any regulatory distortions and lack of gilt supply. The fair value of the default risk-free forward rate (again assuming the swap market is fairly valued) is:

$$FY = FR - E\left(6MLIBOR_m - 6MGCREPO_m\right)e^{-\lambda\left(m+0.5\right)\right)} \tag{9}$$

Equation (9) provides a formula for calculating estimates of (unobservable) risk-free forward rates from forward swap rates, *FR*, by adjusting downwards for the expected difference between future six-month Libor and GC repo rates. The difference between these estimated risk-free forward rates and the observed forward rates derived from government bonds is our measure of the bias in the government bond market. From this bias-adjusted, risk-free forward curve it is also straightforward to construct a zero coupon bias-adjusted curve.

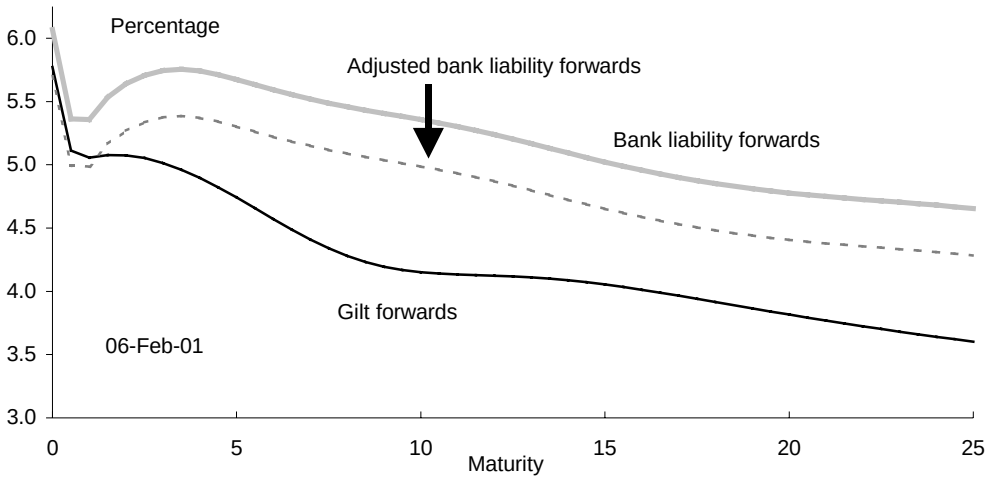
To estimate bias-adjusted, risk-free forward rates, we need estimates of the forward swap and government bond rates, the expectation of the future spread between six-month Libor and six-month GC repo, and λ, the risk premium attached to the risk of movement in the Libor-repo spread.

Government and swap forward rates are not directly observable, so we have to estimate them. This is done using the Bank of England's VRP yield curve estimation technique.[11] This method is applied to US Treasuries and dollar GC repo rates, and to gilts and sterling GC repo rates respectively to estimate government forward curves for both countries. A euro curve is generated using a combination of French and German government bonds. To estimate forward swap rates, we use fitted "bank liability" forward curves.[12] These employ the VRP technique to fit to Libor deposit rates, forward rate agreements (FRAs), three-month Libor futures and interest rate swaps. We do this by first transforming these rates into synthetic bond prices and then fitting forward curves to prices. From these forward curves we can calculate the forward swap rates that correspond to *FR* in equations (5) to (9).

In Charts 12-14 we plot government, bank liability and adjusted bank liability forward curves for the GBP, USD and EUR markets on 6 February 2001. The adjusted bank liability curve may be thought of either as the forward swap curve adjusted for the fair value of the spread between a forward swap rate and a risk-free forward rate or, equivalently, as the forward government rate adjusted for estimated biases caused by supply side and regulatory factors.

Chart 12

GBP government and bank liability forward curves



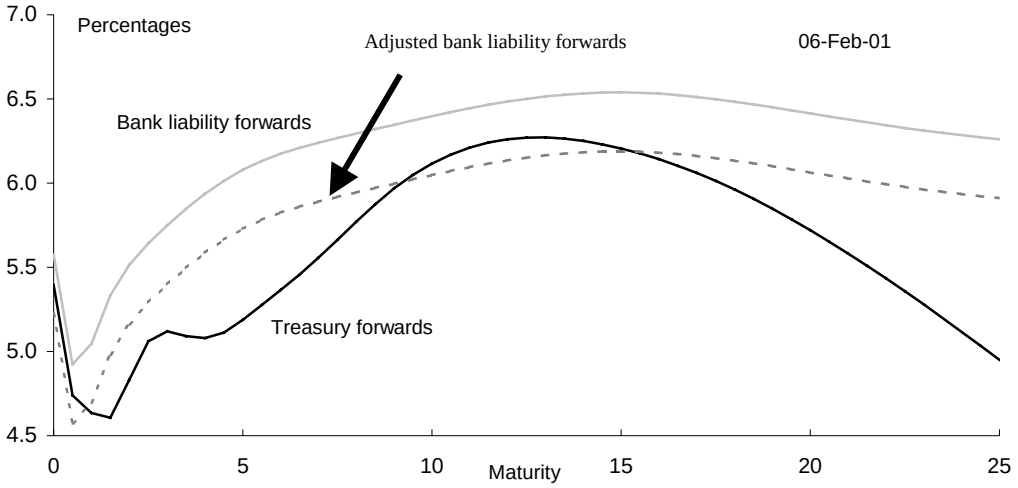
Note: GBP adjusted bank liability forward rates are calculated by subtracting 40 bp - the risk-adjusted estimate of the fair six-month GBP Libor-GC repo spread - from bank liability forward rates.

[11] See Anderson and Sleath (1999) for a description of the Bank of England's Variable Roughness Penalty (VRP) curve-fitting technique as applied to GC repo rates and conventional gilts.

[12] See Brooke et al (2000) for an outline of the Bank of England's Bank Liability VRP curve-fitting technique.

Chart 13

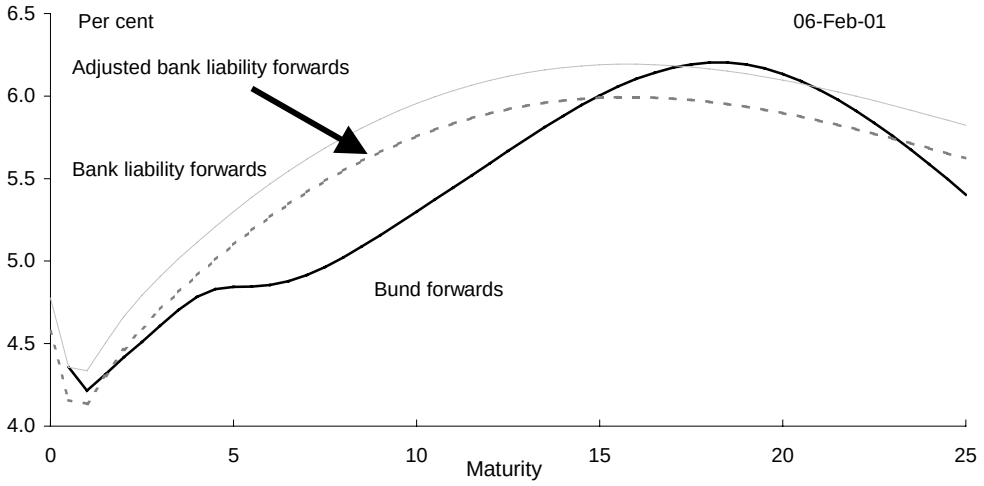
USD government and bank liability forward curves



Note: USD adjusted bank liability forward rates are calculated by subtracting 35 bp - the risk-adjusted estimate of the fair six-month USD Libor-GC repo spread - from bank liability forward rates.

Chart 14

Euro government and bank liability forward curves



Note: EUR adjusted bank liability forward rates are calculated by subtracting 20 bp - the risk-adjusted estimate of the fair six-month USD Libor-GC repo spread - from bank liability forward rates.

For the United Kingdom and the United States there is a clear difference between the solid forward curves estimated directly from government bonds and the dashed "valuation bias" adjusted forwards derived from swaps. This difference represents our estimate of the bias in government forward rates. For the United Kingdom, the bias grows with maturity until it reaches a maximum at around 10-15 years. In the United States the picture is complicated by the difficulties in fitting a sensibly shaped government yield curve when including both *on-the-run* and *off-the-run* bonds.[13] Nonetheless, it is

[13] "On-the-run" securities are the most recently issued securities of a given maturity. Older securities of a given maturity are called "off-the-run". The wide spread between *on-the-run* and *off-the-run* US Treasury yields creates oscillations in the forward curve corresponding to the maturities of the current benchmarks.

clear that on average there is a significant downward bias in the forwards estimated from US Treasuries (except in the 10- to 15-year range, where we think the curve is misestimated for the reasons given above). Beyond 15 years this bias increases with maturity, reflecting the well publicised bias in the 30-year T-bond yield - see McCulloch (2000) for a commentary on this phenomenon.

Finally, Chart 14 provides the equivalent forward curves for the euro market. What is slightly surprising is that although the differences between the government and the bias-adjusted curves is smaller than for the United States and United Kingdom, there is still a bias in the government curve. This estimated bias in the euro curve is a relatively new phenomenon, which can be attributed to the widening of euro swap spreads that occurred during mid-2000.[14]

4.2 New pricing benchmarks for fixed income securities

A major concern for policymakers in a world of diminishing issuance of government bonds is whether the efficiency of other fixed income markets would be affected by the absence of a highly liquid risk-free benchmark security. For the United States, Fleming (2000, 2001) considers whether other fixed income securities, such as interest rate swaps, supranational bonds and mortgage agency securities, could perform the benchmark role traditionally performed by US Treasuries. In this section we examine the extent to which the interest rate swap market has already become the de facto benchmark for high-quality issuers.

What do people mean when they attribute "benchmark" status to a fixed income security? In the case of government bonds it often refers to their use as a measure of the level of default risk-free interest rates. These are then used to reference and hedge other fixed income securities, and to monitor monetary and financial conditions more generally. It should be noted, however, that in our discussions with market contacts we found that market participants do not price bonds by adding an estimated spread to the benchmark government yield to calculate a yield for discounting the cash flows on a new bond. Rather they calculate yields by comparing them to similar comparator bonds. Even so, the yields on benchmark government bonds are widely monitored as measures of risk-free rates in the financial press, by financial market participants and by policymakers to assess monetary conditions and examine financial markets' reactions to news on monetary policy and the macroeconomic outlook.

In what follows we show that the pattern of spreads of European Investment Bank (EIB) and World Bank (IBRD) bonds over swaps is more consistent than against government bonds across currencies. If by benchmark risk-free yields we mean a reliable measure of the nominal risk-free yield for that currency, then we ought to observe very similar spreads between the bonds of these institutions and the chosen benchmark instrument across different currencies. We can think of no compelling reason why spreads of supranationals' bonds over the risk-free curve should be significantly wider in one currency than in another. So if, for example, we want to use government bonds as a benchmark for the risk-free rate in each currency, we should expect that the spreads of supranational bonds versus government bonds ought to be similar for different currencies.

Charts 15 and 17 plot credit spreads for EIB and World Bank bonds denominated in alternative currencies against the respective government bonds across maturities on 10 July 2000. To derive these spreads, we calculate for each bond a redemption yield on a synthetic government bond that has exactly the same cash flows and maturity characteristics using our estimated government zero coupon yield curves. We calculate the spread over this synthetic yield to avoid problems resulting from mismatching maturities or coupon rates between the two bond yields being compared.

If the government bonds are acting as a reliable measure of the risk-free rate, then we would expect these spreads to be consistent across currencies. Although spreads might be different across maturities - a term structure of spreads - we would want this pattern to be consistent across currencies also. What Charts 15 and 17 both show, however, is that the spreads between these supranational bonds' yields and those on governments depend strongly on the currency in which they are calculated. It does not seem credible that the credit spread for 10-year EIB bonds over risk-free rates is 90 bp in

[14] One possible source for this widening of euro swap spreads is that market participants may have begun to anticipate a pay-down of government debt stocks even in Europe, aided at the time by strong GDP growth projections and higher than expected tax revenues from the government auctions of third-generation mobile telephone licences.

sterling or US dollars but only 30 bp for debt denominated in euros. Likewise, does it make sense that the World Bank pays a yield of only 30 bp over risk-free rates for five-year euro-denominated debt but 80 bp over risk-free rates for US dollar- and sterling-denominated? We think it does not and that the reason for the differences in spreads is due to the overvaluation of the US and UK government bond markets and the corresponding depression in government bond yields *below* the true nominal risk-free rates.

Charts 16 and 18 provide the equivalent spreads over swaps (although not adjusted for the fair value of the swap spread). Here again we construct synthetic coupon-and maturity-matched bond yields from our estimated zero coupon bank liability curves and compare these yields to the observed yields of individual bonds denominated in different currencies for the EIB and the World Bank. What Charts 16 and 18 show is that there is a much closer relationship between spreads across different currencies. For a given maturity, these spreads lie within a range of only around 20 bp. So the swap market seems to be providing a much more sensible measure of risk-free rates across currencies than government bond markets. In other words, the interest rate swap market acts as a far more consistent benchmark than the markets for government securities. Of course we know from Section 2 above that if we estimate a curve directly from swap rates, it will be biased versus the true nominal risk-free curve by the fair value of the swap spread. But Section 4.1 showed how we could adjust for this spread to obtain cleaner measures of risk-free forward or spot rates.

Chart 15

EIB bond spreads against government bond curves

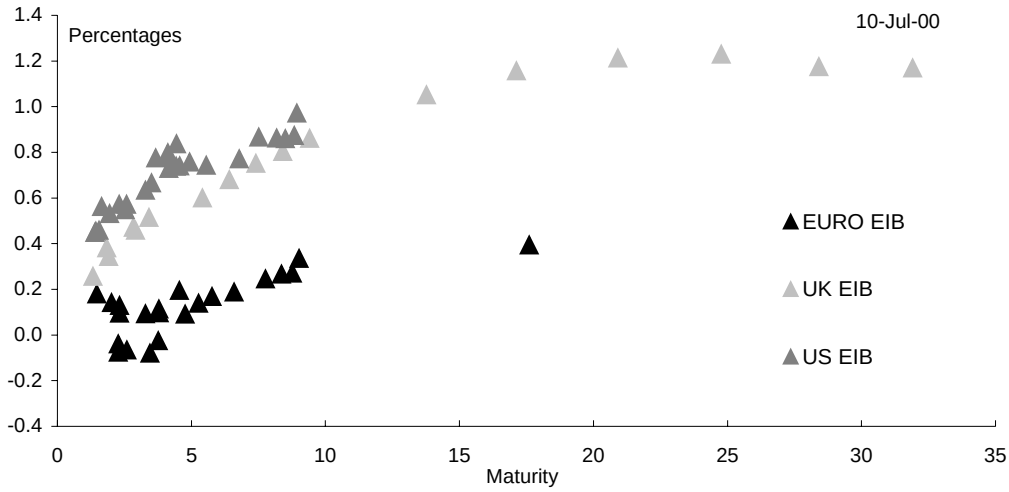


Chart 16

EIB bond spreads against swaps

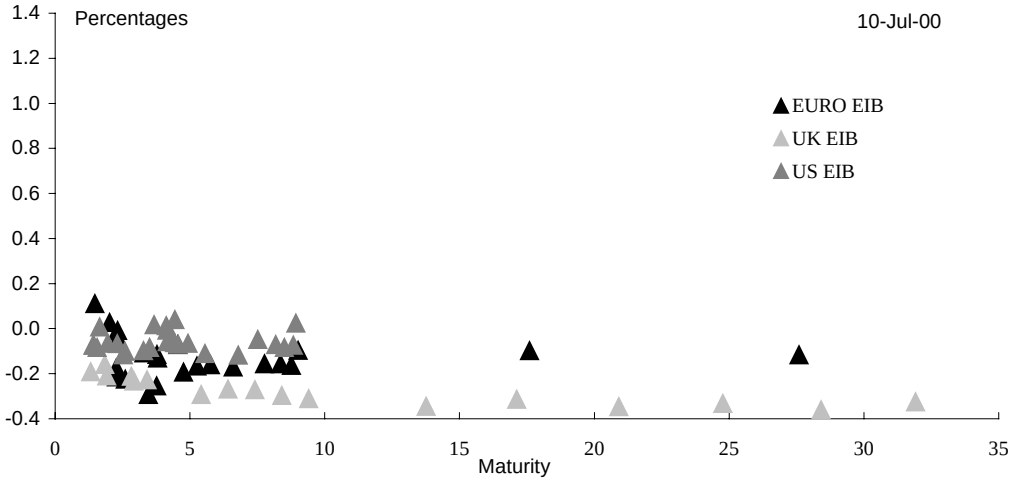


Chart 17

World Bank spreads against government bond curves

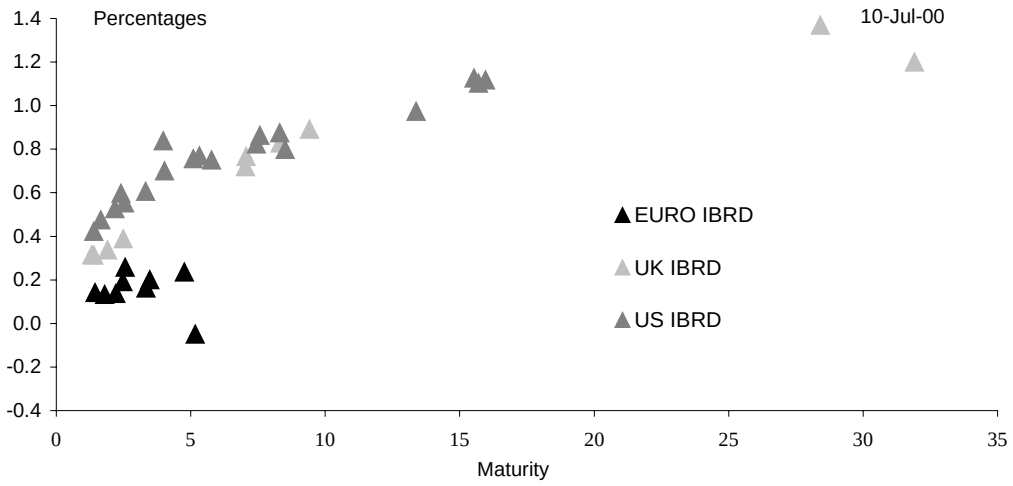
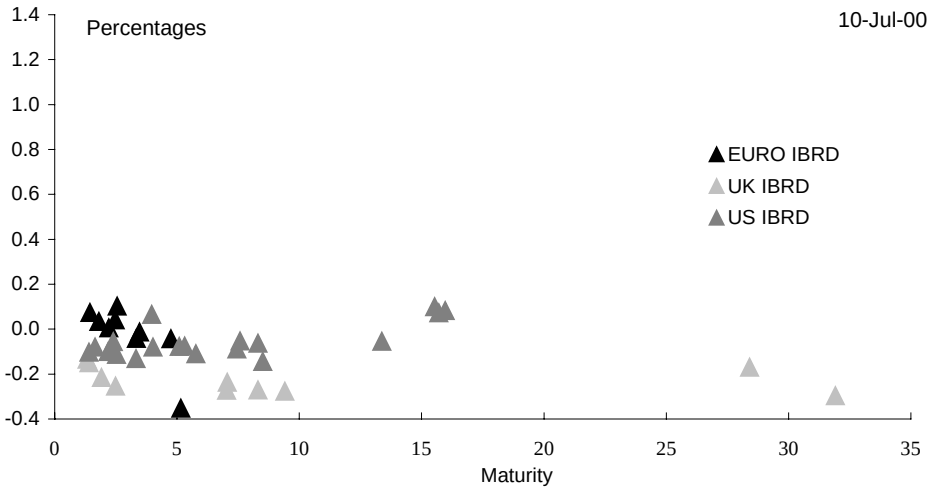


Chart 18

World Bank spreads against swaps



5. Conclusions

Over the last two years there has been widespread comment on the decline in government bond yields in the United Kingdom and the United States resulting from the reduced issuance of gilts and Treasuries. This paper provides a means for assessing the size of the bias between government bond yields and risk-free rates. We do this by assuming that the interest rate swap market is fairly valued. What we mean by this is that interest rate swap rates are priced off the true risk-free curve with an adjustment for the fair value of the swap spread. We show that this fair value swap spread is driven primarily by expectations of the future spread between Libor and the GC repo rate. Counterparty default risk is *not* a significant driver of swap spreads because swap market participants employ mark-to-market margining and collateralisation to mitigate this. Credit risk considerations should only impact on the fair value of the swap spread via expectations of future six-month Libor-repo spreads. By making further assumptions about these expectations based on the historical behaviour of the Libor-GC repo spread, we can make a simple estimate of the fair value of the swap spread. If these assumptions are correct and government bonds are priced consistently with the risk-free curve, then the observed swap spread will be equal to the fair value. Our measure of the divergence of

government bond yields from the risk-free curve, is the excess of the observed swap spread over our measure of its fair value.

How have swap spreads behaved in practice? We have concentrated in this paper on developments in the US dollar, sterling and euro fixed income markets. We have shown that, for much of the 1990s, swap spreads were close to their fair values at maturities up to 10 years for all three currencies. This suggests that, on our measure, government bond yields were close to true default risk-free rates. But starting in 1997, longer maturity swap spreads in both the United Kingdom and the United States widened considerably. This was not just the result of the LTCM crisis (although market anecdote suggests that risk appetite for exploiting wide swap spreads has remained low since autumn 1998), but appears to reflect a longer-term structural change.

This evidence suggests that government bond yields have become depressed in the United Kingdom and the United States. It is another question, though, whether this is attributable to reductions in net supply. The timing of the widening of UK and US swap spreads, which coincides with the beginning of very low or negative net issuance of government bonds, suggests that reduced supply may have depressed long-dated bond yields below risk-free levels. We looked for an econometric link between swap spreads and the net supply of government bonds. The results were mixed. In the United Kingdom a very simple regression suggests a strong negative relationship. But when we incorporated other variables suggested by the literature, in particular the slope of the yield curve, net issuance ceased to be statistically significant. The probable reason for this is that the time series of net issuance of bonds and the slope of the yield curve are highly co-linear. So the change in the slope of the curve is a symptom of the same effect (long government bond yields driven lower by reduced supply).

In the United States the evidence for a link is weaker: the explanatory power of issuance for swap spreads is much lower. And, like in the United Kingdom, issuance appears to be co-linear with the slope of the yield curve, making it difficult to interpret the results. Nevertheless, there is a statistically significant link between net issuance and the swap spread for the two models that omit the slope of the yield curve. Judging from a chart of issuance versus the swap spread, our conclusion for the United States is that if supply has had an impact, it is only a recent phenomenon. But we know that market anecdote suggested that it was expectations of changes in *future* supply that caused much of the widening of swap spreads and our econometrics here could not pick up such a relationship since it was based on current supply.

This paper has also examined two additional issues: (i) how policymakers should measure the risk-free term structure in the presence of distortions to the yield curve; and (ii) whether interest rate swaps are becoming the alternative benchmark for fixed income markets.

Central banks often monitor movements in zero coupon and forward risk-free rates to assess changes in market perceptions of future monetary policy, changes to monetary conditions and the credibility of policy. We have shown how to adjust these curves to correct for biases. To address the second question: by examining spreads of bonds issued by supranationals, we have shown how the swap curve appears to act as a more consistent measure of the risk-free curve than the government curves across currencies. We take this as partial evidence that the swap curve is acting as the new price formation vehicle for movements in risk-free rates across currencies.

As a postscript, in late 2000 and early 2001 swap spreads narrowed somewhat in both the US and UK markets. In the United States, this was partly attributed to the macroeconomic slowdown and the large tax cut packages announced under the new US administration which led to expectations that the outstanding supply of government debt would not fall as quickly as previously thought. In the United Kingdom, the Minimum Funding Requirement legislation (that encouraged defined-benefit pension funds to hold long-dated gilts despite low yields) was, as had been widely anticipated, abolished in the March 2001 budget. So in both cases these moves in the swap spread can be understood as the partial unwinding of the previous demand/supply-driven depression of the respective government bond yields.

Statistical appendix

Table A

Econometric models of sterling 10-year swap spreads

	Model 1	Model 2	Model 3	Model 4
Constant	0.71 (18.23)	0.51 (4.21)	0.51 (4.27)	0.29 (2.80)
Net issuance as a % of GDP	– 0.33 (– 7.22)	– 0.07 (– 1.33)	– 0.06 (– 1.25)	– 0.13 (– 2.87)
Slope of the yield curve		– 0.08 (– 3.07)	– 0.08 (– 3.06)	
Three-month Libor-T-bill spread		0.11 (0.65)		
Three-month Libor		– 0.04 (– 2.37)	– 0.03 (– 2.52)	– 0.01 (– 0.65)
Quarterly return on FTSE		– 0.08 (– 0.28)		
Lagged 10-year swap spread		0.61 (6.05)	0.62 (6.23)	0.71 (6.86)
Adjusted R-squared	0.50	0.76	0.77	0.74

t-statistics in brackets; sample 1987 Q3 to 2000 Q3.

Table B

Econometric models of US dollar 10-year swap spreads

	Model 1	Model 2	Model 3	Model 4
Constant	0.65 (15.75)	0.24 (3.00)	0.24 (1.49)	0.05 (0.66)
Net issuance as a % of GDP	– 0.10 (– 2.10)	– 0.02 (– 0.31)	–0.03 (– 0.57)	– 0.08 (– 2.60)
Slope of the yield curve		– 0.05 (– 2.22)	– 0.05 (– 1.34)	
Six-month Libor-T-bill spread		0.11 (0.80)		
Six-month Libor		– 0.01 (– 0.50)	– 0.01 (– 0.31)	0.02 (1.19)
Quarterly return on S&P 500		– 0.18 (– 0.43)		
Lagged 10-year swap spread		0.77 (5.46)	0.83 (7.93)	0.81 (7.75)
Adjusted R-squared	0.07	0.73	0.74	0.74

t-statistics in brackets; sample 1989 Q3 to 2000 Q3.

Data appendix

Description		SA/NSA	Start	Source
UK BENCHMARK BOND 10-YEAR	RY	-	1986 Q3	Datastream
US TREAS BENCHMARK BOND 10-YEAR	RY	-	1983 Q2	Datastream
GERMANY BENCHMARK BOND 10-YEAR	RY	-	1980 Q1	Datastream
JAPAN BENCHMARK BOND 10-YEAR	RY	-	1982 Q4	Datastream
CANADA BENCHMARK BOND 10-YEAR	RY	-	1986 Q3	Datastream
UK (GBP) IR SWAP 10-YEAR	MR	-	1987 Q2	Datastream
US (USD) IR SWAP 10-YEAR	MR	-	1987 Q2	Datastream
GERMANY (DEM) IR SWAP 10-YEAR	MR	-	1987 Q3	Datastream
JAPAN (JPY) IR SWAP 10-YEAR	MR	-	1989 Q4	Datastream
CANADA (CAD) IR SWAP 10-YEAR	MR	-	1993 Q3	Datastream
UK INTERBANK 3-MONTH	OR	-	1986 Q2	British Bankers' Association
US INTERBANK 3-MONTH	OR	-	1986 Q2	British Bankers' Association
US INTERBANK 6-MONTH	OR	-	1986 Q2	British Bankers' Association
GERMANY INTERBANK 3-MONTH	OR	-	1986 Q2	British Bankers' Association
GERMANY INTERBANK 6-MONTH	OR	-	1986 Q2	British Bankers' Association
JAPAN INTERBANK 3-MONTH	OR	-	1986 Q3	British Bankers' Association
JAPAN INTERBANK 6-MONTH	OR	-	1986 Q3	British Bankers' Association
UK TREASURY BILL DISCOUNT 3-MONTH	MR	-	1980 Q1	Datastream
US TREASURY BILL 3-MONTH	MR	-	1989 Q3	Datastream
US TREASURY BILL 6-MONTH	MR	-	1989 Q3	Datastream
GERMANY GC REPO 3-MONTH	MR	-	1999 Q1	Deutsche Bank
GERMANY GC REPO 6-MONTH	MR	-	1999 Q1	Deutsche Bank
UK Net issuance of government debt, GBP	CUR	NSA	1975 Q1	Office for National Statistics
UK Nominal GDP, GBP	CUR	SA		Office for National Statistics
US Govt net borrowing, USD	CUR	NSA	1968 Jan	International Monetary Fund
US GDP, USD	CUR	SA		International Monetary Fund
Canada Govt net lending, CAD	CUR	SA, AR	1961 Q1	Statistics Canada
Canada GDP, CAD	CUR	SA	1975 Q1	Statistics Canada/IMF
Germany Public sector debt as % of GDP	-	NSA		Bundesbank
Japan National govt debt, JPY	CUR	NSA	1980 Apr	Bank of Japan

CUR	current prices
NSA, SA	(not) seasonally adjusted
RY	redemption yield
OR	offer rate
MR	middle rate

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