

# The changing shape of fixed income markets

Study group on fixed income markets<sup>1</sup>

## 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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<sup>1</sup> 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**

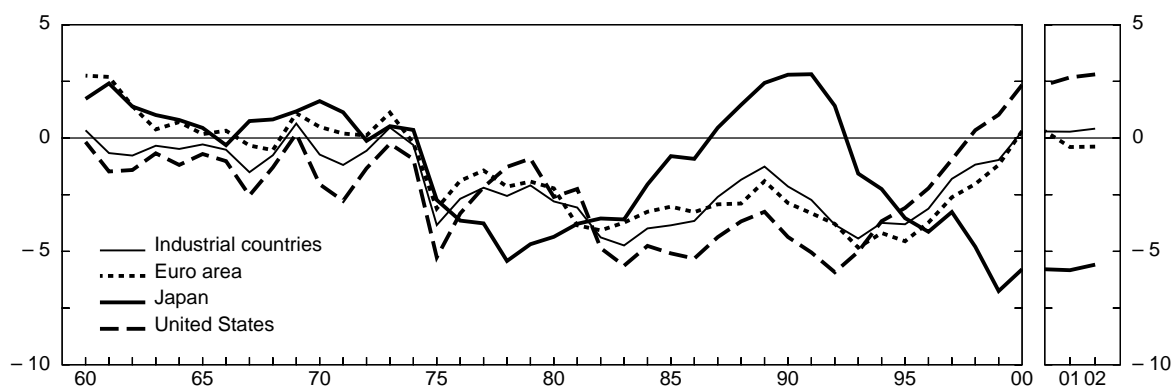
Since the mid-1990s, most industrial countries, with the exception of Japan, have made substantial progress towards fiscal balance (Graph 1). The US federal government posted its first budget surplus in nearly three decades in 1998, and even with the recent tax cuts, surpluses seem likely over the near 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.<sup>2</sup> 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

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<sup>2</sup> 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<sup>1</sup>**  
 As a percentage of nominal GDP



<sup>1</sup> 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.<sup>3</sup> 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.<sup>4</sup> 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.<sup>5</sup> Indeed, several governments with a

<sup>3</sup> 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.

<sup>4</sup> See Chand and Jaeger (1996), European Commission (2000), Group of Ten (1998) and OECD (1998).

<sup>5</sup> 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.<sup>6</sup> 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

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<sup>6</sup> 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.<sup>7</sup> 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.<sup>8</sup> 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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<sup>7</sup> For a discussion of the shift in the relative weight of country and sector factors in pricing euro area equities, see Tsatsaronis (2001).

<sup>8</sup> 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.

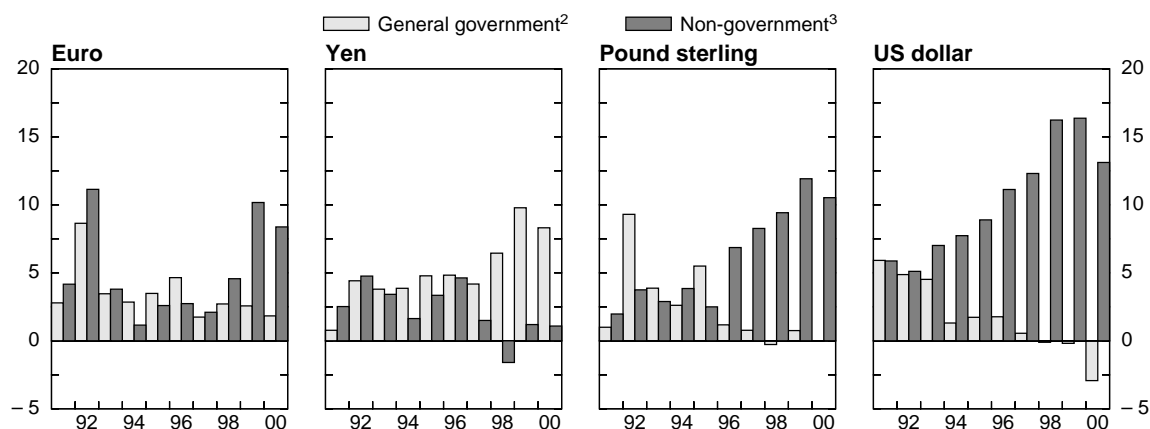
While open dealer systems and multi-dealer customer systems may begin to converge, they remain separated by a difference in technical architectures. Among dealers, the emphasis on safety and speed has translated into the use of secured devoted telephone lines. Between dealers and end investors, the importance 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.

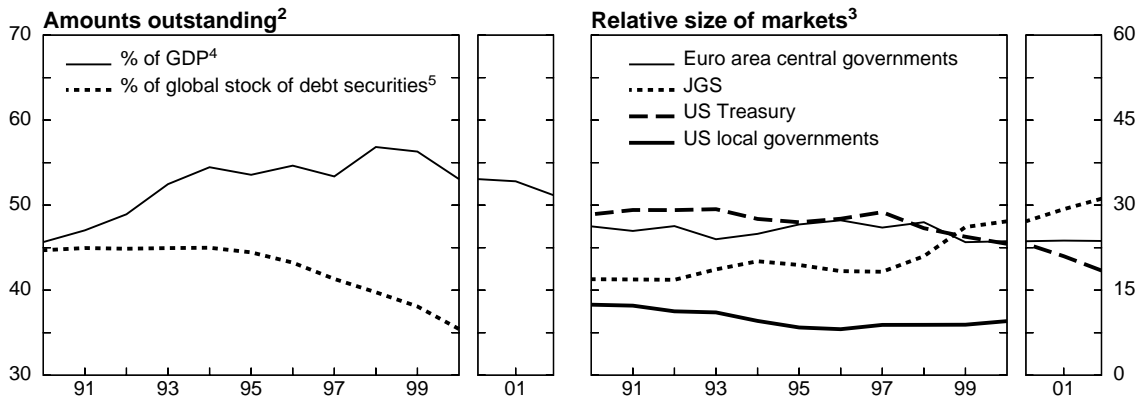
Graph 2  
**Net issuance of debt securities<sup>1</sup>**  
 As a percentage of nominal GDP



<sup>1</sup> Net issuance of money market instruments and bonds in domestic and international markets. <sup>2</sup> Central governments, local governments and central banks. Data exclude issues by foreign governments. <sup>3</sup> 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<sup>1</sup>



<sup>1</sup> Projections for 2001 and 2002 are based on OECD forecasts of general government borrowing requirements (see Graph 1). <sup>2</sup> Outstanding stock of debt securities issued by general government borrowers in industrial countries. <sup>3</sup> As a percentage of the outstanding stock of debt securities issued by general government borrowers in industrial countries. <sup>4</sup> As a percentage of industrial countries' GDP. <sup>5</sup> 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.<sup>9</sup> 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.<sup>10</sup> 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

<sup>9</sup> 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.

<sup>10</sup> 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 <sup>1</sup>      | ...    | ...    | ...    | ...    | 6y    | ...    |
| Japan <sup>2</sup>          | ...    | ...    | ...    | ...    | 5y 6m | 5y 2m  |
| United Kingdom <sup>3</sup> | 10y 5m | 10y 1m | 10y 1m | 10y 2m | 10y   | 9y 11m |
| United States <sup>4</sup>  | 5y 3m  | 5y 3m  | 5y 5m  | 5y 6m  | 5y 6m | 5y 10m |

<sup>1</sup> Domestic government debt. <sup>2</sup> Japanese government securities, excluding financing bills. <sup>3</sup> Debt held by the public, calculated using the latest possible redemption date. Data are as of end-March. <sup>4</sup> 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.<sup>11</sup>

### **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.

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<sup>11</sup> 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 <sup>1</sup>                 | ...  | ...  | 0.0  | 0.0  | ...      | ...  | 6.1       | 12.2 |
| MBS/Pfandbriefe <sup>2</sup>     | 18.6 | 19.6 | ...  | ...  | ...      | ...  | 33.5      | 27.0 |
| of which: Agency <sup>3</sup>    | 1.2  | 8.8  | ...  | ...  | ...      | ...  | 22.4      | 18.8 |
| GSEs <sup>4</sup>                | 11.8 | 5.8  | 26.7 | 24.1 | 0.7      | 0.2  | 11.5      | 13.7 |
| Suprationals <sup>5</sup>        | 4.5  | 3.4  | 3.1  | 2.2  | 5.7      | 8.0  | 1.6       | 1.5  |
| Memo: International <sup>6</sup> | 18.5 | 43.1 | 13.3 | 16.7 | 47.5     | 50.4 | 11.3      | 21.6 |
| Total (trn US\$) <sup>7</sup>    | 3.4  | 4.0  | 2.5  | 2.6  | 0.4      | 0.9  | 7.0       | 13.2 |

<sup>1</sup> Asset-backed securities. <sup>2</sup> For the euro area, Pfandbriefe; for the United States, mortgage-backed securities (MBS) and collateralised mortgage obligations. <sup>3</sup> 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. <sup>4</sup> Government-sponsored enterprises, excluding debt securities issued by non-resident GSEs. <sup>5</sup> Supranational institutions, including debt securities issued by GSEs resident abroad. <sup>6</sup> 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. <sup>7</sup> 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.<sup>12</sup> 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

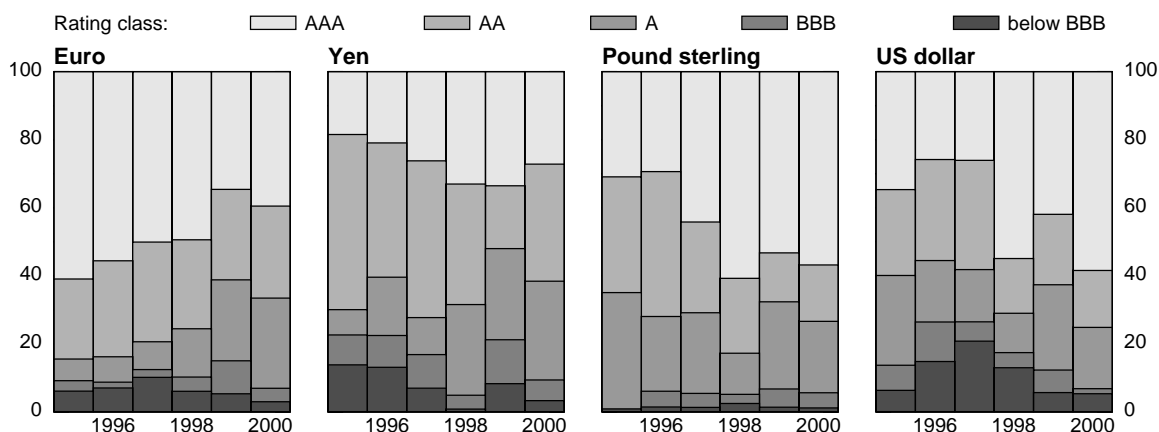
<sup>12</sup> For a survey of the literature on the macroeconomic effects of government debt, see Elmendorf and Mankiw (1999).

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.

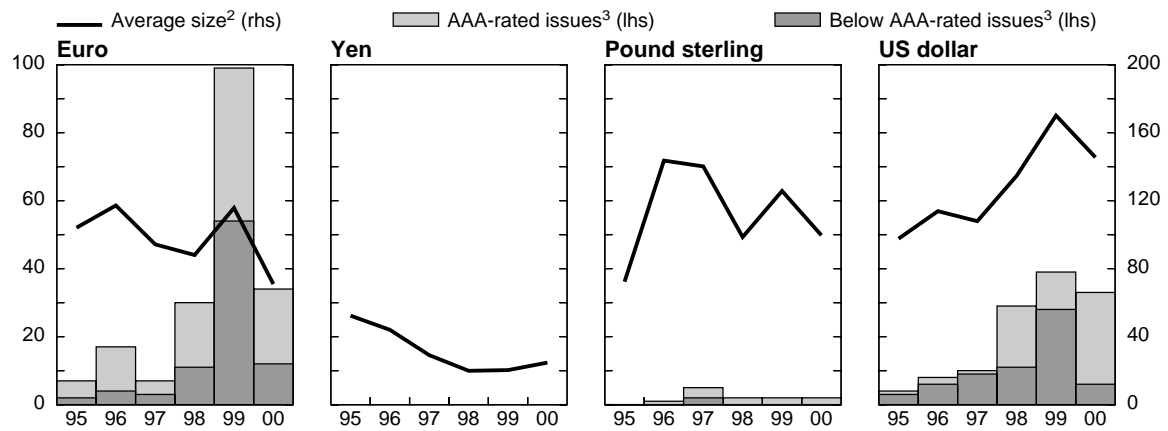
Graph 4  
**Credit ratings of new non-government bond issues**  
 Percentage of announced rated international issues<sup>1</sup>



<sup>1</sup> 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<sup>1</sup>



<sup>1</sup> 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. <sup>2</sup> In millions of US dollars. <sup>3</sup> Number of announced international bond issues larger than \$1 billion.

Sources: Dealogic Capital Data; BIS calculations.

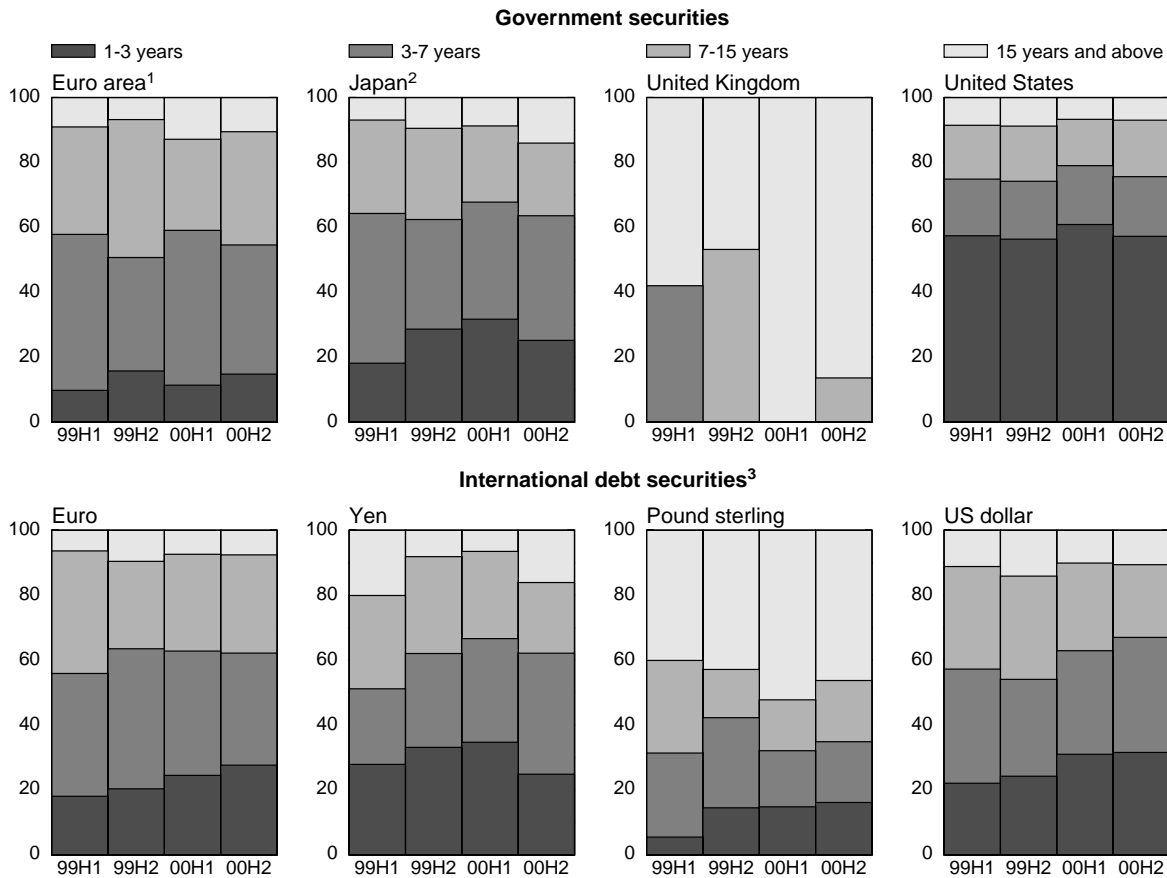
### 3.2.2 Sterling market

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



<sup>1</sup> Sum of issuance by France, Germany and Italy. <sup>2</sup> Data for 1999 H1 refer only to the second quarter. <sup>3</sup> 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 launch 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.<sup>13</sup> 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.<sup>14</sup> 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

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

<sup>14</sup> 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.<sup>15</sup>

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.

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<sup>15</sup> 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 <sup>1</sup> | 2000 <sup>1</sup> | 1995 <sup>2</sup> | 2000 <sup>2</sup> | 1995           | 2000 | 1995          | 2000 |
| <b>Households<sup>3</sup></b>                            |                   |                   |                   |                   |                |      |               |      |
| 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 <sup>6</sup>                     | ...               | ...               | 15.6              | 11.3              | 19.5           | 23.2 | 45.2          | 48.1 |
| of which: Listed shares <sup>7</sup>                     | 13.2              | 19.6              | 6.4               | 4.5               | 8.7            | 8.9  | 19.2          | 21.0 |
| Mutual funds <sup>8</sup>                                | 8.5               | 11.9              | 2.5               | 2.6               | 3.8            | 5.9  | 5.3           | 9.2  |
| Insurance reserves <sup>9</sup>                          | 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\$) <sup>10</sup>                     | 12.8              | 13.1              | 12.0              | 11.5              | 3.0            | 4.3  | 21.7          | 33.4 |
| <b>Insurance companies and pension funds<sup>4</sup></b> |                   |                   |                   |                   |                |      |               |      |
| 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 <sup>6</sup>                     | ...               | ...               | 33.9              | 32.2              | 67.9           | 64.6 | 36.6          | 46.7 |
| of which: Listed shares <sup>7</sup>                     | 63.8              | 51.5              | 22.3              | 17.8              | 45.3           | 42.2 | 30.4          | 36.4 |
| Mutual funds <sup>8</sup>                                | ...               | ...               | 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\$) <sup>10</sup>                     | ...               | 1.8               | 2.6               | 2.5               | 1.5            | 2.4  | 5.7           | 8.6  |
| <b>Banks<sup>5</sup></b>                                 |                   |                   |                   |                   |                |      |               |      |
| 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 <sup>6</sup>                     | ...               | ...               | 8.8               | 6.9               | 2.1            | 2.9  | 0.2           | 0.4  |
| of which: Listed shares <sup>7</sup>                     | 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\$) <sup>10</sup>                     | 12.7              | 13.5              | 10.7              | 9.5               | 3.1            | 4.8  | 4.5           | 6.5  |
| <b>Rest of the world</b>                                 |                   |                   |                   |                   |                |      |               |      |
| 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 <sup>6</sup>                     | ...               | ...               | 20.6              | 31.0              | 16.8           | 29.2 | 34.6          | 43.6 |
| of which: Listed shares <sup>7</sup>                     | ...               | ...               | 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\$) <sup>10</sup>                     | ...               | ...               | 2.0               | 1.8               | 2.5            | 4.8  | 3.5           | 7.2  |

<sup>1</sup> For pension funds, 1997 refers to February 1998. For households, 2000 refers to September 2000. <sup>2</sup> Fiscal year, eg 2000 refers to March 2001. <sup>3</sup> 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. <sup>4</sup> 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. <sup>5</sup> 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. <sup>6</sup> Comprises equity securities, unlisted shares, mutual funds and personal trusts. For Japan, data include foreign debt securities. <sup>7</sup> Shares issued by residents and either listed on an exchange or registered in an over-the-counter market. <sup>8</sup> For the euro area and the United States, money market mutual funds are included with non-government debt securities. <sup>9</sup> Net equity position in life insurance and pension fund reserves, and premium prepayments. <sup>10</sup> 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).<sup>16</sup> 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

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<sup>16</sup> 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 <sup>1</sup> |      | Japan <sup>2</sup> |                   | United Kingdom <sup>3</sup> |                   | United States <sup>4</sup> |      |
|--------------------------------------|------------------------|------|--------------------|-------------------|-----------------------------|-------------------|----------------------------|------|
|                                      | 1995                   | 2000 | 1995 <sup>5</sup>  | 1999 <sup>5</sup> | 1995 <sup>5</sup>           | 1999 <sup>5</sup> | 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 <sup>6</sup>      | ...                    | ...  | ...                | ...               | 5.4                         | 5.4               | 14.0                       | 18.9 |
| Other public sector <sup>7</sup>     | ...                    | ...  | 35.7               | 36.0              | 3.2                         | 3.8               | 11.4                       | 9.6  |
| Insurance companies <sup>8</sup>     | 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 <sup>9</sup>     | 21.0                   | 33.0 | 4.2                | 5.7               | 8.6                         | 14.5              | 9.8                        | 20.1 |
| Memo: Total (trn US\$) <sup>10</sup> | 5.2                    | 4.2  | 2.6                | 3.9               | 0.4                         | 0.5               | 3.3                        | 3.0  |
| Non-marketable <sup>11</sup>         | ...                    | ...  | ...                | ...               | ...                         | ...               | 1.7                        | 2.7  |

<sup>1</sup> General government gross consolidated debt, including coins, loans and debt securities. <sup>2</sup> Japanese government securities, including financing bills. <sup>3</sup> UK government securities. <sup>4</sup> Marketable US Treasury securities. <sup>5</sup> Fiscal year, eg 1999 refers to March 2000. <sup>6</sup> For Japan, foreign central banks are included with other non-residents. <sup>7</sup> 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. <sup>8</sup> For the euro area, insurance companies refer to non-bank financial institutions. <sup>9</sup> For the euro area, other non-residents include residents of the euro area outside the country whose government issued the debt. <sup>10</sup> Outstanding stock of government securities, converted into US dollars at end-of-period exchange rates. <sup>11</sup> 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.

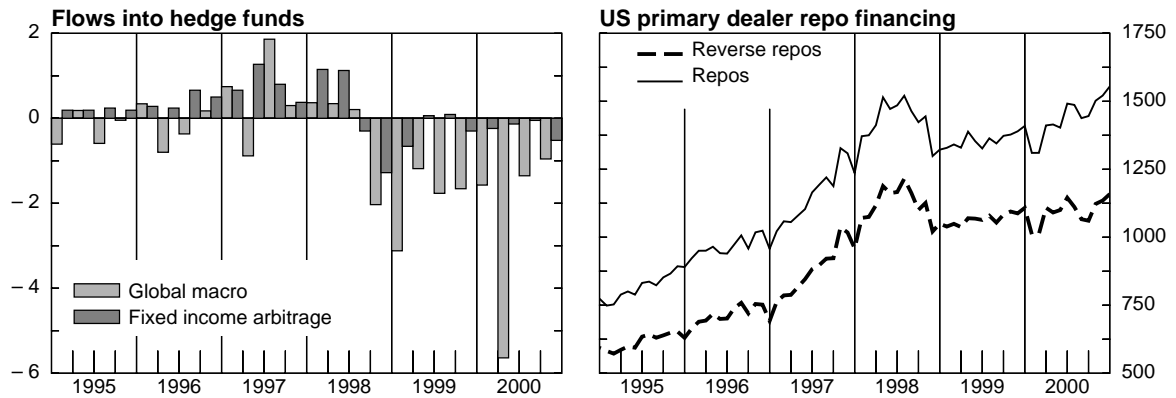
Investors' discomfort with the rising share of JGS in the global securities market was also a factor behind the recent advent of global indices offering broad market coverage. Prior to 1999, the only multicurrency indices available to investors with international portfolios were composed exclusively 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



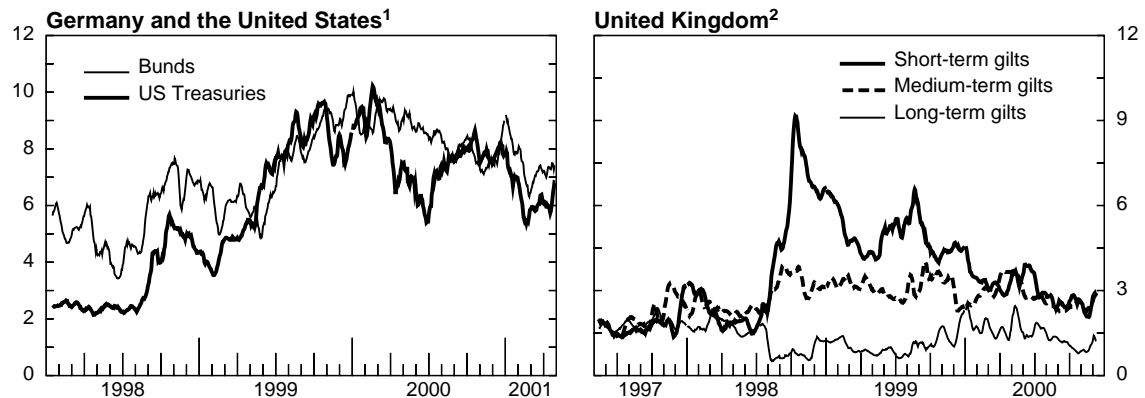
Sources: Federal Reserve System; TASS Research.

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



<sup>1</sup> Measured as the standard deviation of yield differentials for all bond cash flows from a fitted yield curve, excluding callable bonds. <sup>2</sup> 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.<sup>17</sup> 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

|                 | <b>Number of contributors</b> | <b>Minimum rating</b> | <b>Maximum rating</b> | <b>Average rating</b> | <b>Trimmed average rating<sup>1</sup></b> |
|-----------------|-------------------------------|-----------------------|-----------------------|-----------------------|---|
| Euribor         | 49 <sup>2</sup>               | 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                                  |

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

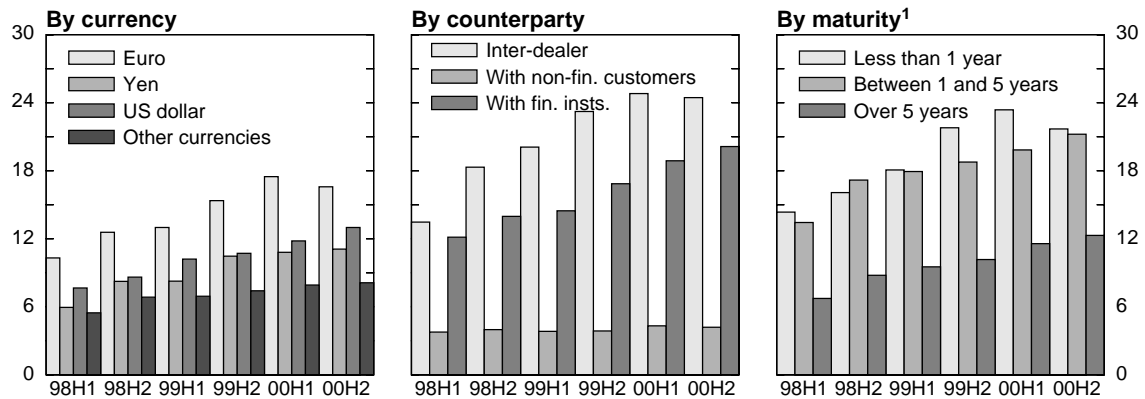
Sources: Bloomberg; British Bankers' Association; European Banking Federation.

<sup>17</sup> 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



<sup>1</sup> 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

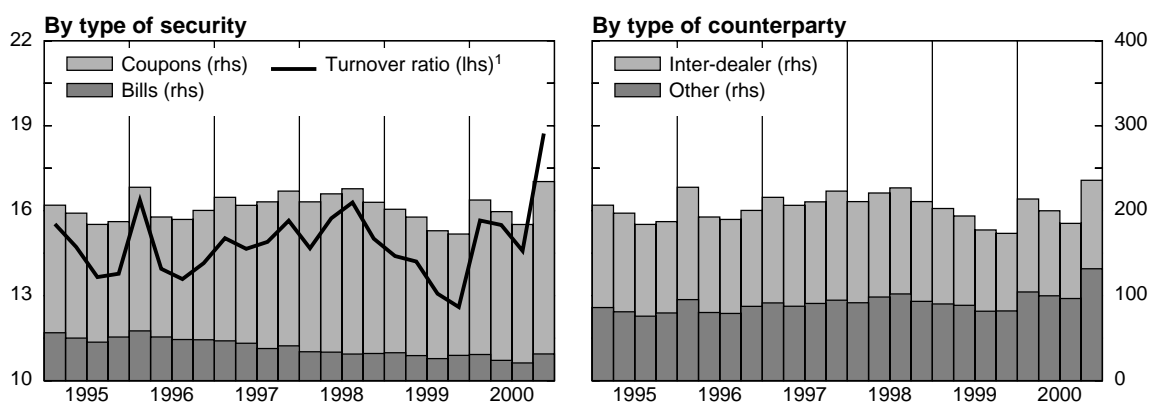
Debt securities issued by industrial country governments have historically been among the most liquid assets available to investors. On the whole, this remains true even today. However, the financial market turbulence in 1998 and consequent changes in investor behaviour appear to have had a lasting deleterious 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

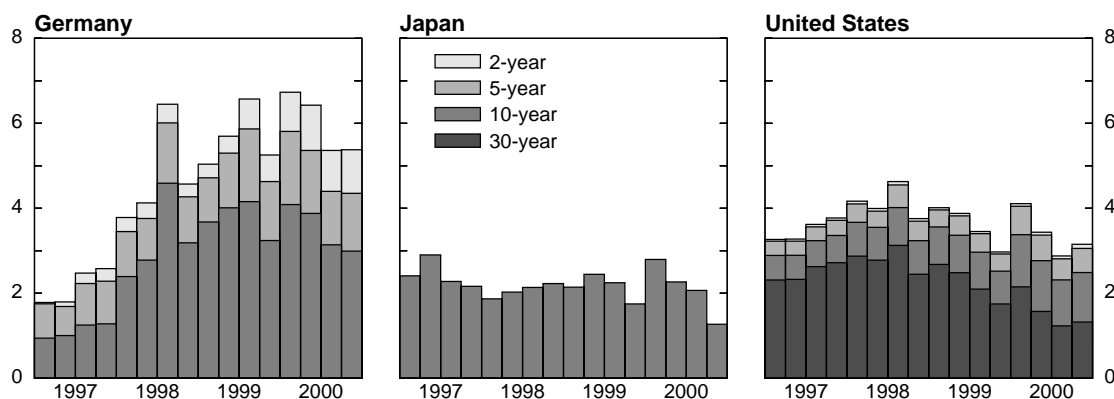


<sup>1</sup> Annualised trading volume divided by amounts outstanding.

Sources: Federal Reserve System.

Graph 11

**Turnover of government bond futures**  
Quarterly trading volume, in trillions of US dollars<sup>1</sup>



<sup>1</sup> Number of contracts traded multiplied by the face value of the futures contract.

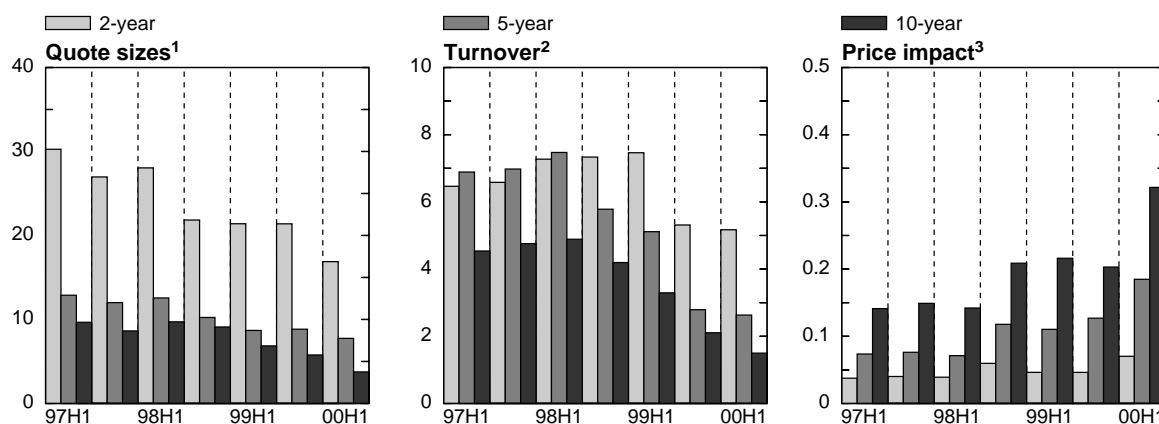
Sources: FOW TRADEdata; Futures Industry Association.

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**



<sup>1</sup> Average quantity of securities bid or offered during the period. <sup>2</sup> Average daily turnover, in billions of US dollars.

<sup>3</sup> Basis points per trade.

Sources: GovPX; Fleming (2001).

### 5.1.2 Euro area government securities markets

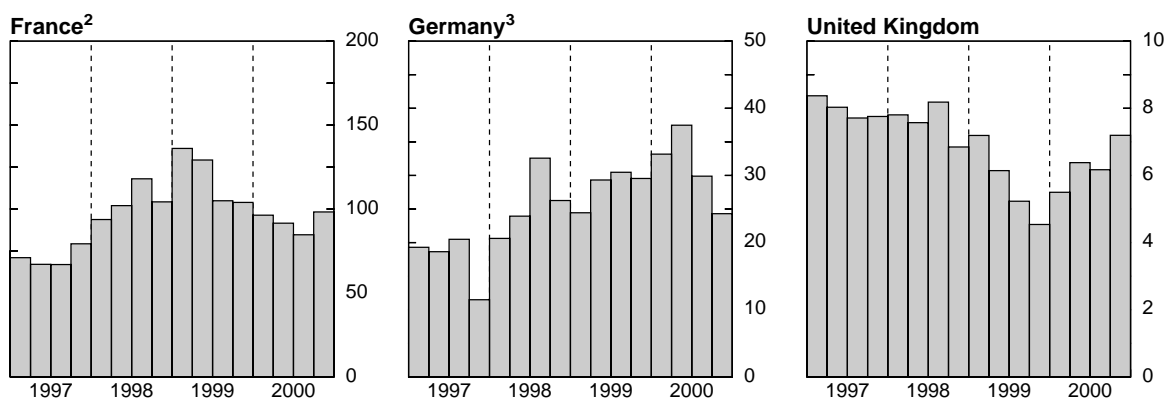
In contrast to the situation in the United Kingdom and the United States, government securities markets in the euro area seem to have gained liquidity. Data on the most actively traded bonds on Euroclear indicate that the average daily turnover of German government bonds increased steadily between 1997 and mid-2000 (Graph 13).<sup>18</sup> 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<sup>1</sup>



<sup>1</sup> For France and Germany, euros; for the United Kingdom, sterling. <sup>2</sup> Includes futures, options and repo transactions.

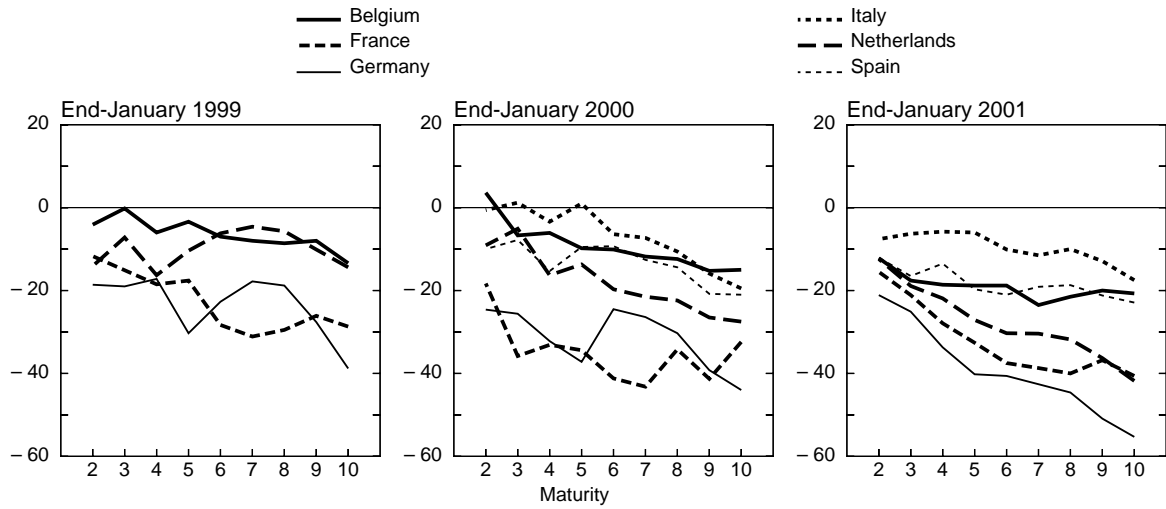
<sup>3</sup> Turnover of the most actively traded bunds settled through Euroclear.

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

<sup>18</sup> 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



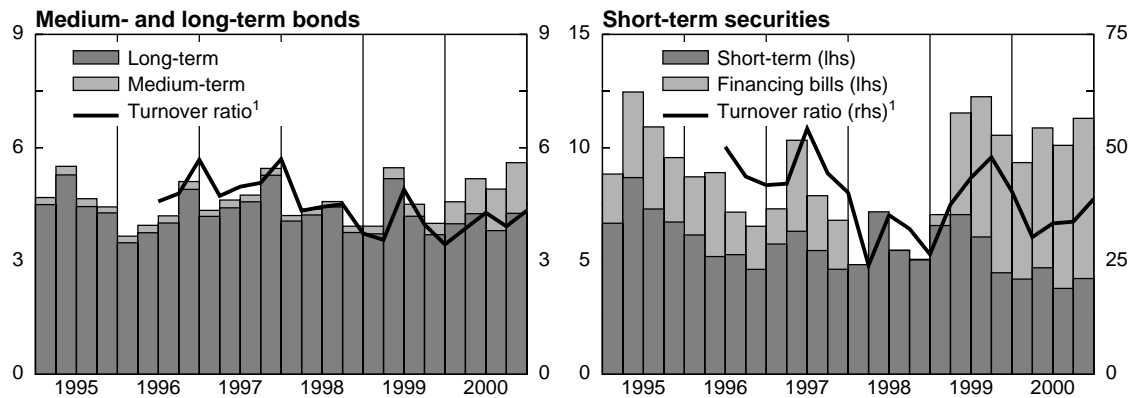
Sources: Bloomberg; Datastream.

**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.

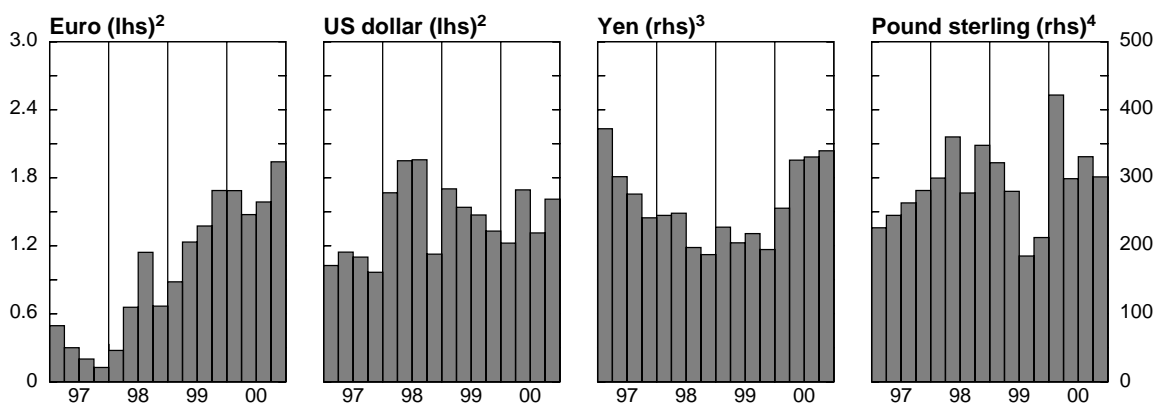
## 5.2 Non-government bond markets

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).<sup>19</sup> 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<sup>1</sup>



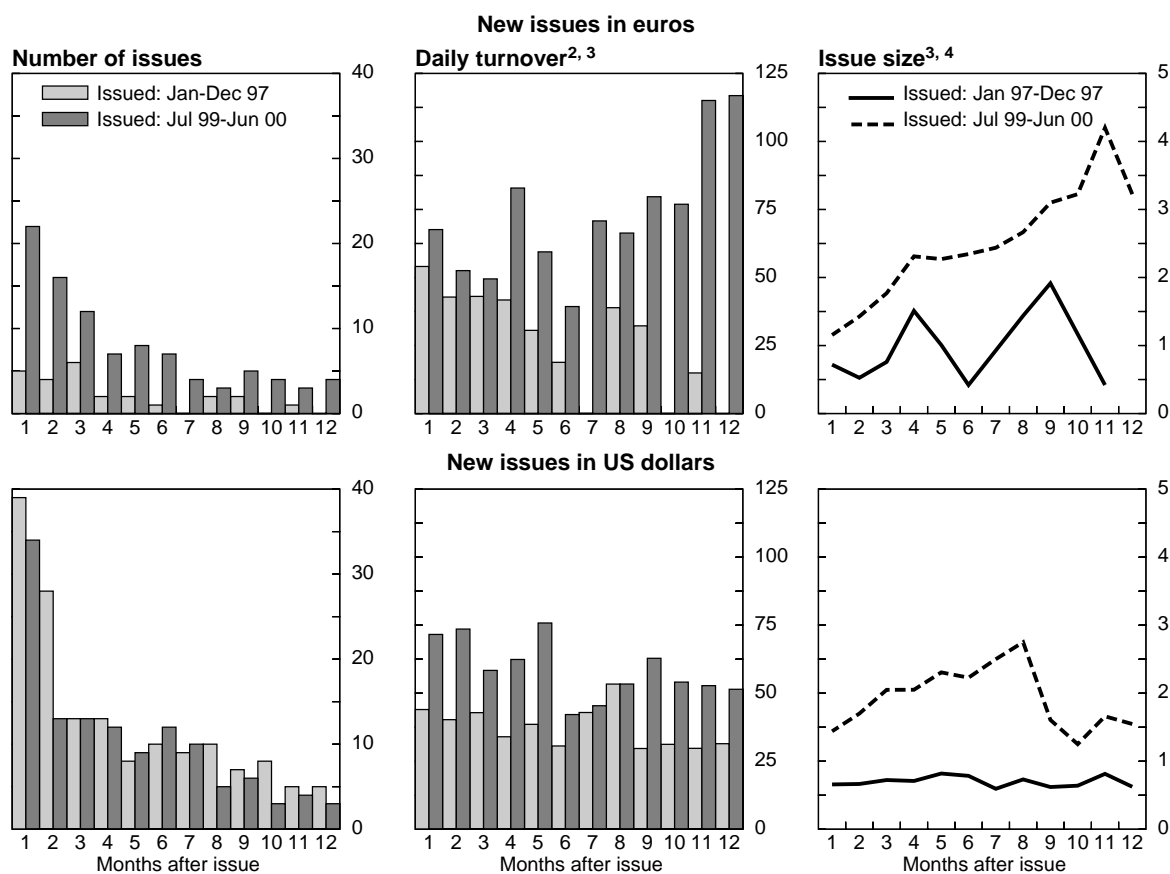
<sup>1</sup> For euros and US dollars, in billions; for yen, in 10 millions; for sterling, in millions. <sup>2</sup> Turnover of the most actively traded bonds settled through Euroclear, excluding money market instruments and medium-term notes. <sup>3</sup> Turnover of bonds issued in Japan's domestic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

Sources: Euroclear; JSDA; LSE; BIS calculations.

<sup>19</sup> 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<sup>1</sup>



<sup>1</sup> Based on the most actively traded bonds settled through Euroclear. <sup>2</sup> In millions of US dollars. <sup>3</sup> Average of all new issues traded actively during the month. <sup>4</sup> 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.<sup>20</sup> A

<sup>20</sup> 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.<sup>21</sup> 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.

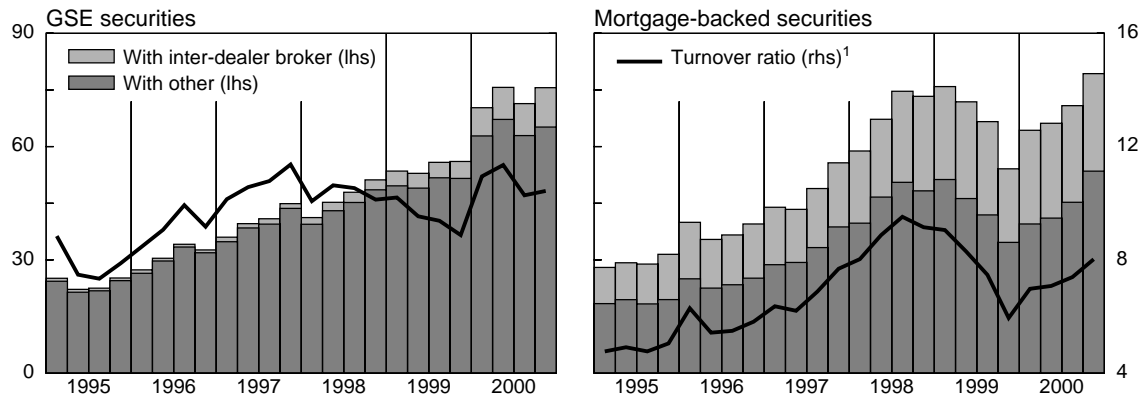
While trends in cash markets indicate that Fannie Mae's and Freddie Mac's "benchmark" programmes have had their desired effect of improving liquidity, activity in futures markets suggests that GSE securities have yet to gain broad market acceptance as instruments for hedging and price discovery. After 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.

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<sup>21</sup> 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



<sup>1</sup> 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.<sup>22</sup>

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

<sup>22</sup> 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.<sup>23</sup> 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.<sup>24</sup> 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

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<sup>23</sup> 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.

<sup>24</sup> 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.<sup>25</sup> 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 supnationals 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

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<sup>25</sup> 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.<sup>26</sup>

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.

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<sup>26</sup> 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.<sup>27</sup>

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<sup>27</sup> 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.

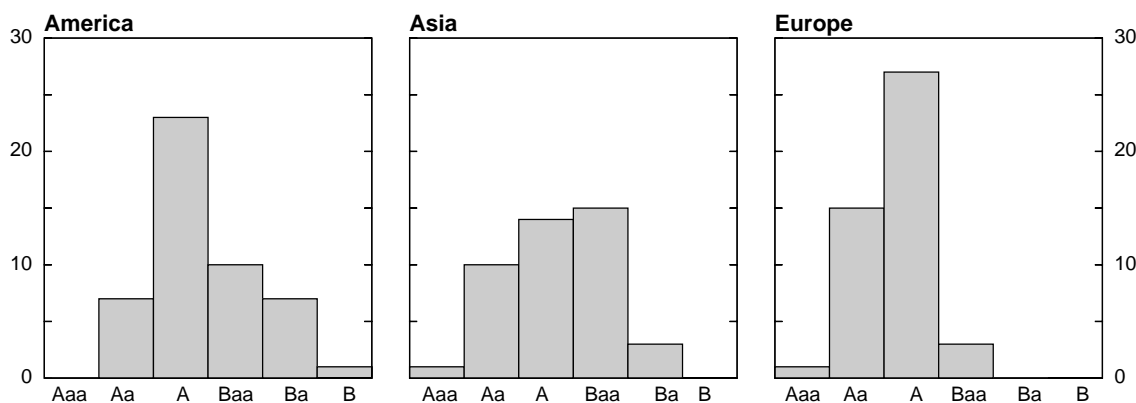
The development of credit derivatives has played an important part in the shift towards non-government benchmarks. In the past, it was difficult to isolate credit risk from other factors, in particular liquidity risk. Credit derivatives facilitate the decomposition of spreads into their various risks 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)<sup>1</sup>



<sup>1</sup> As of 27 November 2000.

Source: JP Morgan.

Table 6  
**Quote conventions for non-government bonds**  
Common pricing benchmarks<sup>1</sup>

| 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    |

<sup>1</sup> 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<sup>1</sup>

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

<sup>1</sup> 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  |
|------------------------|---|--|--|
| <i>Zero coupon</i>     |   |  |  |
| 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<br>Frequency unchanged at 52/yr  |
| 6 months               | Size rose to >¥2trn from ¥1.4trn<br>Freq unchanged at 12/yr                         |  | Size unchanged \$12bn<br>Frequency unchanged at 52/yr  |
| 1 year                 | Introduced in Apr 99<br>Size rose to >¥1trn from ¥0.8trn<br>Freq unchanged at 12/yr | Not issued   | Size fell to \$14b from \$20b<br>Frequency fell to 4/yr from 13/yr in Feb 00                               |
| <i>Floating rate</i>   |   |  |  |
| 5 years                | Not issued  | Last issued in Jun 96  | Not issued   |
| 15 years               | Introduced in Jun 00<br>Size unchanged at ¥0.6trn<br>Frequency unchanged at 4/yr    | Not issued   | Not issued   |
| <i>Fixed rate</i>      |   |  |  |
| 2 years                | Size rose to ¥1.4trn from ¥0.1trn<br>Frequency unchanged 12/yr                      | Not issued   | Size fell \$10bn from \$18bn<br>Frequency unchanged at 12/yr   |
| 3-4 years <sup>2</sup> | Last issued in Apr 01   | Not issued   | Last issued in May 98  |
| 5 years                | Introduced in Feb 00<br>Size unchanged at ¥0.9trn<br>Frequency unchanged at 12/yr   | Last issued in 1996  | Size unchanged at \$12bn<br>Frequency fell to 4/yr from 12/yr in May 98 <sup>3</sup>                       |
| 6 years                | Last issued in Apr 01   | Not issued   | Not issued   |
| 10 years               | Size rose to ¥1.4trn from ¥1trn<br>Frequency unchanged 12/yr                        | Size varies from £8bn to 11bn  | Size fell to \$10bn from \$12bn<br>Frequency unchanged at 4/yr   |
| 20 years               | Size rose to ¥0.6trn from ¥0.4trn<br>Frequency unchanged at 4/yr                    | Last issued in 1997  | Not issued   |
| 30 years               | Introduced in Sep 99<br>Size unchanged at ¥0.3trn<br>Frequency unchanged at 3/yr    | Issuance varies  | Size unchanged at \$10bn<br>Frequency fell to 2/yr from 3/yr in Feb 00                                     |
| <i>Indexed</i>         |   |  |  |
| 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<br>Last issued in Sep 98  |
| 10 years               | Not issued  |  | Introduced in Jan 97<br>Size fell to \$5bn from \$7bn<br>Frequency unchanged at 2/yr                       |
| 30 years               | Not issued  |  | Introduced in Apr 98<br>Size fell to \$5b from \$8b<br>Frequency fell to 1/yr from 2/yr in Feb 00          |
| <i>Reopenings</i>      | 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 |
| <i>Debt buybacks</i>   | 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       |

<sup>1</sup> Changes between 1997 and 2000 in the average size of auctioned issues (including reopenings) and the frequency of auctions. <sup>2</sup> Four-year bond in Japan and three-year bond in the United States. <sup>3</sup> 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<sup>1</sup>

|  | 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 <sup>1</sup> | 740   | 916   | 1,014              |
| Total US dollar reserves                   | 835   | 1,082 | 1,451 <sup>2</sup> |
| Total foreign exchange reserves            | 1,347 | 1,640 | 1,909 <sup>2</sup> |

<sup>1</sup> Identified US dollar reserves exclude US dollar-denominated securities held outside the United States, such as international dollar bonds. <sup>2</sup> 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 <sup>1</sup> |
|---|----------|------------|---------------|----------|---------------------|
| <b>Bonds issued between January and December 1997</b> |          |            |               |          |                     |
| 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 Cr dit 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           |
| <b>Bonds issued between July 1999 and June 2000</b>   |          |            |               |          |                     |
| 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 f r 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               |

<sup>1</sup> 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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