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THE EUROPEAN BOND MARKETS UNDER EMU

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In this paper, we document how, in the wake of monetary unification, the markets for euro-area sovereign and private-sector bonds have become increasingly integrated. Issuers and investors alike have come to regard the euro-area bond market as a single one. Primary and secondary bond markets have become increasingly integrated on a pan-European scale. Issuance of corporate bonds has taken off on an unprecedented scale in continental Europe. In the process, both investors and issuers have reaped the considerable benefits afforded by greater competition in the underwriting of private bonds and auctioning of public ones, and by the greater liquidity of secondary markets. Bond yields have converged dramatically in the transition to EMU. The persistence of small and variable yield differentials for sovereign debt under EMU indicates that euro-area bonds are still not perfect substitutes. However, to a large extent, this does not reflect persistent market segmentation but rather small differentials in fundamental risk. Liquidity differences play at most a minor role, and this role appears to arise partly from their interaction with fundamental risk. The challenges still lying ahead are numerous. They include: the imbalance between the German-dominated futures and the underlying cash market; the vulnerability of the cash markets' prices to free-riding and manipulation by large financial institutions; the possibility of joint bond issuance by euro-area countries; the integration of clearing and settlement systems in the euro-area bond market; and the participation of new accession countries' issuers in this market.

I. INTRODUCTION

The European Monetary Union (EMU) has probably been the single most important policy-induced innovation in the international financial system since the collapse of the Bretton-Woods system. It has opened the possibility for the creation of a new, fully integrated continental financial market, of the same

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scale as that of the United States. By eliminating exchange-rate risk, EMU has eliminated a key obstacle to financial integration. Before EMU, otherwise identical financial claims issued in different euro-area currencies were imperfect substitutes and traded at different prices. EMU has eliminated this source of market segmentation.

While a single currency is a necessary condition for the emergence of pan-European capital markets, it is not a sufficient one. Other frictions may still stand in the way of full integration: even after the removal of exchange-rate risk, persistent differences in tax treatment, standard contractual clauses and business conventions, issuance policy, security trading systems, settlement systems, availability of information, and judicial enforcement may still segment financial markets along national borders.

In the European bond market, however, monetary unification triggered a sequence of policy actions and private-sector responses that swept aside most of the other obstacles to integration. This was facilitated by the intrinsically standardized nature of bonds and by the limited number of issuers in the sovereign bond market. The issuers coincided with the policy-makers who had promoted EMU, and were determined to gain in terms of reduced funding cost from a broader and more liquid market.

While the push towards integration arose in the public bond market, it had a powerful spillover effect on the private bond market, where it generated a dramatic growth in issuance, secondary market trading, and competition among underwriters. In this paper, we describe the emergence of an integrated market for public as well as private euro-area bonds, highlighting both the impressive changes that have already occurred and the reasons why these bonds are still imperfect substitutes.[2]

We start by illustrating, in section II, the chain reaction of policy actions and private-sector responses that reshaped the institutional framework of the sovereign bond market, leading to more homogeneous issuance and trading arrangements, and show how their effects spilled over into the market for private-sector bonds. In section III, we document how these changes fostered convergence in government bond yields in the transition to EMU. In section IV, we highlight that, in spite of all these achievements, euro-area bonds are still imperfect substitutes, and investigate the reasons and implications of the remaining yield differentials and of their changes over time. Section V concludes by summarizing and taking a look at possible future developments in this market.

II. EMERGENCE OF INTEGRATED BOND MARKETS IN EUROPE

While the introduction of the euro sparked off bond-market integration, its effects were magnified by its concomitance with a worldwide expansion in private bond issuance, which outweighed the stagnant public debt issuance of the 1990s. Indeed, it is private-sector issuance that has nurtured the growth of the euro-area bond market in the wake of EMU, and transformed the euro into a leading currency of denomination for international bond issues. It seems appropriate, therefore, to start our account by setting European developments in their global context. Our next step is to document how the introduction of the euro changed both the behaviour of euro-area issuers and that of investors. It prodded the former to compete in the supply of more homogeneous securities to a much larger potential market, and the latter to shift their portfolio selection away from home issuers. At the same time, it opened up great opportunities to trading platforms with pan-European capabilities, and to intermediaries willing to compete for underwriting business on a pan-European basis. As we shall see, the response of markets and intermediaries to this challenge contributed to the integration of the market, by compounding the responses of issuers and investors.

(i) The European Market in Global Perspective

Before EMU, European bond markets were largely domestic and significantly smaller than their US counterparts. Table 1 gives an overview of the size of international bond markets in 1998; in that year, the value of total bonds outstanding in the euro area was still 56 per cent of the value in the USA. This

[2] Danthine *et al*. (2001), Galati and Tsatsaronis (2001), and Hartmann *et al*. (2003) provide broader overviews, including other sectors of the financial market.

Table 1
Size of International Bond Markets in 1998

	Total bonds outstanding[a]	Of which: government bonds
USA	11,656.45	7,031.77
Euro zone	6,526.42	3,577.49
Japan	3,958.94	2,824.40
Rest of the world	4,369.43	2,229.01
World total	26,511.24	15,662.67

Note: [a] By country of origin of issuer, in $ billion, end of third quarter 1998.
Source: Bank for International Settlements (BIS), own calculations.

Table 2
Global Net Issuance of Debt Securities

Currency/year	1994	1995	1996	1997	1998	1999	2000	2001	2002
US dollar	664.3	796.9	1,125.4	1,255.5	1,726.4	1,511.9	1,053.5	1,302.1	1,443.6
Euro						876.4	626.3	562.9	714.0
Euro-area currencies	425.3	366.3	528.7	326.9	435.3				
Yen	336.7	434.6	458.7	237.9	185.8	496.1	450.6	570.6	280.6
Other currencies	578.3	544.1	392.6	362.4	438.9	470.7	375.9	450.6	494.3
Total	2,004.6	2,141.9	2,505.4	2,182.7	2,786.4	3,355.1	2,506.3	2,886.2	2,932.5

Source: BIS, own calculations.

size differential existed for both the private and the public bond market. However, the euro-area public and private bond markets taken together already accounted for 25 per cent of the world total, and were significantly bigger than their Japanese counterparts.

Segmentation along national boundaries was a major feature of bond markets in Europe. At the start of the 1990s, almost all public debt was still issued domestically, while for private-sector issues the ratio of domestic to international debt securities in Europe was about 4:1. Except for a few public or semi-public benchmark bonds, such as the 10-year Bund or the German Pfandbriefe, secondary market activity in Europe also remained largely domestic until the late 1990s.

All this changed drastically in the late 1990s. There was sustained growth in issuance of bonds worldwide, and Europe shared in this growth of the market especially with much increased corporate bond issuance and international debt issuance. Table 2 shows that global net debt issues increased by 65 per cent between 1994 and 1999, and Figure 1(*a*) indicates that this was mostly driven by the growth in bond issuance by the private sector. This growth occurred on both sides of the Atlantic, though with slightly different timing.

In the United States, the economic boom of the mid-1990s was accompanied by a strong expansion of private-sector debt issues, with volumes rising from $280 billion in 1994 to $1,061 billion in 1998, as shown by Figure 1(*b*). Yet, in the aftermath of the Long Term Capital Management and Russian debt crises, private-sector issues in the USA declined sharply in 1999 and 2000, before issuing activity picked up again.

In the euro area, the private-sector debt expansion was more modest than in the United States in the mid-1990s: it rose from $124 billion to $273 billion between 1994 and 1998. But, after the introduction

of the euro, private issuance more than doubled to $657 billion in 1999, as illustrated by Figure 1(*c*). Despite the subsequent reduction, euro-area private-sector issuance later remained much higher than in the first part of the decade. That the 1999 boom is associated with the euro is underscored also by the different pattern of private bond issuance observed for European countries outside the euro area (Figure 1(*d*)), where the growth occurred gradually since 1994, as in the USA.

In Japan, by contrast, private-sector issues were almost flat in the 1990s, owing to the prolonged recession. In contrast, public debt issuance increased drastically after 1998. This pattern is the opposite to that observed in the USA and Europe, where net government borrowing decreased for most of the period. The spike of public debt issues in the USA in 1998–9 was exclusively due to strong issuing activity by local governments and the housing finance agencies.

Hence, global bond issuance expanded dramatically in the 1990s, in three different areas: first, US private-sector issues in the mid-1990s; second, euro-area private-sector issues after the introduction of the euro; and third, Japanese public borrowing after 1998. As of 2004, all these three features seemed to be persistent: between 1999 and 2003, average private bond issuance in the USA was about $900 billion, up from $280 billion in 1994; that in the euro-area was about $550 billion, more than four times the 1994 level; and Japanese government borrowing averaged roughly $450 billion, up from an average of $250 billion in 1994–8.

The strong expansion of the euro-area bond market is reflected in an increase in the importance of the euro as international issuing currency. Table 2 shows no increase in the relative importance of the euro (or its precursor currencies) with respect to the dollar, but these numbers aggregate domestic and international debt issues. Unfortunately, the empirical classification of bond issues in these categories is controversial. According to the international statistics of the BIS, the euro overtook the US dollar in 1999 as the most heavily used currency for international debt issues, and has traded the lead in this category with the dollar since then. International issues, according to the BIS, include all issues except the domestic-currency bonds issued by residents and targeted to domestic investors. However, Detken and Hartmann (2000) have rightly pointed out that these numbers understate the international use of the dollar, because of the global importance of the US market. They present data on announced debt issues that take this bias into account and find that the dollar has remained the most important international issuing currency, although the euro has doubled its share in international debt issues between 1994 and 2003.[3]

(ii) The Supply Side

Public issues

The fiscal discipline stemming from the Maastricht Treaty criteria has restrained the total volume of sovereign bonds issued in the euro area. As shown in Figure 1(*c*), total public-sector debt issues in the euro area fell from $414 billion in 1994 to $111 billion in 2000. Recently this process has been partially reversed, but despite the *de facto* scrapping of the Stability and Growth Pact in 2003, its remnants can still be expected to curb the expansion of public debt in the foreseeable future.

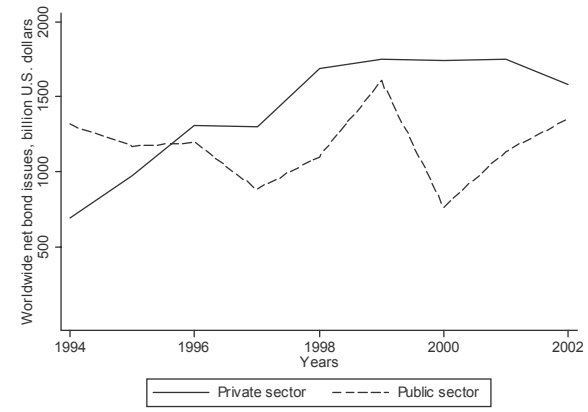
Yet, despite this overall restraint on the size of the public debt market, the introduction of the euro has deeply changed the way in which public debt is issued in Europe. In fact, the changes in issuing policy by sovereign issuers went far beyond a simple currency conversion.

In 1995, EU governments decided that, as of January 1999, all new fungible public debt by EMU member states should be issued in euros. This was a direct consequence of the introduction of the euro and in itself would have already created relatively large euro markets for long-term public debt. Yet, governments were undecided at the time whether to redenominate their outstanding debt into euros with the inception of EMU. Redenomination would not only have added large volumes to the long end of the yield curve, but also created euro markets for shorter maturities. This potentially beneficial effect needed to be balanced against the costs and technical difficulties of such a switch. The French and the Belgian governments opted very early in favour of

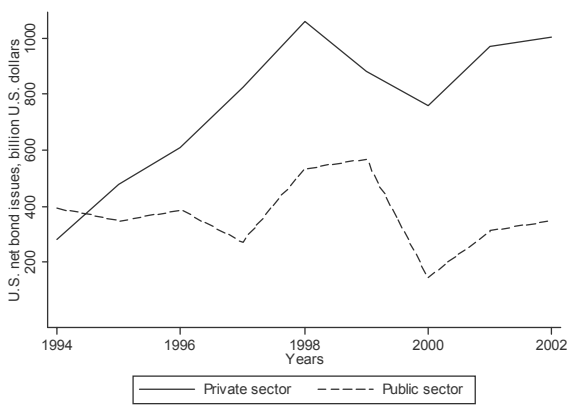
[3] We are grateful to Philipp Hartmann for sharing his updated data with us.

Figure 1
Global Bond Issuance

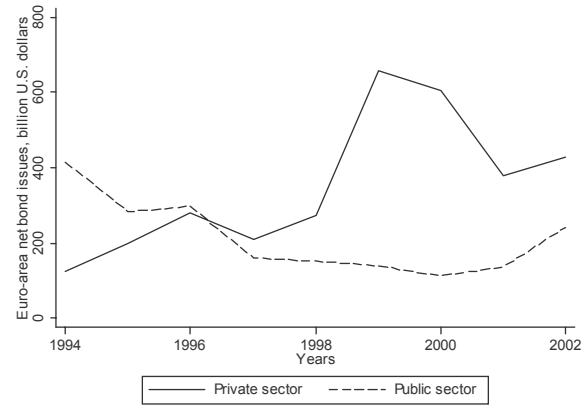
(*a*) Total net bond issues, worldwide



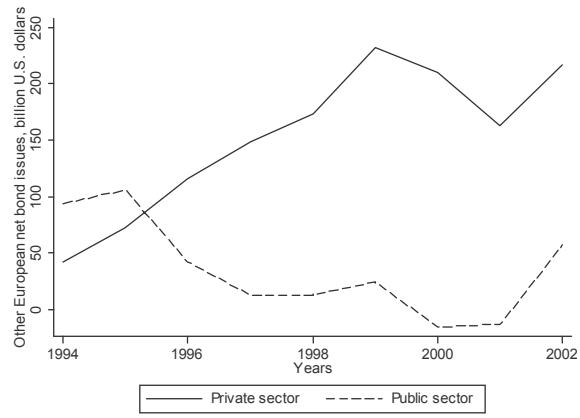
(*b*) Total net bond issues, USA



(*c*) Total net bond issues, Euro area



(*d*) Total net bond issues, rest of Europe



(*e*) Total net bond issues, Japan

Note: Net issues in billions of US dollars. 'Private sector' comprises financial institutions and non-financial corporations; 'public sector' comprises central governments, local governments, public-sector firms, and international organizations.
Source: BIS, own calculations.

redenomination, whereas the German government for a long time seemed to be undecided. However, mostly for fear of a loss of competitiveness of the Frankfurt bond market, the German 'Euro Introduction Law' of June 1998 stipulated the full conversion of existing German fungible federal debt by 1 January 1999.[4] In the wake of these decisions, all other EMU countries followed suit soon afterwards.[5]

The debate about debt conversion was driven by the concern about the benchmark status of national debt. As in the private debt market, benchmark status confers substantial benefits on the country that enjoys it, but a large market size is obviously a key requirement for this status. Therefore, the 'race to the benchmark yield curve' was probably the most important factor in the decisions of governments to redenominate their outstanding public debt.

The competition behind the race for benchmark status was complemented by important cooperative elements in the development of the European public bond market. In fact, once the debt conversion decision was made, governments decided to go one step further and homogenize bond conventions. Shortly after the introduction of the euro, all member countries switched the day-count of their outstanding and new issues to a common standard, and most of them switched to using the operating days of the TARGET settlement system as official business days for the service of their public debt. Many private bond issuers adopted similar reconventioning plans.[6] These changes made public bonds more easily comparable and substitutable. While not logical consequences of the introduction of the euro, they show that unification in one area brought about by the euro—the redenomination of bonds—entailed a further element of unification—the reconventioning.

Subsequently, euro-area governments took several even farther-reaching decisions concerning the harmonization of issuing practices, the coordination of issuing dates, the optimal choice of issuing formats, and similar matters.[7] Although more progress is still possible on these fronts, issuing practices, in particular of smaller euro countries, have changed considerably since the 1990s. Pre-announced auction calendars have become standard; re-openings and clusterings of issues in different parts of the maturity spectrum have become widely used tools of public management. In general, issue sizes have increased, with Treasuries buying back old illiquid and/or short-dated bonds and exchanging them for new issues and concentrating new issues in fewer benchmark securities. Some smaller issuers introduced syndicated procedures instead of auctions to attract more investors. Moreover, the competition between national Treasuries pushed them to innovate the menu of bonds offered: Spain and France have issued constant-maturity bonds; France, followed by other issuers, has introduced inflation-indexed bonds. Initially, these were indexed to national price indices, but more recently some issues have been indexed to a European price index.

Interestingly, the euro has reached out even into the non-euro area. For example, the Bank of England has been issuing euro-denominated Treasury Bills since 1999. This broadening of the euro-denominated public debt market has partly compensated for the reduction in issuing volumes in most of the euro-area countries until the early 2000s.

Private-sector issues

As documented by Figure 1(*c*), the private bond market in Europe experienced a major change in 1999, when issuing volumes more than doubled from $273 billion to $657 billion. While the 1998 issuing volume in the euro area was less than 26 per cent of that in the USA, the 1999 volume was more than 74 per cent of the US level. Part of this surge probably reflects exceptional and transient factors. First, the financial crisis of late 1998 resulted in catch-up issuing activity in early 1999 (which, however, was equally relevant for the USA and Europe). Second, the desire to set benchmarks with euro issues pushed issuers to go to the market earlier and in more concentrated volumes than they might have chosen otherwise. But Figures 1(*b*) and 1(*c*) show

[4] Except for some short-term obligations, which comprise less than 3 per cent of the fungible federal debt.

[5] With some minor exceptions such as Austria, which redenominated only the most liquid portion of its tradable debt (34 per cent).

[6] For details, see Bank of England (1998). By 'reconventioning' we mean changing the terms of legacy transactions to bring them into line with the new harmonized euro conventions.

[7] For a discussion, see Favero *et al*. (1999).

Table 3
Bank Debt of Non-financial Firms

	All non-financial firms, 1993	239 largest manufacturing firms, 1996
Benelux	83.2	48.1
France	80.2	44.3
Germany	85.1	63.2
Italy	94.6	73.9
Spain	77.3	—
United Kingdom	49.4	34.1
United States	32.4	9.4
Japan	—	56.4

Note: Numbers are shares of bank debt in total debt.
Source: Danthine *et al*. (2001).

that a significant part of this change was longer-lived.

The relatively small corporate bond market in Europe until the late 1990s is mirrored by the correspondingly greater importance of bank lending. While in the USA bank loans play a negligible role in the financing of large companies and face strong competition from the bond market even for medium-sized companies, they have been traditionally the dominant source of debt financing for almost all European companies, even the largest ones, as shown by Table 3.

This feature of European corporate finance began to erode in the second half of the 1990s. It is difficult to tell whether the change towards a stronger reliance on bonds has been driven mainly by firms or by the banks themselves. Part of the explanation is certainly the increasing reluctance of European banks to provide traditional loans, which inflate the asset side of balance sheets and thus depress key earnings ratios and require higher regulatory capital. But the introduction of the euro has clearly also been a crucial event for the other side of the market: companies have seen the opportunity of accessing a larger pool of investors and diversifying their liabilities, so as to provide some competition to their bank financiers and decrease their vulnerability to credit crunches.

As in the public sector, bond-issuance policy in the private sector changed fundamentally in Europe in the late 1990s. For example, the size of the largest issues increased substantially. While in 1998 there were just three bond issues in euro legacy currencies above the equivalent of €1 billion, the three issues by Tecnost, the financing vehicle for Olivetti's takeover of Telecom Italia, in June and July 1999 alone raised €15.65 billion. Although these issues were widely perceived as exceptional, issue sizes in general in Europe have increased significantly since 1999, with issues above €1 billion becoming more and more frequent.

Furthermore, the quality range of bond issues expanded significantly. In particular, the average credit rating of issuing companies has fallen significantly since EMU. While European bond markets used to be dominated by AAA and AA issues, almost 50 per cent of all corporate bonds issued in 1999 had a single A credit rating. Further down the spectrum, even the first signs of a European junk bond market exist, although this segment is still underdeveloped.

Interestingly, Rajan and Zingales (2003) show that the boom of the corporate bond market after the introduction of the euro was indeed stronger in the euro area than outside. They conduct a simple panel data analysis for a sample of European countries since 1990 and find that net private debt issues became significantly larger for countries that adopted the euro. This suggests that the introduction of the euro had a causal impact on the development of the corporate bond market in Europe.

Much of this supply-side development is undoubtedly due to the boom of some industries, such as telecommunications, which were liberalized and deregulated in the late 1990s in many western

Table 4
Issuance of Private-sector International Debt Securities by Area and Type of Issuer

Area/issuer	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
United States										
Financial institutions	19.3	32.9	84.0	98.1	138.5	182.8	230.4	191.8	302.2	246.6
Corporate issuers	18.9	24.4	32.0	64.7	61.6	155.6	47.3	72.4	28.6	27.8
Euro area										
Financial institutions	68.6	87.5	154.0	147.2	163.8	356.5	430.3	325.2	385.6	591.4
Corporate issuers	7.2	8.1	4.4	17.1	32	120.5	96.1	82.7	10.6	56.8

Note: Net issues in US $ billion.
Source: BIS, own calculations.

European countries. The resulting restructuring and consolidation fuelled a wave of mergers and acquisitions (M&A) that were largely financed by bonds. After the collapse of the equity market in 2000 and the worsening of the commercial paper market in the early 2000s, the bond market gained particular importance as a source of long-term funding. Figures 2(*a*) and 2(*b*) show that debt issuance was closely correlated with M&A activity both in the euro area and in other European countries (chiefly the UK, which accounts for most M&A activity in the second group). The correlation is actually greater in the euro area (94.3 per cent) than in other European countries (66.3 per cent), but the total value of M&A deals is much larger in the second group of countries.

Finally, Table 4 shows that the lion's share of private-sector international debt securities in Europe continues to be issued by financial institutions.[8] This feature was weakened in 1998–2001, when the share of non-financial corporate issues began exceeding 20 per cent, but was reasserted in 2002–3 when it declined to traditional levels of 10 per cent and lower. However, the current breakdown is not dissimilar to that in the USA.

(iii) The Demand Side

At the same time as the supply of euro-area bonds increased and issuance policies converged, geographical diversification increased strongly in euro-area bond portfolios on the demand side.

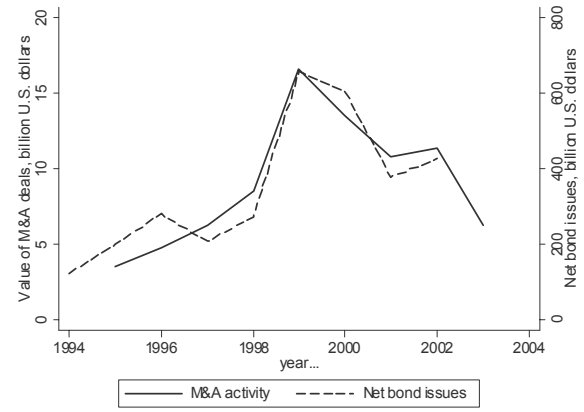
This change was felt most dramatically with private issues. While until 1998 bond distribution in the euro zone for all but the very few largest firms was almost exclusively domestic, the larger bond issues were already in 1999 sold on a truly European scale that surprised even most market participants. A typical example was the €1 billion issue of Alcatel, the French telecom firm, in February 1999, 28 per cent of which was placed with Italian and more than 20 per cent with German investors. Alcatel's surprised Chief Finance Officer remarked, after the issue, 'that a French corporate can sell its bonds primarily to Italy is something new'. A similar example was the 1999 issue by Principal Life, a US insurer, where the head of the syndicate at Credit Suisse First Boston for the European issue noted that 'we sold 30 per cent of this deal in France. In the past we might have sold 3 per cent there'.[9]

A similar evolution happened in the public bond market. According to European Central Bank (ECB) data quoted by Blanco (2001, Table 3), the share of euro-area government securities held by non-residents increased steadily from 16 per cent in 1991 to 26.8 per cent in 1998 and up to 33.5 per cent in 2000. As shown by Adam *et al*. (2002), much of this increase is due to institutional investors. Their study looks at the share of assets managed by money and

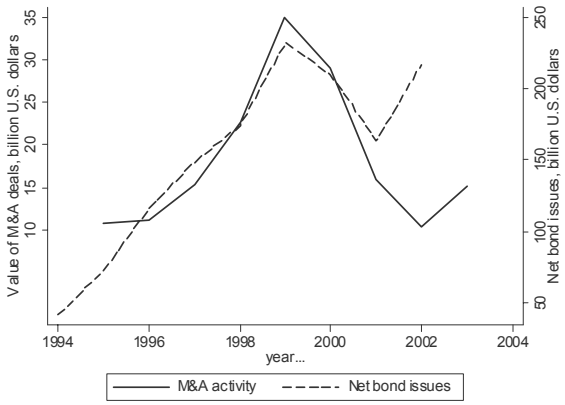
[8] The break-down of domestic private issues is not available for the whole 1994–2003 interval. However, from available data European non-financial corporations appear more active domestically than internationally, which contradicts the finding in Table 4.
[9] See *Euromoney*, August and September 1999.

Figure 2
Bond Issuance and M&A Activity in Europe

(*a*) Private net bond issues and value of M&A deals, Euro-area



(*b*) Private net bond issues and value of M&A deals, other European countries



Note: M&A activity is the total value of all M&A deals whose value is reported in the SDC Platinum database (US $ billion). Net bond issues are private-sector issues (US $ billion).
Sources: Thomson Financial Securities Data and BIS, respectively.

bond funds that pursued a Europe-wide investment strategy between 1997 and 2001, based on data provided by the Fédération Européenne des Fonds et Sociétés d'Investissement (FEFSI).[10] The figures given by Adam *et al*. (2002) have been recalculated and updated to 2003 by Baele *et al*. (2004). Both studies indicate that the adoption of the euro is associated with a large increase in the asset share of internationally investing bond funds in Austria, Finland, France, and Germany, with most of the change occurring at the time of the introduction of the euro. The euro-area unweighted average of the share of assets invested in bond funds with a Europe-wide strategy rose from 17 per cent in 1998 to 60 per cent in 2002 (Baele *et al*., 2004, Chart 21).

Incidentally, a similar shift occurred also in the investment policies of pension funds and life-insurance companies, since EMU relaxed a number of regulatory restrictions on the currency matching of assets and liabilities, such as a 20-per-cent ceiling on the permissible mismatch in their denomination and other restrictions on the purchase of foreign assets.

Table 5 (column 1) shows that by 2003 more than half of the assets of bond funds were invested with an Europe-wide strategy in each euro-area country except Spain (the latter being likely due to misclassification of Spanish funds in the FEFSI data base). The countries where bond funds are more diversified are Belgium, Italy, and Portugal. The greater appetite for diversification by investors based in these countries may reflect their greater concern with the solvency risk of their respective home issuers: Belgium, Italy, and Portugal have the lowest-rated debt among those for which these data are available.[11]

Interestingly, this shift in portfolio-allocation strategy is limited to the euro area, in two senses. First, it is peculiar to bond funds based in the euro area: in Denmark, Sweden, and the UK the share of bond funds with a European-wide investment strategy remained low and rather stable between 1998 and 2001 (Adam *et al*., 2002). Second, euro-area funds did not extend their diversification strategy also to bonds issued outside the euro area itself: the share of bond funds with a global bond investment strategy

[10] However, the FEFSI classification of funds according to their investment strategy (domestic, European or global) and type (money market, bond, or equity) seems not entirely consistent across countries, being based on national schemes.

[11] These figures are a lower bound on the diversification attainable by individual investors since, even if all funds in a given country completely specialize in domestic investments, individual investors can diversify internationally by holding a mix of funds offered by foreign intermediaries, if they have access to the investment products of other countries.

Table 5
International Diversification of Bond Portfolios in the Euro Area

Country	Share of assets invested in bond market funds with Europe-wide investment strategy, % in 2003	International investor base as fraction of total investor base, % in 2004
Austria	55	90–99
Belgium	88	48.4
Finland	61	62
France	60	37
Germany	52	—
Greece	—	55
Ireland	—	75
Italy	81	42
Netherlands	—	81
Portugal	98	80
Spain	0	37
Average	62	61.2

Sources: The numbers in column 1 are from Baele *et al*. (2004, p. 53); those in column 2 are from MTS Group (2004, p. 13).

actually declined from 30 per cent in 1998 to 20 per cent in 1999 and stood roughly constant at that level until 2003. Apparently, euro-area investors now view the euro-area bond market as their home market, so that the traditional home bias 'may have been replaced with a "euro area home bias"' (Baele *et al*., 2004, p. 54).

Rather than asking how diversified euro-area bond portfolios are, one can look at the weight of foreign investors in each of the euro-area bond markets. The latter is only to a certain extent related to the former. For example, the investors from a given country can have diversified portfolios and still absorb most of the domestically issued bonds. Moreover, foreign investors include also those based outside the euro area.

But it turns out that along this dimension, too, the euro-area bond market has become highly integrated. Euro-area public debt bought by international investors is currently 61.2 per cent of the total (unweighted average, excluding Germany), according to data collected by national treasuries and reported by MTS Group (2004). As shown in column 2 of Table 5, the investor base is more international in euro-area countries with a smaller absolute amount of outstanding debt, such as Austria, Finland, Ireland, the Netherlands, and Portugal, possibly because foreign institutional investors loom larger in these small markets.

(iv) The Response of Intermediaries

While euro-area governments laid the institutional framework for an integrated bond market, financial intermediaries supported this integration by providing increasingly homogeneous secondary trading facilities and by competing on the primary market for government debt and corporate issues. This response by financial intermediaries was obviously triggered by the considerable business opportunities stemming from a pan-European bond market, but in turn it reinforced the process of integration, by feeding back into the behaviour of other market participants. For instance, trading platforms set homogeneous and more demanding requirements on issuers' policies and on dealers' market-making activity, and at the same time allowed investors to access an increasingly large menu of bonds with standardized trading procedures.[12] Similarly, investment banks' more aggressive competition for un-

[12] While the contribution of electronic trading platforms to euro-area bond market activity appears to be substantial, we are not aware of any formal econometric analysis that attempts to quantify such a contribution.

derwriting business reduced and homogenized the fees they charged to corporate customers, increasing companies' inducement to issue bonds even in the low-grade segment.

Public debt trading platforms

The emergence of pan-European trading platforms has been an important force in the process of integrating the secondary market for European government bonds. The most important among them are MTS in the cash market, and EUREX in the futures market.

MTS is a quote-driven, electronic trading platform that emerged from a public institution created in 1988 by the Italian Treasury and the Bank of Italy in collaboration with Italian primary dealers, to improve the liquidity of the Italian government bond market. The success of its trading model led to its privatization in 1997 and to the expansion in 1999 into the Netherlands, Belgium, and France, establishing similar trading platforms—a first set of domestic MTS markets.

Currently, MTS is the parent company that partially owns subsidiaries in all the euro-area countries and in Denmark,[13] and trades government bonds in several eastern European countries through its division 'New EuroMTS' (since November 2003). MTS S.p.A. is owned by financial intermediaries: 55 per cent of its capital belongs to non-Italian banks, and 45 per cent to Italian ones.

The breakthrough in MTS's business model was the creation of EuroMTS, a pan-European inter-dealer platform that offered trading facilities for the largest and most liquid European government bonds and subsequently became the standard setter for European benchmark bonds—that is, the newly issued bonds at the 5- and 10-year maturities. The key to the success of this trading platform is to be found not only in its technical capabilities but also in MTS's ability to bring together issuers and dealers and to commit them to a few simple rules so as to foster secondary market liquidity—a mutual commitment that MTS labels a 'liquidity pact'. Dealers commit to quote continuously two-way firm prices with a maximum spread, and issuers commit to an issue listing size at least equal to €5 billion for benchmark bonds and to a random allocation of bonds among bond dealers for quoting obligations. Moreover, MTS volumes contribute to the total trading volume that Treasuries require of all dealers for admission to the primary market. In this way, the MTS-sponsored 'liquidity pact' has promoted the homogenization of the euro-area sovereign bond market around minimum standards of size and liquidity.[14] For its part, MTS guarantees high pre-trade transparency, feeding real-time price and quantity data to final investors via 20 data distributors, and thereby encouraging competition in quotation-setting.

Table 6 illustrates the impressive liquidity of the 10-year and 5-year benchmark bonds traded on EuroMTS. The bid–ask spread statistics in the table are based on daily data for 2002 and 2003 and refer to the best bid and ask prices quoted at 11 a.m. during all business days across all the cash markets. The data show that the average bid–ask spreads are tiny, ranging between 2 basis points in the most liquid market (Italy) to almost 5 in the least liquid (Finland). Interestingly, the German cash market is not the most liquid one, even in the 10-year maturity bucket for which the Bund is considered the benchmark. This is because most of the trading for 10-year German bonds occurs on the futures market, which is more liquid and far deeper than the corresponding cash one. Table 6 also shows that the bid–ask spread does vary over time: for instance, for Italy it ranges between a minimum of 1.2 and a maximum of 15 basis points. As we shall see, the time variation of liquidity is important in the empirical analysis of yield differentials.

Liquidity is lower for issues that are no longer benchmark bonds. These are traded in the domestic MTS markets, where the liquidity and size requirements established on EuroMTS for benchmark

[13] MTS created subsidiaries or divisions in the Netherlands in September 1999, Belgium in May 2000, France and Portugal in July 2000, Finland in April 2002, Spain in May 2002, Ireland in June 2002, Austria in June 2003, and Denmark, Greece, and Germany in November 2003 (but has traded German bonds since April 2001 through a division of EuroMTS).

[14] More recent innovations by EuroMTS include a real-time index of European government bonds (since 2003), the vertical integration into clearing and settlement, and the expansion into the corporate bond market through its BondVision subsidiary. At the time of writing, it is too early to evaluate these developments.

Table 6
Liquidity of the EuroMTS Market

Country	10-year benchmark bonds, daily bid–ask spread data, 2002–3			5-year benchmark bonds, daily bid–ask spread data, 2002–3		
	Average	Minimum	Maximum	Average	Minimum	Maximum
Austria	4.6	2.8	9.8	4.1	2.8	6.5
Belgium	3.5	2.4	6.6	2.7	2.0	3.6
Finland	4.9	2.8	8.4	4.1	2.8	6.2
France	2.9	1.6	5.0	2.5	1.8	3.4
Germany	3.2	2.0	7.0	3.2	1.8	5.0
Italy	2.5	1.2	15.0	2.1	1.0	3.7
Netherlands	3.5	2.6	5.6	3.7	2.4	5.0
Portugal	4.3	2.7	8.4	3.2	2.2	4.6
Spain	3.5	2.0	6.4	2.9	1.6	4.6
Average	3.66	2.23	8.02	3.17	2.04	4.73

Note: The bid–ask spread is measured in basis points and computed as the difference between the best bid and ask prices (divided by the mid-quotation) quoted at 11 a.m. during all business days in EuroMTS cash markets.
Source: MTS Group.

bonds are not enforced. However, the benchmark requirements tend to extend automatically also to these bonds, as older issues are gradually replaced with new ones, which formerly were benchmark issues.

While the market discipline imposed by the 'liquidity pact' on dealers creates obvious benefits to all market participants, the discipline is not perfect and the 'pact', like most other multilateral arrangements, is prone to moral hazard. The problem is that individual market participants can benefit from the liquidity provided by everybody else even at the expense of others, in which case the discipline can become a liability for the complying market-makers. This indeed happened on 2 August 2004, when Citigroup flooded MTS (and other trading platforms) with sales of almost €12 billion across more than 200 bonds within seconds, pushing down prices by about 15 cents. As banks tried to hedge on the Bund future market, the future price dropped 47 cents. At that point, Citigroup bought back €4 billion of bonds at lower prices on the MTS trading system.[15] The price drop was quickly reversed, and Citigroup earned an estimated €15 million at the expense of other market-makers.[16] In effect, Citigroup was able to earn this sum because it had a fleeting informational advantage over the rest of the market: the information about its own future trading strategy, which is price-relevant because of the sheer size of the orders that it can place. Normally, when they suspect that they may be receiving orders from an informed trader, market-makers protect themselves by widening their quotes or refusing to trade. But the MTS market-makers were committed to quoting firm prices for large amounts and keeping tight spreads, and this allowed Citigroup to trade such a large amount before they could react.

Besides exposing the market's vulnerability to manipulation by large traders, this episode may be a deliberate attempt to break the 'liquidity pact' by a large market-maker. That Citigroup shows little concern for the liquidity of MTS may partly stem from its inherent conflict of interest *vis-à-vis* this trading platform—a situation common to several other large market players. It is at the same time a market participant and dealer in all 11 MTS sovereign bond markets, a shareholder of MTS, and a

[15] This account is based on a number of news reports in August 2004 and MTS sources.
[16] Citigroup's profit could have been even larger if a few dealers had not eventually stopped trading as the US bank kept buying back bonds at lower prices, as reported by Munter and van Duyn (2004).

potential competitor of the trading platform owing to its in-house trading capabilities and its participation in competing platforms. This episode indicates that, for all their benefits to issuers, the implicit rules that guarantee the impressive liquidity of MTS are not unchallenged.[17] Accordingly, it has raised concerns by government officials that disruptions to market liquidity may increase the cost of issuing debt, and prompted investigations by security regulators for the possible breach of trading rules.

While MTS is by far the largest trading platform in the euro-area cash market (especially in the Italian market), it has a low profile in the German bond market, where trading concentrates in the derivatives market, especially in the futures market managed by EUREX. The volume of trade on EUREX increased almost tenfold between 1996 and mid-2001, from €172.4 billion to €1,639.1 billion (see Blanco, 2001, Table 4).[18] In the process it killed off Bund futures trading on London's LIFFE. Also futures trading in French, Italian, and Spanish bonds dwindled into disappearance by 2001.

The trading activity in the futures based on German bonds is so large that the open interest of the Bund futures contracts often exceeds the stock of deliverable bonds. This occasionally generates 'squeezes', which are situations where few market participants buy a large fraction of the deliverable bonds before the maturity of the future contract. If successful, they profit at the expense of the holders of short positions in the futures contract, who must borrow deliverable bonds and lend money at below-market rates in the repo market. Squeezes generate sudden increases in the price of bonds, which spill over to the corresponding cash and repo markets. The problem is amplified by the relative lack of depth of the German cash market, coupled with the fact that other euro-area bonds are still less than perfect substitutes of German Bunds, as we shall see in section III.

Corporate-bond underwriters

The successful integration of secondary government bond markets in the euro zone is not paralleled in the corporate bond market, which is more fragmented. Most of this fragmentation is due to the fragmentation of clearing and settlements systems in Europe. Although the problem has been well known since the late 1990s (see, for example, Padoa-Schioppa, 1999), progress has been slow. Securities settlement in the euro area is still dominated by national players, whose number had only come down from 23 to 14 by 2003 (compared to two in the USA), and hampered by national rules that restrict cross-border activities of settlement houses.[19]

Yet, as highlighted in section II(ii), the true explosion of bond issuance associated with EMU occurred in the corporate-bond market, not in the sovereign-bond segment. An important reason for this success was the corporate-bond underwriters' response to EMU. As the barriers that segmented the European market for corporate-bond underwriting began to erode, investment banks started to benefit from the scale economies in the provision of underwriting services and from the lower entry barriers in the industry. Santos and Tsatsaronis (2002) show that, as a result, underwriting fees in the euro-denominated market converged rapidly with the corresponding fees in the dollar-denominated segment of the industry. They show that, while total underwriter proceeds quadrupled between 1998 and 1999 (and remained around the new level until 2001), the average gross fees in the euro-denominated segment of the bond market halved in the year the euro was introduced, dropping from 1.7 per cent in 1998 to 0.8 per cent in 1999, and remained at the average level of 0.6 per cent in the 1999–2001 period—exactly the same figure as in the US-denominated segment (Santos and Tsatsaronis, 2002, Table 5). By multivariate regression analysis of a sample of 3,110 bonds, they highlight the key role of EMU in the reduction of fees.

[17] It should be noticed that the formal rules of MTS do not prescribe spreads as tight as those actually quoted: the actual spreads are five times tighter than the required ones. But issuers informally require banks to quote the tightest possible spreads, and this induces them to take such positions with so little reward and, as this episode highlighted, so much risk.

[18] Between 1999 and 2003, the number of contracts for Bund, Bobl, and Schatz traded yearly on EUREX increased by 126.6 per cent; by comparison, over the same interval, the value of yearly trading volume on the MTS cash platform increased by 46.7 per cent (data kindly provided by Philippe Rakotovao).

[19] The report by the Giovannini Group (2003) provides an assessment of the situation and proposes various policy reactions.

Melnik and Nissim (2004) confirm the convergence of underwriting characteristics (extent of underpricing, underwriter compensation, bond maturity, syndicate size) in the euro area and the USA after EMU, but point out that the reduction of fees alone does not mean that EMU has reduced underwriter compensation. In a careful analysis of the pricing of Eurobond issues around 1999, they show that the strong reduction in underwriter fees after 1998 was almost fully compensated for by an increase in the underwriter spread (i.e. the difference between the price charged to the public and the price guaranteed to the issuer). Thus total underwriter compensation remained largely stable with the introduction of EMU. The real impact of EMU, according to Melnik and Nissim (2004), was the almost complete elimination of the significant bond underpricing that had prevailed until 1998.

At the same time, the degree of concentration in the industry dropped, especially as a result of the entry of US investment banks into this market: the Herfindhal index more than halved, from 971.2 in 1998 to 400 in 1999, and the share of the top five banks dropped from 57.1 to 33.4 per cent (Santos and Tsatsaronis, 2002). The increased competition was felt particularly in the smaller currency segments, where before EMU the share of the top 5 bookrunners was higher than 75 per cent. Interestingly, borrowers appear to have switched away from their home-currency underwriters for their euro-denominated issues, compared to those in legacy currencies (59.5 per cent versus 80.5 per cent before EMU). Essentially, European corporate issuers moved away from their home bankers, generally towards the larger US investment houses.

III. CONVERGENCE OF YIELDS IN THE TRANSITION TO EMU

The combined effect of EMU, concomitant institutional changes, and private-sector responses illustrated so far translated into a dramatic convergence of the yields on public debt of the same maturity on the eve of monetary unification. This is illustrated in Figure 3 with reference to the 10-year benchmark bonds (but qualitatively similar pictures are obtained for other maturities).

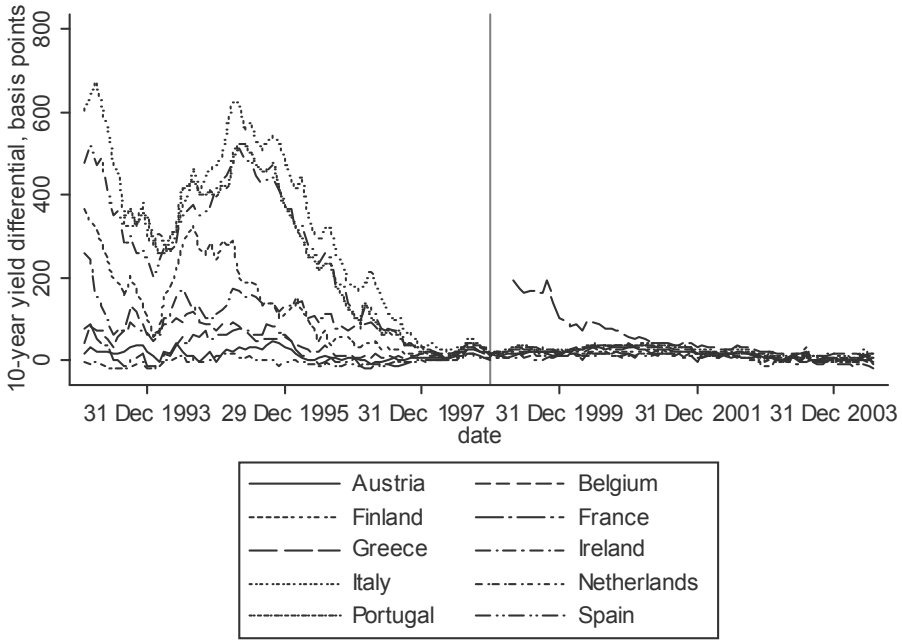
The figure shows end-of-month yield spreads for euro-area benchmark government bonds relative to Germany from January 1993 to July 2004. The convergence of the spreads toward zero is dramatic. Considering all initial EMU participants (and thus excluding Greece), the mean yield spread over the German yield fell from 218 basis points in 1995 to 111 in 1996, 39 in 1997, 19 in 1998, and 20 in 1999. It rebounded slightly in 2000–1, before resuming its downward trend.

Most of the action in these years derives from the convergence of the non-core EMU participants: Finland, Ireland, Italy, Portugal, and Spain, and later Greece, which joined the euro area at the beginning of 2001. The bonds issued by Austria, Belgium, France, and the Netherlands already featured low spreads relative to German bonds since 1996. This is because, before EMU, the probability of depreciation relative to the deutschmark was considerable in the first set of countries, but not in the second. Indeed, for the non-core EU countries the drop of the 10-year yield spreads is overwhelmingly due to the elimination of this possibility, as shown by Blanco (2001). He measures this risk factor by the spread between the 10-year swap rate of the currency and the German swap rate, and finds that the foreign-exchange factor accounts for 41 of the 46 basis points of the 1996–8 yield differential for Finland, 37 out of 45 for Ireland, 132 out of 154 for Italy, and 96 out of 115 for Spain. In contrast, it accounts for a negligible fraction of the differentials for Austria, Belgium, France, and the Netherlands.

The convergence associated with the transition to the euro is confirmed also by formal indicators proposed by Adam *et al*. (2002) using panel data techniques. The idea behind these indicators is that markets are integrated if price differentials are not *persistent*, i.e. if price discrepancies are rapidly eliminated by arbitrage, and if price *dispersion* for these products is small or absent. Applied to bond yields, β-convergence measures if they converge to the same steady-state value, by regressing their changes on their past levels and σ-convergence measures bond-market integration at a point in time, by assessing if the cross-sectional dispersion of yields decreases over time.

Adam *et al*. (2002) measure β-convergence of bond yields on data from January 1995 to September 2001 for euro-area countries (plus Denmark). They regress the changes in bond yield spreads relative to Germany on their past levels (allowing for different

Figure 3
10-year Benchmark Bond Yield Spreads, January 1993 – July 2004



Note: Yield differentials are computed as the difference relative to the yield on German 10-year benchmark bonds, based on monthly data (end-of-month observations).
Source: Datastream.

coefficients in the pre- and post-EMU regimes), controlling for fixed-country effects and lagged interest-rate changes. The coefficients of the lagged interest-rate level—if negative—measure the speed of convergence before and after the transition to the single currency. The estimated coefficients are respectively –0.041 and –0.079, both significantly different from zero, though not significantly different from each other. So β-convergence appears to be consistent with the data for the whole interval.

However, measuring σ-convergence can be of independent value to assess financial integration, since β-convergence does not necessarily imply σ-convergence: mean reversion does not require the cross-sectional variance to decrease, and it could even be associated with σ-divergence.[20] Adam *et al*. (2002) report that in the 10-year government bond market the standard deviation of yield differentials relative to the German yield in 1999 declined to ¼ of its 1995 value. They also regress the cross-sectional standard deviation on a broken linear time trend, the breakpoint being January 1999. In the regression for euro-area countries only, the estimated coefficients of the two time trends indicate that σ-convergence took place until the launch of the euro, but not afterwards: only the coefficient that applies to the pre-EMU interval is negative and statistically different from zero. This evidence adds an important element relative to that on β-convergence: the convergence in the euro-area government-bond market occurred before 1999, not later. This already points to the persistence of residual segmentation under EMU—consistent with the evidence that will be reviewed in the next section.

Baele *et al*. (2004) propose yet another method of measuring the changing degree of bond-market integration, based on the idea that in an integrated market local yields changes are driven by common rather than local shocks. To measure the relative role of these shocks, they estimate a regression of the changes in each country's 10-year government-bond yield on a constant and the change in the German yield. They estimate the regression over a moving window of 18 months, so as to obtain a time-series of constant and slope estimates for each country, and find that the slope coefficients start to

[20] See Quah (1993) for further details on this issue.

converge towards one after 1998. So local bond markets have become less affected by idiosyncratic local news. Accordingly, the fraction of the total variance in local yield changes explained by changes in the German yield increased from less than 50 per cent to over 97 per cent between 1997 and 2002 in Finland, Greece, Italy, Portugal, and Spain.

The same authors also analyse the degree of integration of the corporate-bond market under EMU. They wish to estimate if corporate yields embody country effects, after controlling for all the other measurable characteristics associated with the time-profile of the bond's cash flow, with the likelihood of default, and with liquidity. To this purpose, they collect the yields of 1,256 corporate bonds from Austria, France, Germany, Ireland, the Netherlands, and Spain for the EMU period, and estimate cross-sectional regressions of yield differentials (relative to an equally weighted corporate-bond portfolio) on a constant and a set of bond characteristics: coupon, liquidity, time to maturity, rating, sector, and country. The estimation produces a time series of coefficients for each explanatory variable. Among these, the country dummies' coefficients may be seen as a measure of the respective country-specific risk factors. For all countries except Germany, these country coefficients are significantly different from zero at the 5 per cent level, but are extremely small: 4, 6, and 2 basis points for Spanish, Irish, and Austrian bonds, –8 basis points for French ones, and close to zero for German and Dutch bonds. They typically account for no more of 2 per cent of the cross-sectional variance of yield differentials. This suggests that the corporate-bond market has also achieved a remarkable degree of integration.[21]

This study of the corporate-bond market is a useful reminder that bond-market integration does not require complete convergence of bond yields. Even in an integrated market, differentials may persist to the extent that they are a reflection of the various bonds' different risk, maturity, or cash-flow characteristics, rather than stemming from trading costs, taxes, clearing and settlement costs, or other institutional barriers to trade. Due to their highly standardized nature and low idiosyncratic risk, government bonds are well suited to an assessment of such differentials. This is the objective of the following section.

IV. BOND-YIELD DIFFERENTIALS UNDER EMU

Despite the dramatic convergence documented in the previous section, yield differentials have not disappeared completely under EMU, so that euro-area sovereign bonds are still not perfect substitutes. This can be seen in Figure 4, which is based on the same data as Figure 3 except for the time interval, which includes only the EMU period, and for the omission of Greece, whose yield differential would dwarf all the others. Table 7 reports descriptive statistics by country and by year based on the same data. Taken together, Figure 4 and Table 7 shows four important facts.

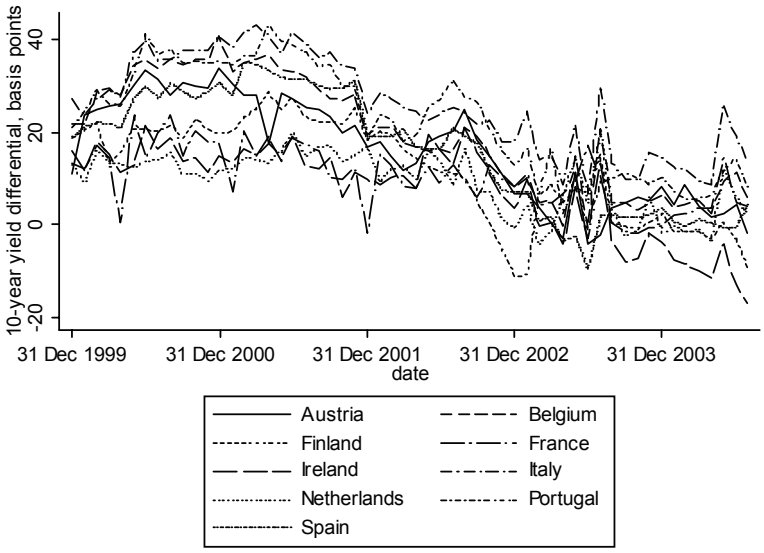
First, yield differentials vary considerably *across countries*, from 8 basis points for Irish debt to 26 basis points for Italian one. This raises the question of what explains these cross-country differences.

Second, for each given country the yield differential varies considerably *over time*. Therefore, yield spreads are a source of additional risk that must be taken into account and priced by investors and traders. This is especially important for traders who go long in the cash market on higher-yield bonds while hedging their interest-rate exposure by shorting the very liquid German Bund on the future market: these positions are risky, since they are exposed to yield-spread risk. In fact, there are traded derivatives, such as spread options, that explicitly refer to observed yield spreads.

Third, the yield spreads have a clear tendency to co-move. This is evident from Figure 4, but it is formally confirmed by the statistical evidence reported in Codogno *et al*. (2003), and Geyer *et al*. (2004). This comovement implies that yield-spread risk cannot be fully hedged by holding a diversified portfolio of euro-area bonds, and raises the question of what

[21] An interesting attempt to estimate the determinants of yield spreads of individual corporate issues in the euro zone is Driessen (2002), who uses a three-factor model for corporate bonds of various rating classes and distinguishes between global factors, rating-class-specific factors, and issuer-specific factors.

Figure 4
10-year Benchmark Bond Yield Spreads under EMU



Note: Yield differentials are computed as the difference relative to the yield on German 10-year benchmark bonds, based on monthly data (end-of-month observations).
Source: Datastream.

Table 7
10-year Benchmark Bond Yield Differentials under EMU
(descriptive statistics by country and by year)

Time-series statistics by country	Average	Standard deviation	Minimum	Maximum
Austria	16.2	11.1	–4.1	33.8
Belgium	19.8	12.3	–0.6	40.9
Finland	11.9	11.0	–11.1	28.8
France	10.5	6.8	–1.9	23.9
Ireland	7.7	10.0	–17.1	21.4
Italy	26.0	10.6	6.5	43.1
Netherlands	9.4	6.7	–4.4	20.4
Portugal	22.7	12.0	–1.0	43.3
Spain	16.2	12.9	–9.5	35.2
Cross-country statistics by year	**Average**	**Standard deviation**	**Minimum**	**Maximum**
1999	20.0	7.0	6.7	29.4
2000	24.4	8.3	11.5	34.9
2001	26.8	9.0	11.0	37.8
2002	15.3	6.0	5.3	25.2
2003	5.3	6.1	–4.9	16.5
2004 (January–July)	3.0	7.0	–10.3	14.5

Note: Yield differentials are computed as the difference relative to the yield on German 10-year benchmark bonds. The statistics are based on monthly data (end-of-month observations). The standard deviation, minimum, and maximum by year shown in the lower panel of the table are the yearly averages of the respective monthly cross-sectional statistics.
Source: Datastream.

generates such comovement. As we shall see later in this section, the empirical studies just quoted have made considerable progress in this direction

Finally, in the figure there is a distinct trend reduction in yield differentials relative to the Bund. One may be tempted to conclude that convergence has continued also after the inception of EMU, so that euro-area yield differentials will soon be a thing of the past. This would be a mistake, however. The *level* of most yield differentials features a trend decline because the yield on the Bund has been rising relative to most other euro-area public debt, possibly in connection with the deteriorating position of the German budget. But in absolute value the yield differentials are not declining or disappearing. To see that, it is sufficient to consider that their cross-sectional *dispersion* has remained rather stable around a value of 7 in the period 1999–2004, as shown by the lower panel of Table 7. Also, the difference between the maximum and the minimum has not changed much (about 25 basis points) over this time period, even while both the minimum and the maximum declined gradually.

Therefore, since yield differentials cannot be yet written off in the euro-area government-bond market, we now analyse the determinants behind their variation across countries and over time, and review the available evidence.

(i) Possible Determinants

The reasons why yield spreads may continue to be non-zero under EMU fall into two groups: (fundamental) risk factors and residual market frictions.

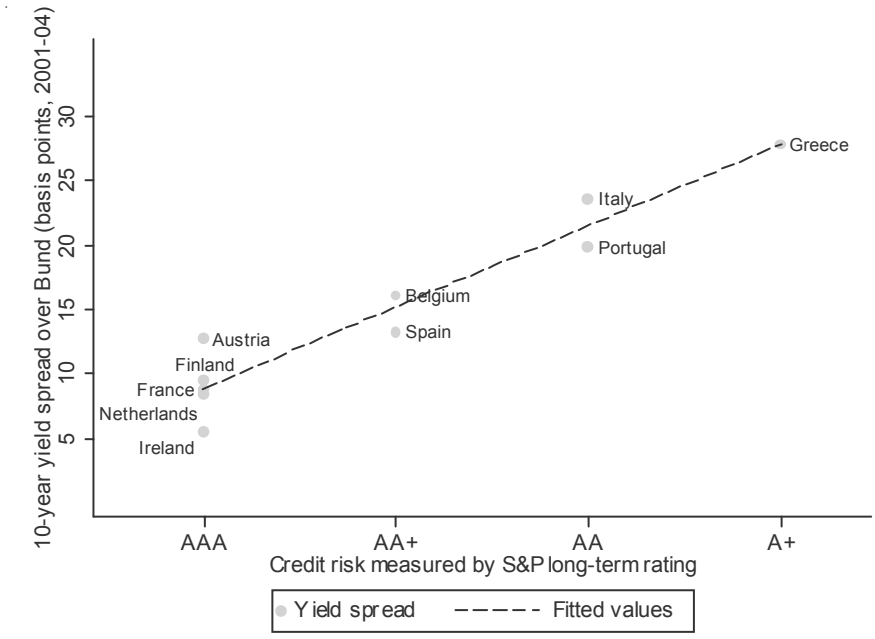
As already noticed in our discussion of the corporate bond market, yield spreads owing to risk differences are not inconsistent with market integration. They may arise from either (i) intrinsic differences in country-specific default risk (due, for instance, to different debt–GDP ratios of different countries) or (ii) different sensitivities of the bonds' future payoffs to common shocks. As an example of the latter, consider the scenario in which EMU eventually collapses and euro-area countries revert to national currencies. In such a scenario, the convergence process analysed in the previous section would most likely operate in reverse, with countries such as Italy, Greece, Portugal, and Finland experiencing large increases in yield differentials owing to the resurgence of their currency risk. In this scenario, the holders of these bonds would suffer larger losses than those of other sovereign bonds. *Ex ante*, a revision of the estimated probability of a future EMU collapse (a common shock) has greater effects for the prices of these euro-area bonds, which should therefore be considered as riskier.

The other possible explanation for the persistence of euro-area yield differentials—market frictions—is instead synonymous with segmentation. Frictions include (i) trading costs, arising from bid–ask spreads, brokerage commissions, or transaction fees; (ii) clearing and settlement fees; and (iii) taxes. From the perspective of market participants, some trading costs (such as the cost of market presence, clearing and settlement fees, and taxes) are exogenous, while other trading costs (such as search costs and bid–ask spreads) are endogenous in the sense that they result from strategic responses by market participants to the structure of the market and the information available. Practitioners generally refer to all these factors related to the ease and cost of trading under the common label of 'liquidity', and, in fact, often argue that the residual euro-area yield differentials are due to differential liquidity.

Interestingly, illiquidity can itself generate a particular type of risk—liquidity risk. One may have to liquidate an asset at an unexpected time of need or buy at an unexpected time of affluence. Risk-neutral investors would value a euro of transaction costs identically in all contingencies. Instead, a risk-averse investor would value it differently in different states of the world, since his or her marginal utility of wealth differs across different states of nature. In this sense, transaction costs not only have a welfare cost for investors in terms of their income effect (as they reduce lifetime resources), but also because of their risk-bearing implications. If the size of the transaction cost can vary, this creates a further source of risk.

In addition, fundamental risk and liquidity may interact with each other in non-trivial manners, which are potentially quite important for empirical work, as we shall see in section IV(ii). Favero *et al*. (2004) make this point in the context of a general equilibrium model where idiosyncratic liquidity shocks may force investors to sell their bonds before maturity.

Figure 5
10-year Average Yield Differentials and Credit Risk



Note: Yield differentials are averages of the difference relative to the yield on German 10-year benchmark bonds, based on monthly data from January 2001 to July 2004.
Sources: Yields are from Datastream; S&P long-term ratings are from MTS Group (2004, p. 11).

They show that the interaction between liquidity and fundamental risk has different effects on yields depending on whether one refers to *current* or to *future* liquidity.

If a bond has high *current* transaction costs, this *softens* the negative price impact of an increase in fundamental risk. Here the intuition is similar to the logic of trading distortions resulting from taxation in public economics. Suppose that, on an asset, the buyer and seller must pay a proportional transaction tax. Then the larger is the transaction tax, the lower the after-tax price faced by either one. If the asset becomes riskier, the effect on the price will be smaller the larger is the tax, since the initial after-tax price is correspondingly lower. The tax effectively reduces the variance of the price arising from news about the future.

The opposite is the case if a bond is expected to have a high *future* transaction cost, that is, when the bond may have to be liquidated. In this case, illiquidity tends to *amplify* the price effect of an increase in risk. To understand why, consider that an asset with risky fundamentals is one whose future cash flow is likely to be low in 'bad times'. If such an asset is also relatively illiquid, the investor who sells it in 'bad times' not only is likely to get a low price because of poor fundamentals, but will also pay a high transaction cost. So liquidity risk exacerbates the effects of fundamental risk. By the same token, future liquidity may compensate for fundamental risk: when the price of risk increases—for instance because of an increase in aggregate fundamental risk—investors may prefer a more liquid bond, even if it is more sensitive to fundamental risk.

All this suggests that, to identify at the empirical level the factors that explain euro-area yield spreads, one has not only to account for differences in fundamental risk, and for differences in liquidity, but also for their interactions.

(ii) The Evidence

Figure 5 shows that fundamental risk clearly plays a role in euro-area yield spreads. It plots average 10-year bond-yield differentials relative to the German yield against the respective Standard & Poors (S&P) long-term ratings, which presumably are a summary

measure of credit risk. The points are clearly scattered along a regression line with positive slope, with Greece, Italy, and Portugal at the top of the range, Spain and Portugal in the middle, and Austria, Finland, France, Ireland, and the Netherlands, all with AAA rating, closely clustered in a range from 5.5 to 12.7 basis points.

Despite the paucity of the data points, this suggests that credit risk can, indeed, explain a considerable portion of cross-country differences in yields. This already is striking, as a sovereign default of any of these countries within 10 years seems far-fetched, given their economic history since the Second World War.[22] But ratings may also reflect the different currency risk of these bonds in the event of a collapse of the EMU and a re-introduction of national currencies.

Even though they are closely correlated with the cross-country variation in yield spreads, ratings explain very little of their variation over time, which creates 'yield-spread risk'. Explaining this time variation is quite challenging, mainly because its two possible determinants—liquidity and fundamental risk—are detectable on very different time scales. Liquidity is best captured in relatively high-frequency data, where a precise measurement of transaction costs is possible. Fundamental risk determined by macroeconomic variables, instead, is better measured at lower frequencies, or by evaluating the impact of macroeconomic news over a long time-horizon.[23] Existing studies place themselves at different points in this difficult trade-off to identify the two potential determinants of yield spreads.

Geyer *et al*. (2004) estimate a multi-issuer state-space version of the Cox–Ingersoll–Roll (1985) model of the evolution of bond-yield spreads (over Germany) for four EMU countries (Austria, Belgium, Italy, and Spain). They work with weekly yield spreads for the full maturity spectrum of 2–10 years from January 1999 to May 2002. Their approach allows the factors driving the process of yield spreads to be left unspecified and the number and type of relevant factors to be identified. Their main findings are that (i) one single ('global') factor explains a large part of the movement of all four processes, (ii) idiosyncratic country factors have almost no explanatory power, and (iii) the variation in the single global factor can to a limited extent be explained by EMU corporate-bond risk (as measured by the spread of EMU corporate bonds over the Bund yield), but by nothing else (in particular not by measures of liquidity), and thus remains largely mysterious.[24]

The most striking finding by Geyer *et al*. (2004) is the virtual absence of country-specific yield-spread risk. In fact, when they estimate a version of their model restricted to one common factor and one country-specific factor for each country, the four country-specific factors still have an average correlation of 0.76, almost as high as the correlation among common factors in individual-country models. Therefore, they focus on a model with two common factors for all issuers and no country-specific factors. In this estimation, all country-specific factor weights are highly significant and standard errors of residuals small. They conclude that 'there is no . . . issuer specific structure in EMU government bond spreads' and that 'country-specific variation in spreads is best modeled by country-specific Gaussian errors' (p. 188).

Therefore, it is no surprise that these authors find no role for their liquidity variables, which are typically related to local market features and frictions. Their measurement of liquidity variables is, however, not very satisfactory, as they do not use data on bid–ask spreads, which are commonly considered to be the best measures of liquidity,[25] but rather indirect measures of liquidity, such as the yield differential between on-the-run and off-the-run bonds and the issue size.

[22] The relevance of sovereign default risk is further supported by credit default swap (CDS) data, available for most EMU countries since 2001. As documented by Codogno *et al*. (2003) for 2002, CDSs were priced between close to zero basis points (for France) to more than 12 basis points (for Italy) relative to Germany, suggesting that markets perceived and priced the possibility of a default for at least some euro-zone countries (this evidence should not be overstated, as the market for CDSs is fairly thin and market prices, therefore, are noisy).

[23] For such analyses using US data see Balduzzi *et al*. (2001) and Green (2004).

[24] The same applies to the result by Collin-Dufresne *et al.* (2001), who analyse US corporate-bond spreads.

[25] See, for example, Fleming (2001).

The studies by Codogno *et al*. (2003) and Favero *et al*. (2004) address this problem, by using richer data to measure liquidity, including data on bid–ask spreads in the EMU government bond market. Furthermore, these studies are more explicit in the search for relevant risk factors, by including specific international and domestic factors in their regressions.

Using monthly data, Codogno *et al*. (2003) proxy the country-specific risk factor by national debt to GDP ratios (noting that other variables do not add explanatory power) and international risk factors by US bond-yield spreads.[26] Similarly to Geyer *et al*. (2004), they find that the domestic risk factor is irrelevant, except for the cases of Austria, Italy, and Spain. Interestingly, for the last two countries the ratio of debt to GDP is insignificant as a single variable, but significant when interacted with one of the US risk factors. This non-linearity points to a possible interaction between international market conditions and domestic fundamental risk. In particular, it suggests that, at least for Italy and Spain, international investors take domestic risk into account when reacting to changing world market risk (as proxied by US market conditions).

In a second approach, Codogno *et al*. (2003) combine the daily data on US bond prices with daily data on bid–ask spreads and market activity for European government bonds in 2002. With daily data, of course, macroeconomic variables move too slowly to allow estimation of the impact of the domestic risk factor, and thus are not included. In this estimation, the international factor is statistically significantly different from zero for all countries except for Finland, France, and Ireland, while liquidity (as measured by the trading volume on EuroMTS) plays a statistically significant and correctly signed role for France, Greece, the Netherlands, and Spain. When compared to the first set of results in the same paper, the fact that international risk remains significant for several countries, once liquidity is controlled for, may imply that 'differences in default risk are the main propagation mechanism' (p. 524). But, as the authors admit, this conclusion is not very strong. In particular, most countries in the sample display very similar debt to GDP ratios, with only Belgium and Italy clearly above, and Ireland clearly below the median. Hence, it seems difficult to attribute observed market segmentation directly to these national differences.

Favero *et al*. (2004) analyse the possible causes and consequences of liquidity in more detail. In particular, they point out that transactions costs should affect yield differentials in two ways: directly with a positive sign (as investors require higher returns to compensate them for transaction costs), and indirectly through the interaction of liquidity with fundamental risk. The sign of the coefficient of this interaction term depends on whether the liquidity variable reflects current or future trading costs, as explained in section IV(i) above. Depending on which component is more prominent, the impact of changing international (common) risk factors may be different. The main insight of the theory for the econometric specification is that liquidity effects should enter both linearly and via their interaction with the risk factor.

The empirical analysis by Favero *et al*. (2004) uses 2 years of daily transactions data from EuroMTS and bid–ask spreads carefully synchronized with return data. First, they confirm the previous two studies' finding that the international risk factor is highly significant for all countries.[27] Second, they find a greater role for liquidity variables, provided they are interacted with risk variables in the specification, as suggested by their model. Focusing for brevity on their results for the 10-year maturity, the coefficient of the bid–ask spread is positive for all countries except Finland, but significantly different from zero only for Austria, Belgium, the Netherlands, and Portugal. So, as predicted by the theory, for these four countries a higher bid–ask spread is associated with a higher yield spread. Importantly, in all four cases, the positive effect of the bid–ask spread on yield differentials is paired with a significantly negative coefficient of the interaction term between the liquidity measure and the international risk factor. This illustrates the importance of

[26] More precisely, the two variables considered are (i) the spread between fixed interest rates on US swaps and US government-bond yields and (ii) the spread between the yields on US AAA corporate bonds and government bonds (all for 10 years). The variables proxy the risk of the banking and the corporate sectors, respectively.

[27] In this study, the international risk factor is measured as the spread between the fixed interest rates on US swaps and the yield on US government bonds of the same maturity.

non-linearities in the effect of liquidity indicators on yield differentials. In fact, the coefficient of the liquidity differential is significant only when this interaction term is included.

In conclusion, despite their considerable differences in the methodology and data used, all three studies agree on the finding that yield differentials under EMU are driven mainly by a common risk (default) factor, related to the spread of corporate debt over government debt. They also agree on the conclusion that liquidity differences have at best a minor direct role in the time-series behaviour of yield spreads, and—according to the last of the three studies—an indirect role, in that they modify the impact of the risk factor on yield spreads.

An open question remains about why the common international risk factor is best measured by the differential between corporate- and public-bond yields in Europe and in the USA: does this capture events in the USA that have a direct impact on European bond markets? Or is there a common latent variable that makes European and US data comove? And if there is such a common factor, is its impact on European spreads mainly a direct one or is it mediated by liquidity or macroeconomic variables?

A possible approach towards answering the first two questions is to study the dynamic linkages between the time series of bond returns explicitly. This is done by Skintzi and Refenes (2004) who estimate an extended GARCH model of European and US weekly bond returns and (time-varying) volatilities.[28] They find stronger evidence for spillovers between the volatilities of the return series than for the returns themselves. In particular, they find return spillovers from a euro-area index into the series of four out of eight EMU countries (Belgium, France, the Netherlands, and Spain), and volatility spillovers for six out of the eight countries (Austria, Belgium, France, Germany, Italy, and Spain). These spillovers have intensified after the start of EMU. For the four European non-EMU countries in the sample, they find no spillovers for returns, but volatility spillovers into the series for Denmark, Sweden, and the UK.

Concerning the impact of the US series (modelled as an exogenous factor), Skintzi and Refenes (2004) find an impact on returns within EMU only for Austria, Belgium, and Spain (and the three Scandinavian countries), but a clear impact on the volatilities of all eight EMU countries. The first of these two results is surprising in the light of the findings discussed earlier in this section, and the second suggests that further studies should pay more attention to volatilities, and not only returns.

V. CONCLUSIONS

The years since monetary unification have witnessed the emergence of an integrated euro-area bond market. Issuers and investors alike have come to regard the euro-area bond market as a single one. Primary and secondary bond markets have become increasingly integrated on a pan-European scale. Issuance of corporate bonds has taken off on an unprecedented scale in continental Europe. In the process, both investors and issuers have reaped the considerable benefits afforded by greater competition in the underwriting of private bonds and in the auctioning of public ones, and by the greater breadth and liquidity of secondary markets.

These benefits have been particularly valuable for euro-area governments, many of whom must service a large stock of public debt: for them, even shaving a few basis points off the cost of debt servicing makes a considerable difference in terms of reduced taxes to be raised in the future. But the benefits have been no less important for European companies, which have acquired cheaper access to a market that can disenfranchise them from banks for the provision of debt finance. The effect on company financing and the attendant effects on credit markets are likely to be the most pervasive legacy of European bond-market integration.

Bond yields have converged dramatically in the transition to EMU. The persistence of small and variable yield differentials for sovereign debt under EMU indicates that euro-area bonds are still not perfect substitutes. However, to a large extent this is not the reflection of persistent market

[28] The EMU countries in their study are Austria, Belgium, France, Germany, Ireland, Italy, the Netherlands, and Spain; the European non-EMU countries Denmark, Norway, Sweden, and the UK. They rely on the national Datastream Benchmark Bond Indices (total returns) with 5 years average maturity for the period 1 February 1991 to 31 December 2002.

segmentation but of small differentials in fundamental risk—either in default risk or in vulnerability to the risk of eventual EMU collapse. Liquidity differences appear to play at most a minor direct role, but a more significant role through their interaction with changes in fundamental risk.

The challenges and opportunities still lying ahead are numerous. First, there is a striking unbalance between futures and cash markets. Euro-area futures refer almost entirely to German bonds, while the cash market for German bonds is far less developed, which periodically determines squeezes and inefficient price volatility. In contrast, other large cash markets, such as the Italian one, are very liquid but lack a corresponding future market.

Second, the impressive liquidity of the cash markets is due to market-makers' collective commitment to quote bid and ask prices for very large amounts at very tight spreads; but this commitment is vulnerable to free-riding and manipulation by large financial institutions, as the August 2004 Citigroup episode demonstrates. It is still unclear whether such opportunistic behaviour is a serious threat to the persistence of the current liquidity levels.

Third, the possibility of joint bond issuance by euro-area countries has been repeatedly considered because of its ability to exploit fully the liquidity benefits of a completely unified market. However, issuers have so far discarded it because it would generate an implicit debt guarantee by some countries in favour of others, with potentially serious incentive effects on fiscal discipline. The challenge here is to design a scheme capable of reaping the liquidity benefits of joint issuance, while minimizing its adverse effects. For instance, joint issuance could be allowed only to EU countries that respect certain standards of fiscal discipline and/or could be limited to short maturity bonds.

Another challenge is to overcome the persistent fragmentation of clearing and settlement systems in the euro-area bond market, which prevents a full integration of the market for private-sector bonds.

Last, but not least, the euro-area bond market will expand further as new EU member countries gradually join EMU. In fact, in anticipation of this outcome, their bonds are already being actively traded on the same platforms that cater to the bonds of existing EMU members.

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