EMU AND EUROPEAN GOVERNMENT BOND MARKET INTEGRATION*

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Abstract

The main objective of this paper is to study whether the introduction of the euro had an impact on the degree of integration of European Government bond markets. We adopt the CAPM-based model of Bekaert and Harvey (1995) to compare, from the beginning of Monetary Union until June 2008, the differences in the relative importance of two sources of systemic risk (world and Eurozone risk) on Government bond returns, in the two groups of countries (EMU and non-EMU) in EU-15. Our empirical evidence suggests that the impact of the introduction of the euro on the degree of integration of European Government bond markets was important. The markets of the countries that share a monetary policy are less vulnerable to the influence of world risk factors, and more vulnerable to EMU risk factors. However, euro markets are only partially integrated, since they are still segmented and present differences in market liquidity or default risk. For their part, the countries that decided to stay out of the Monetary Union present a higher vulnerability to external risk factors.

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1. Introduction

The market capitalization of international bond markets is much larger than that of international equity markets. However, compared to the large body of literature on international equity market linkages (see Bessler and Yang (2003), among others) few empirical studies have been carried out of bond systemic risk or international bond market co-movements. The extent of international bond market linkages merits investigation, as it may have important implications for the cost of financing fiscal deficit, monetary policymaking independence, modelling and forecasting long-term interest rates, and bond portfolio diversification. Conversely, more has been written on emerging countries, where a very important question in the study of yield co-movements is the analysis of the relative influence of fundamental variables on their behaviour (see Cifarelli and Paladino, 2006), and on volatility spillovers in international bond markets (see Cappiello *et al.* (2003), Christiansen (2003), or Skintzi and Refenes (2006), among others)

Little has been written on the sources of co-movements in Government bond markets in the European context. Studies of this issue include Geyer, Kossmeier and Pischer (2004), Gómez-Puig (2009a and 2009b), and Pagano and Von Thadden (2004). The aim and methodology of the present paper are completely different from those of the studies just mentioned. Here, we study financial integration, exploiting the implications of asset pricing models. In particular, following Barr and Priestley (2004) who assess the degree of integration of the US, UK, Japan, Germany and Canada bond markets, we adopt Bekaert and Harvey's CAPM-based model (1995). This model allows partially integrated markets and still has not been used to study bond markets integration in the European context. Moreover, it has only been used to analyse the impact of one kind of common or systemic risk factor over bond or stock returns behaviour (see Hardouvelis, Malliaropulos and Priestley (2006 and 2007)).

Ten years after the introduction of the euro, the aim of this paper is to compare the differences in the relative importance of two sources of systemic risk (world and Eurozone risk) on Government bond returns since January 1999. The model used in this paper draws on Barr and Priestley (2004), but goes beyond it. As far as we know, this is the first empirical study that applies this methodology to analyse the impact of the euro on European Government bond markets integration with a weekly dataset that covers almost ten years since the introduction of the common currency.

The main objective of this paper is to study whether the introduction of the euro had an impact on the degree of integration of European Government bond markets. Therefore, we will carry out a comparative analysis of the degree of integration of Government bond markets in two groups of EU-15 countries: those that joined the European Monetary Union (EMU) and those that stayed out. Our sample will span the period since the beginning of Currency Union until June 2008. Our intention is to separate each individual country's Government bond return into three effects: a local (own country) effect, a regional (Eurozone) effect, and a global (world) effect, and to establish whether there are significant differences between EMU and non-EMU participating countries. That is, we analyse whether participation in the Monetary Union is an important factor which determines the differences in the impact of world and regional risk on each EU-15 Government bond market.

The rest of the paper is organized as follows. Section 2 summarizes the related literature. The model is explained in Section 3. The instrumental variables and data are described in Section 4. Section 5 reports the results and, finally, Section 6 draws the main conclusions.

2. Related Literature

Some recent literature has assessed the relative importance of systemic and idiosyncratic risk in EMU sovereign yield spreads (see Geyer, Kossmeier and Pischler (2004), Gómez-Puig (2009a and 2009b) or Pagano and von Thadden (2004)). Geyer *et al.* (2004) estimate a multi-issuer state-space version of the Cox-Ingersoll-Ross (1985) model of the evolution of bond-yield spreads (over Germany) for four EMU countries (Austria, Belgium, Italy and Spain). 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 hardly any explanatory power, and (iii) the variation in the single global factor can be explained, to a limited extent, by EMU corporate-bond risk, but by nothing else. The most striking finding of the Geyer *et al.* study is the virtual absence of country-specific yield-spread risk. Pagano and von Thadden (2004), despite the considerable differences in the methodology and data used, also agree that yield differentials under EMU are driven mainly by a common risk (default) factor and suggest that liquidity differences have at best a minor role in the time-series behaviour of yield spreads. Gómez-Puig (2009a and 2009b) estimates panel regressions for two groups of EU-15 countries (EMU and non-EMU) including both domestic (differences in market liquidity and credit risk) and international risk factors. Her results present evidence that it is domestic rather than international risk factors that mostly drive the evolution of 10-year yield spread differentials over Germany in all EMU countries during the seven years after the beginning of Monetary Integration. Conversely, in the case of non-EMU countries, adjusted yield spreads are influenced more by world risk factors. The fact that these countries do not share a common Monetary Policy might explain these results, which may also show that government bonds from EMU countries have a better safe-haven status than those of non-EMU countries. These results are consistent with the empirical evidence presented by other authors like Cappiello, Hördahl, Kadareja, and Manganelli (2006), who used a completely different methodology to investigate whether the introduction of the euro had an impact on the degree of integration of European financial markets. Controlling for the impact of global factors, they document an overall increase in co-movements in euro area financial markets, especially in bond markets, suggesting that integration in the euro area has progressed since the introduction of the single currency. In contrast to previous studies, they propose two methodologies to measure integration: one that relies on time-varying GARCH correlations, and the other on a regression quantile-based co-dependence measure (see Cappiello, Gérard, Kadareja and Manganelli, 2005).

Another perspective is given by Christiansen (2003), who assesses volatility spillovers in European bond markets. She finds strong evidence of volatility-spillover effects from both the US and Europe into individual European bond markets. For EMU countries, regional effects have become dominant over both own country and global effects. The opposite applies to non-EMU countries where pure local volatility effects are substantial.

Finally, a number of papers have studied financial integration exploiting the implications of asset pricing models. The works by Barr and Priestley (2004) and Hardouvelis, Malliaropulos and Priestley (2006 and 2007) are in this vein. In particular, Barr and Priestley (2004) use a version of Bekaert and Harvey's (1995) CAPM-based model to analyse the degree of integration of the US, UK, Japan, Germany and Canada bond markets, and find strong evidence that national markets are only partially integrated into world markets. Around one quarter of total expected excess returns is related to local market risk, the remainder being due to world bond market risk. A similar methodology is used by Hardouvelis *et al.* (2006 and 2007) to analyse the impact of EMU on European stock market integration. They present evidence linking the process of increased integration of European stock markets to the prospects of the formation of EMU and the adoption of the euro as the single currency. Specifically, these authors show that in the second half of the 1990s, expected stock returns in Europe became increasingly more determined by EU market risk and less by local risk. However, this methodology has not yet been used to study bond markets integration in the European context.

3. Model

We assume that Government bond excess returns (r_i) for country i are linearly related to world and local information variables as follows:

$$r_{i,t} = a_i + b^W_i Z^W_{i,t-1} + b^L_i Z^L_{i,t-1} + \varepsilon_{i,t} \qquad (1)$$

where Z^W_i represents the world variables, Z^L_i, represents local variables for country i, and $\varepsilon_{i,t}$ is an error term.

Equation (1) is consistent with a range of asset pricing models, and with any level of integration. If a market is fully integrated, the local variables should be absent from Eq. (1). Similarly, if it is completely segmented, the world variables will be absent. We estimate this equation by OLS to identify the relevant world and local instruments.

Once the instruments are identified, we adopt Bekaert and Harvey (1995)'s CAPM-based model and assume that excess returns in country *i* are generated by the following version of the conditional international CAPM:

$$r_{i,t} = \theta^{W} \lambda_{w,t-1} \, \mathrm{cov}_{t-1}(r_{w,t}, r_{i,t}) + (1-\theta^{W}) \lambda_{i,t-1} \, \mathrm{var}(r_{i,t}) + e_{i,t} \quad (2)$$

In equation (2), $\boldsymbol{\theta^{W}}$ is interpreted as a measure of the degree of integration with world bond markets, $\boldsymbol{\lambda_{w,t}}$ is the world price of risk, and $\boldsymbol{\lambda_{i,t}}$ is the local price of risk.
The excess return on the world portfolio Government's bonds is modelled similarly as:

$$r_{w,t} = \lambda_{w,t-1} \, \mathrm{var}(r_{w,t}) + e_{w,t} \quad (3)$$

When markets are completely integrated the coefficient $\boldsymbol{\theta^{W}}$ takes the value 1, and the variance term in Equation (2) is reduced to zero. To model the conditional covariance matrix we use a multivariate GARCH model. Specifically, we use the BEKK model proposed by Engle and Kroner (1995). This model can be written as:

$$H_t = C'C + A' e_{t-1} e'_{t-1} A + B' H_{t-1} B \quad (4)$$

where **C** is a (NxN) symmetric matrix and A and B are diagonal (NxN) matrices of constant coefficients. By doing this, we allow the variances to depend only on lagged squared errors and lagged conditional variances and the covariances to depend only upon cross-products of lagged errors and lagged conditional covariances (see Bollerslev *et al.* (1988) and De Santis and Gerard (1997, 1998)).

Following the financial literature (see Bekaert and Harvey, 1995 and De Santis and Gerard, 1997, among others), we model the price of risk as a function of a set of information variables. As the price of risk must be positive (see Merton, 1980), the functional form that we assume is:

$$\lambda_{w,t-1} = \exp\left(K'_{w} Z^{w}_{t-1} \right) \quad (5)$$

$$\lambda_{i,t-1} = \exp\left(\delta'_{L} Z^{L}_{i,t-1} \right) \quad (6)$$

We estimate a system of equations using the Quasi-Maximum Likelihood method. Bollerslev and Wooldridge (1992) show that the standard errors calculated using this method are robust even when the normality assumption is violated. Then, we estimate equations (2), (3) and (4) jointly with the price of risk (equations (5) and (6)), for each of the local Government bond markets, and for the world Government bond market. This estimation is implemented in two steps. First, we estimate the world equation, and then impose the results on the individual countries in 13 bivariate regressions (10 EMU countries, and 3 EU-15 countries that did not join the euro in 1999). We thus restrict the estimates of the world Government bond market price of risk and of the coefficients in the conditional variance of the world market variance to be the same in all countries. Once these estimates are imposed on each bivariate regression, in the second step we will obtain the following for each country: $\boldsymbol{\theta_i^W}$ (the estimated level of integration with the world bond market) and $\boldsymbol{\delta^L}_i$ (the vector of estimated coefficients for the local price of risk).

As we explained in the previous sections, our analysis goes beyond Barr and Priestley (2004) and Hardouvelis *et al.* (2006 and 2007), who only analyse the impact of one kind of common or systemic risk factor over bond or stock returns behaviour respectively. Unlike them, our aim is to compare the differences in the relative importance of two sources of systemic risk (world and Eurozone risk) on Government bond excess returns since the beginning of Monetary Union, in the two groups of countries (EMU and non-EMU) in EU-15. This is the reason why we also assume that excess returns (r_i) for country i are linearly related to regional (EMU) and local information variables as follows:

$$r_{i,t}=a_i+b^E_i Z^E_{i,t-1}+b^L_i Z^L_{i,t-1}+\varepsilon_{i,t} \qquad (7)$$

where Z^E_i represents the regional (EMU) variables, Z^L_i, represents local variables for country i, and $\varepsilon_{i,t}$ is an error term.

If we consider that $r_{e,t}$ represents the excess return of the Eurozone Government bond portfolio and replace $r_{w,t}$ by $r_{e,t}$ in equations (2) to (5), we will obtain another system of equations for each of the local bond market and the Eurozone bond market. In particular, analogously to equation (5), the Eurozone price of risk will follow this functional form:

$$\lambda_{e,t-1}= \exp\left(K'_E Z^E_{t-1}\right) \qquad (8)$$

We also estimate this system in two steps and obtain, for each country, $\boldsymbol{\theta_i^E}$ (the estimated level of integration with the Eurozone Government bond market), and $\boldsymbol{\delta^L_i}$ (the vector of estimated coefficients for the local price of risk).

Hence, two bivariate models will be estimated for each of the countries in our sample: one with world and local risk factors, and the other with European and local risk factors. The final goal is to analyse the impact on each EU-15 country's Government bond return of the three sources of risk: local (own country), regional (Eurozone), and global (world). We also aim to establish whether $\boldsymbol{\theta_i^W}$ and $\boldsymbol{\theta_i^E}$ have differed between EMU and non EMU-countries and across the different countries of each group since the introduction of the euro.

4. Instrumental variables and data

We use weekly data (sampled on Wednesdays) covering the period from January 1999 to June 2008. Using weekly data (compared to, e.g., daily data) partially overcomes the potential problem of non-synchronous data, which may arise because there are instances in which markets are closed in one country and open in another (Burns and Engle (1998) and Lo and MacKinlay (1990) study the effects of this problem). Moreover, we analyse European sovereign bond return behaviour with the perspective given by a long time period (almost 10 years since the beginning of Monetary Union). The empirical analysis makes use of the 10-year Government benchmark yields, and the sample includes 13 countries (all EU-15 countries with the exception of Luxembourg and Greece)[1]. Data have been collected from Datastream and Global Financial Data. Bond returns are continuously compounded and are computed with the following formula:

$$R_{it} = p_{it} - p_{it-1} = n(y_{it-1} - y_{it}) \qquad (9)$$

Where R_{it} denotes the (weekly) returns on bonds, p_{it} the log price of the bond, $p_{it} \equiv \ln(P_{it})$, y_{it} the log of the gross yield to maturity, $y_{it} \equiv \ln(1+ Y_{it})$, and n the maturity, which in our case is ten years. The dependent variable in our model (r_{it}) is the excess return[2] which is calculated relative to the appropriate 1-month Euro-deposit rate quoted in London[3].

We use the following instrumental variables to capture the different prices of risk (world, regional and local risk): (1) the slope of the yield curve, as measured by the difference between the 10-year

[1] Luxembourg's public debt market is negligible and Greece did not join Monetary Union until January 2001. For these reasons, these two countries are not included in the analysis.

[2] International CAPM models (ICAPM) contain additional terms to reward exchange rate risk. Concretely, risk premium are based on the covariances of assets with exchange rates, in addition to the traditional premium based on the covariance with the market portfolio (see Solnik (1974) and Adler and Dumas (1983)). These models are mostly used to analyze the predictability of international stock returns, which is usually examined in terms of a common currency. However, since the volatility of exchange rates greatly exceeds that of interest rates (see Thomas and Wickens, 1993), the predictability of bond returns, however, is more usually analyzed only using local-currency returns (see Barr and Priestley, 2004). Otherwise, results might produce more evidence on the predictability of exchange rates than of bond returns. Consequently, in order to avoid this bias in the results, the dependent variable in this paper is the excess bond returns in local-currency.

[3] Euro-deposit rates are used as a proxy for the risk free rate due to the lack of a liquid Treasury bill market in some of the countries. The excess world return is calculated with reference to the rate on $US deposits, whilst the excess Eurozone return is calculated with reference to the Euribor rate.

and the 3-year Treasury yield. Several studies (Campbell and Shiller, 1991; Ilmanen, 1996) have found that steeper yield curves are associated with higher subsequent yields on longer-maturity bonds. The interpretation of this finding is that the yield curve steepens primarily because of an increase in the risk premium. Moreover, the slope of the yield curve is also a proxy of the business cycle. (2) Lagged stock indexes returns are included to allow for the possibility that stock returns lead bond returns. In recent years, important cross-asset linkages between stocks, bonds and money market instruments have been observed. Fleming, Kirby and Ostdiek (1998) investigate the nature of volatility linkages between stocks, bonds and money markets and conclude that volatility linkages between the three markets are strong. In particular, stock market weakness has been associated with economic weakness, which has corresponded to bond market strength[4]. If equity market weakness gives rise to subsequent bond market strength, the coefficient on lagged stock indexes returns should be significantly negative (see Hunter and Simon, 2005).[5] (3) Lagged 10-year Government returns are also added to the specification. Taking into account that some aspects of risk premiums (related to domestic factors such as liquidity or credit risk) do not change over the period considered, the objective will be to identify their relative importance in explaining fluctuations, rather than returns levels. With this aim a lag of the dependent variable is introduced in the model, which will allow for a slow dynamic adjustment to a long-term equilibrium value of Government returns. (4) Moreover, we include the difference between lagged 10-year Government returns and lagged stock index returns to capture bond markets relative risk compared to stock markets. Finally: (5) the difference between lagged corporate bond returns and 10-year Government returns is also an important information variable that will be included in the specification. It can be interpreted as a proxy of the credit cycle or, more importantly, as a proxy for time-varying credit risk premium in the bond market[6].

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[4] Kim *et al.* (2006) present evidence that the introduction of the monetary union has Granger caused an apparent segmentation between bond and stock markets within Europe. Hence, the EMU has increased benefits of diversification across stocks and government bonds at the country level.

[5] Nevertheless, note that other authors (see McQueen and Roley (1993)) demonstrate that the opposite results are obtained when market participants are concerned about an overheating economy. During these periods, data suggesting a weaker-than-expected economy lead to stronger bond and stock prices as this makes it less likely that the Federal Reserve will be forced to tighten monetary policy aggressively and possibly drive the economy into a recession.

[6] For each individual country (except for Ireland and Portugal due to the lack of available data) we use a corporate bond index which has been built by Lehman Brothers or The Economist, depending on the country. These data have been provided by Datastream.

The same five variables are used as information variables to capture the price of regional and world risk. In the case of regional risk, we use German returns (the German 10-year yield is the benchmark in the euro area) as proxies of the behaviour of Euro area debt markets. We think that this is a better way to capture regional risk effect than using the return of a synthetic Euro area bond that will always contain the evolution of its own local market return. Similarly, US data are used to capture the price of world risk[7].

Therefore, the following regional instruments are used: (1) the slope of the German yield curve, as measured by the difference between the 10-year and the 3-year German Treasury yield. (2) The lagged return of the Eurostoxx50. We think that the use of this index is appropriate as it reflects the price evolution of the 50 most important firms in the euro area (unlike the Eurozone 10-year synthetic Government yield, it is not built up as an average of the different local market indexes). (3) The lagged value of the 10-year German Government return. (4) The difference between lagged 10-year German Government return and lagged Eurostoxx50 return. And (5): the difference between lagged German corporate bonds return and 10-year German Government return. For their part, the world instruments are: (1) the slope of the US yield curve, as measured by the difference between the 10-year and the 3-year US Treasury yield. (2) The lagged return of the Standard & Poor's 500. (3) The lagged value of the 10-year US Government return. (4) The difference between lagged 10-year US Government return and lagged Standard & Poor's 500 return. And (5): the difference between lagged US corporate bonds return and 10-year US Government return.

Then, we will estimate 13 bivariate models (all EU-countries except Luxembourg and Greece) which will contain local and world instruments, and 12 models (all EU-countries with the exception of Germany, Luxembourg and Greece) which will contain local and regional instruments.

[7] Barr and Priestley (2004) present evidence that the US-world return correlation is very high, reflecting the relatively large proportion of US bonds in the world portfolio.

5. Results

First, we investigate the extent and sources of predictability in local bond markets. To do this, we estimate equation (1) using world and local instruments (Panel A in Table 1) and regional and local instruments (Panel B in Table 1). In each case we test the separate hypothesis that the coefficients associated with the world (regional) and local variables are zero. When we use world and local instruments jointly (Panel A) the R^2s range from 53% in Ireland to 93% in the Netherlands, indicating a high degree of predictability. For all countries we reject the null hypothesis that both sets of instruments can be excluded. Then, we estimate equation (1) using the world and local instruments separately. In both cases, the results show clear patterns of predictability in all the local bond markets using local instruments. We observe that when we use only one set of instruments the R^2s are lower than when we use both sets, implying that it is necessary to include all kinds of instruments. Similarly, if we use regional and local instruments jointly (Panel B) the R^2s range from 68% in Denmark to 92% in the Netherlands, also indicating a high degree of predictability. The F-tests reveal that each set of instruments is separately and jointly significant. We also report estimated equations for local returns based on the regional instruments only. The results indicate that regional instruments are able to predict local bond returns in all markets. Overall, these results show that a set of world (regional) and local instruments are useful to predict local bond returns, suggesting incomplete integration.

Tables 2 and 3 present the results of the estimation of the system of equations [(2), (3), (4) jointly with the prices of risk, (5) and (6)] using the Quasi-Maximum Likelihood method for each of the local Government bond markets jointly with the world (United States) Government bond market (Table 2) and the Eurozone (German) Government bond market (Table 3). Tables 4 and 5 show the standardized residuals analyses. It can be observed (with few exceptions) that the standardized residuals appear free from serial correlation and heteroskedasticity. In all cases, the necessary conditions for the stationarity of the process are satisfied.

All world instruments are relevant in forecasting the world price of risk, as it is shown in the first row of Table 2. The estimates of δ^L s in Table 2 indicate that all local instruments are also important in explaining the local price of risk except for the cases of Sweden and the U.K, confirming its higher degree of dependence on world risk factors. The results of the estimation including world and local risk factors indicate that EMU and US Government bond markets present a low degree of integration. The estimated level of integration with the world bond market (θ^W) displays an average value of 0.052 in the countries that belong to the euro. This level seems low in view of the absence of major impediments to cross-country investment[8]. There are no significant differences within countries: Germany presents one of the highest degree of integration with the US Government bond market (0.067), only surpassed by Belgium (0.069). These results present clear evidence that it is domestic (idiosyncratic) rather than international (systemic) risk factors that mostly drive the evolution of 10-year Government debt returns in all EMU countries throughout almost all of the ten-year period after the beginning of Monetary Integration.

These results also indicate that the degree of integration with US markets clearly differs between euro and non-euro participating countries. Whilst the average value is 0.052 in the case of euro countries, it is 0.468 in the case of non-euro countries. Hence, in the case of non-EMU countries, Government debt returns are influenced more by world risk factors. The fact that these countries do not share a common Monetary Policy may explain their higher vulnerability to international (systemic) risk factors.

Finally, note that there are important differences in θ^W value in the case of non-euro countries. Denmark is the country that presents the lowest degree of integration (0.086) with US debt markets. Actually, the fact that the exchange rate regime, in that country, links the evolution of its

[8] Differences between bonds in different countries are small, so it seems reasonable to expect a high degree of integration in bond markets (much larger than in equity markets). However, there are some reasons for expecting that bond markets may not be "fully" integrated, which are basically related to "home bias" on both the investors and issuers' side. For instance, one of the major impediments in the debt market is the currency matching rule widely adopted across countries. Pension funds for example are forced to invest a share of their funds in local currency.

currency to the Euro explains why the Danish Government debt returns present a behaviour that is closer to EMU-countries than to non-EMU countries. Moreover, the degree of integration with US markets is much larger in the case of Sweden (0.936) than in the case of the United Kingdom (0.383). The fact that the British market is one of the most important European debt markets (the fourth biggest, after the Italian, the German and the French markets), could be the reason for its higher degree of independence from world risk factors.

The first row in Table 3 shows that all regional instruments are relevant in forecasting the regional price of risk. Similarly, all local instruments are also important in explaining the local price of risk (with few exceptions) As expected, the estimated level of integration with the German bond market ($\boldsymbol{\theta_i^E}$) differs between euro and non-euro participating countries. The average values are 0.376 and 0.078, respectively, for EMU and non-EMU countries. Within EMU countries, the Finnish market is the one that presents the lowest degree of integration (0.149), and The Netherlands presents the highest (0.627); the rest of the countries present very similar values, around 0.376 on average, indicating that euro-participating markets are only partially integrated with the German market. This fact captures the idea that European Government bond markets are still imperfect substitutes due to differences in their domestic risk factors (either market liquidity or default risk)[9]. Outside the Monetary Union, Denmark is again the market that presents a behaviour that is much closer to euro than to non-euro participating countries. In addition, Britain and Sweden present a similar degree of integration with the German market, 0.049 and 0.044, respectively.

The introduction of the euro had a major impact on the degree of integration of European Government bond markets. Within the Currency Union, on average, the estimated level of integration with the world ($\boldsymbol{\theta^W}$) and German ($\boldsymbol{\theta^E}$) bond markets is 0.052 and 0.379 respectively. Conversely, outside the Monetary Union, these levels present the following average values: 0.468

[9] Gómez-Puig (2008) provides evidence that market size scale economies seem to have increased with Currency Union and that the smaller the debt market, the higher the rise. Therefore, the removal of the exchange rate barrier seems to have punished smaller countries twice (they are forced to compete in terms of liquidity with larger countries for the same pool of funding, only being able to offer smaller bond issues), by making them pay both higher liquidity and a higher default risk premium than larger ones.

and 0.067. Consequently, the markets of those countries that share a monetary policy are less vulnerable to the influences of world risk factors and more vulnerable to EMU risk factors. However, they are only partially integrated with the German market since their markets are still segmented and present differences in their market liquidity or default risk. The empirical evidence presented by Laopodis (2008) also shows a weak degree of integration among the EMU bond markets since the beginning of the Currency Union. These findings have important implications for investors in terms of portfolio diversification benefits, and are an argument against the issue of a single European bond, a matter that is currently under debate.

For their part, the countries that decided to stay out of Monetary Union and maintain monetary autonomy present a higher vulnerability to external risk factors. These results are in concordance with Gómez-Puig (2009b), who presents empirical evidence that it was mostly idiosyncratic rather than systemic risk factors that drove the evolution of 10-year yield spread differentials over Germany in all EMU countries during the first seven years of Monetary integration. Conversely, in the case of non-EMU countries, adjusted yield spreads (corrected from the foreign exchange factor) are influenced more by systemic risk factors.

Finally, we re-estimate the model to test the restriction of a constant price of risk. We use the likelihood-ratio test procedure to examine whether the reduced model (with a constant price of risk) provides the same fit as the full model (with a time-varying price of risk). Results (not reported) imply strong rejection of the null hypothesis of a constant price of risk and justify modelling the price of risk as a time varying function.

6. Conclusions

In this paper we analyse the impact of Monetary Union on European debt market integration. We look at integration both with world debt markets and with Eurozone debt markets. To do this, we separate each individual country's Government bond return into three effects: a local (own country) effect, a regional (Eurozone) effect, and a global (world) effect. We examine whether there are significant differences between two different groups of European countries: those that joined the euro in 1999 and those that did not. The objective is to explore whether participation in the Monetary Union is an important factor that determines the difference in the impact of world and regional risk on each European Government bond market.

Our sample period goes from January 1999 to June 2008, covering almost ten years since the introduction of the common currency. We use Bekaert and Harvey's CAPM-based model (1995). This is the first time that this methodology has been used to analyse the differences in the relative importance of two sources of risk, systemic and idiosyncratic. In contrast to the previous literature, which has focused only on one kind of systemic risk, we distinguish between the world and the Eurozone risk.

The most important results of the paper are the following. First, the results show that apart from a set of world (regional) instruments, a set of local instruments are also able to predict local bond returns. This result suggests incomplete integration. Second, we find that EMU and US Government bond markets present a low degree of integration, indicating that it is domestic rather than international risk factors that mostly drive the evolution of government debt returns in EMU countries.

Third, the results show that the degree of integration with the US and German bond markets clearly differs between euro and non-euro participating countries. Government bond returns of non-EMU countries are more influenced by world risk factors. This result agrees with Gómez-Puig (2009b) and indicates that these countries present a higher vulnerability to external risk factors. On the other hand, Government bond returns of EMU countries are more influenced by Eurozone risk factors. In spite of this, EMU countries are only partially integrated with the German market since their markets are still segmented and present differences in their market liquidity or default risk. In a different context, Laopodis (2008) reached the same conclusion, suggesting that benefits from portfolio diversification are still possible within Monetary Union.

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8. Tables

<u>Table1</u>: Predicting local excess returns

	Germany	Austria	Belgium	Denmark	Spain	Finland	France	Ireland	Italy	Netherlands	Portugal	Sweden	U. K
Panel (A). Word and local instruments													
R2	0.82	0.85	0.86	0.61	0.85	0.65	0.92	0.53	0.75	0.93	0.54	0.67	0.82
F-test	223.62	278.90	292.03	76.23	269.82	89.26	545.55	61.40	148.51	619.21	62.14	98.77	216.50
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
F-test exclude local	167.39	229.70	248.37	27.33	220.06	43.82	553.98	14.10	104.82	570.30	14.09	73.51	204.23
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
F-test exclude world	35.87	31.48	24.27	56.08	24.95	52.96	33.25	59.83	46.12	11.39	65.41	21.64	17.05
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Local instruments only													
R2	0.76	0.80	0.82	0.39	0.81	0.46	0.89	0.24	0.64	0.92	0.22	0.60	0.79
F-test	303.08	401.08	452.03	61.61	413.28	81.93	795.09	39.56	171.58	1109.00	35.00	145.20	357.22
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
World Instruments only													
R2	0.51	0.50	0.49	0.50	0.50	0.49	0.45	0.48	0.49	0.50	0.48	0.42	0.43
F-test	103.46	98.14	94.98	98.55	98.50	93.62	80.58	89.61	93.14	97.78	90.84	71.17	74.22
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Panel (B). Regional and local instruments													
R2	--	0.85	0.85	0.68	0.84	0.74	0.91	0.64	0.73	0.92	0.69	0.76	0.84
F-test	--	272.17	284.12	104.43	254.14	140.99	463.16	95.19	131.90	574.23	117.66	149.58	251.42
	--	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
F-test exclude local	--	85.05	133.47	16.33	90.96	14.75	277.05	4.50	25.56	306.13	2.74	71.49	191.00
	--	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.03)	(0.00)	(0.00)
F-test exclude regional	--	28.84	21.46	90.66	18.96	109.21	15.24	105.79	34.07	4.11	143.10	62.49	32.04
	--	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Regional Instruments only													
R2	--	0.72	0.65	0.63	0.69	0.71	0.63	0.63	0.66	0.68	0.68	0.58	0.52
F-test	--	246.78	184.44	166.39	217.16	234.22	169.59	163.06	190.34	204.13	206.65	132.19	105.83
	--	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)

Note: The table reports OLS estimations of equation (1). R2 denote R-squared statistic. F-test denotes the F-statistic from a test of the hypothesis that all of the slope coefficients (excluding the intercept) in the regression are zero. F-test exclude X denotes the F-statistic from a test of the hypothesis that some coefficients (all excluding the set X) in the regression are zero. P-values are displayed in parentheses.

Table 2. **Model estimates for each of the local Government bond market jointly with the world Government bond market**

$$r_{i,t} = \theta^{W} \exp\left(K'_{w} Z^{w}_{t-1} \right) cov_{t-1}\left(r_{w,t}, r_{i,t} \right) + \left(1 - \theta^{W}\right) \exp\left(\delta'_{L} Z^{L}_{i,t-1} \right) var\left(r_{i,t} \right) + e_{i,t}$$

$$r_{w,t} = \exp\left(K'_{w} Z^{w}_{t-1} \right) var\left(r_{w,t} \right) + e_{w,t}$$

$$\mathbf{H}_{t} = \mathbf{C'C} + \mathbf{A'} e_{t-1} e'_{t-1} \mathbf{A} + \mathbf{B'} \mathbf{H}_{t-1} \mathbf{B}$$

	$K0_w$	$K1_w$	$K2_w$	$K3_w$	$K4_w$	$K5_w$		C	A	B		
World	-186.825	-40.500	-4.195	-23.031	-71.391	2.751		0.000	0.085	0.346		
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)		(0.000)	(0.000)	(0.000)		
	$\delta0_L$	$\delta1_L$	$\delta2_L$	$\delta3_L$	$\delta4_L$	$\delta5_L$	θ^W	C11	C22	C12	A22	B22
Germany	-97.562	-15.238	-3.877	24.685	10.444	13.597	0.067	0.012	0.000	0.005	-0.205	0.792
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.816)	(0.000)	(0.025)	(0.007)
Austria	-20.903	-22.028	-4.855	1.709	-0.437	8.896	0.041	0.012	0.000	0.005	-0.206	0.798
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.850)	(0.000)	(0.026)	(0.007)
Belgium	-24.183	-4.331	0.614	1.377	0.646	-1.452	0.069	0.012	0.000	0.005	0.243	0.802
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.743)	(0.000)	(0.023)	(0.007)
Spain	-21.889	-455.78	-9.353	-0.298	0.744	0.545	0.054	0.012	0.000	0.005	-0.170	0.803
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.785)	(0.000)	(0.029)	(0.007)
Finland	-51.677	3.918	0.018	-10.936	-0.596	-12.460	0.055	0.012	0.000	0.005	-0.173	0.797
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.804)	(0.000)	(0.026)	(0.006)
France	-20.221	-78.632	24.850	0.496	1.582	-1.557	0.025	0.012	0.000	0.005	0.242	0.819
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.768)	(0.000)	(0.022)	(0.006)
Ireland	-26.289	0.824	0.211	0.055	-7.271	---	0.047	0.012	0.000	0.005	0.215	0.816
	$(9.667 \cdot 10^{10})$	(0.000)	(0.000)	(0.000)	(0.000)	(---)	(0.000)	(0.000)	(2.561)	(0.000)	(0.024)	(0.005)
Italy	-42.269	-1.125	2.512	14.853	1.555	13.208	0.061	0.012	0.000	0.005	0.242	0.819
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.740)	(0.000)	(0.022)	(0.006)
Netherlands	-43.784	0.440	0.422	41.781	0.883	-2.258	0.051	0.012	0.000	0.005	-0.184	0.793
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.876)	(0.000)	(0.026)	(0.007)
Portugal	-22.893	-9.393	-4.333	2.152	0.908	---	0.054	0.012	0.000	0.005	0.223	0.814
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(---)	(0.000)	(0.000)	(0.749)	(0.000)	(0.024)	(0.006)
Denmark	-29.084	1.359	0.874	3.091	-0.148	-1.324	0.086	0.012	0.000	0.005	-0.180	0.829
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.779)	(0.000)	(0.026)	(0.006)
Sweden	5.024	-0.136	6.765	39.481	5.045	28.779	0.936	0.012	0.000	0.004	-0.192	0.850
	(0.108)	(0.163)	(4.253)	(12.271)	(2.772)	(1.004)	(0.007)	(0.000)	(0.529)	(0.000)	(0.021)	(0.005)
U.K.	2.576	0.219	1.831	-22.187	3.797	169.543	0.383	0.012	0.000	0.004	-0.105	0.845
	(0.135)	(0.132)	(4.052)	(11.827)	(3.882)	(8.823)	(0.083)	(0.000)	(0.485)	(0.000)	(0.030)	(0.004)

Note: We estimate a system of equations [(2), (3), (4) jointly with (5) and (6)] using the Maximum Likelihood method for each of the local Government bond market jointly with the world Government bond market. Standard errors are displayed in parentheses.

Table 3: Model estimates for each of the local Government bond market jointly with the Eurozone Government bond market

$$r_{i,t} = \theta^E \exp(K'_E Z^E_{t-1})\, \text{cov}_{t-1}(r_{E,t}, r_{i,t}) + (1-\theta^E) \exp(\delta'_L Z^L_{i,t-1})\, \text{var}(r_{i,t}) + e_{i,t}$$

$$r_{E,t} = \exp(K'_E Z^E_{t-1})\, \text{var}(r_{E,t}) + e_{E,t}$$

$$\mathbf{H}_t = \mathbf{C'C} + \mathbf{A'}e_{t-1}\, e'_{t-1}\, \mathbf{A} + \mathbf{B'}\, \mathbf{H}_{t-1}\mathbf{B}$$

	$K0_E$	$K1_E$	$K2_E$	$K3_E$	$K4_E$	$K5_E$		C	A	B		
Germany	-282.034	6.968	-8.231	2.878	0.188	-12.081		0.000	0.156	0.812		
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)		(0.000)	(0.001)	(0.001)		
	$\delta0_L$	$\delta1_L$	$\delta2_L$	$\delta3_L$	$\delta4_L$	$\delta5_L$	θ^E	C11	C22	C12	A22	B22
Austria	0.042	0.456	-6.973	-101.27	-3.530	166.624	0.320	0.005	0.000	0.006	0.089	0.750
	(0.140)	(0.143)	(8.420)	(11.195)	(5.468)	(10.960)	(0.095)	(0.000)	(0.031)	(0.000)	(0.004)	(0.001)
Belgium	-0.747	1.449	-2.915	-93.850	6.511	151.250	0.446	0.005	0.000	0.005	0.004	0.809
	(0.228)	(0.220)	(9.304)	(17.961)	(7.708)	(12.973)	(0.126)	(0.000)	(0.023)	(0.000)	(0.001)	(0.004)
Spain	-221.724	-3.936	0.202	-2.836	1.101	2.831	0.344	0.005	0.000	0.006	0.070	0.758
	$(3.568\cdot10^7)$	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.003)	(0.001)
Finland	-48.783	7.830	1.596	-5.830	3.428	0.609	0.149	0.005	0.000	0.006	0.031	0.796
	$(2.078\cdot10^9)$	(951120865)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.003)
France	-47.139	10.942	0.544	-7.688	-0.252	1.977	0.336	0.005	0.000	0.004	0.230	0.859
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.021)	(0.000)	(0.002)	(0.001)
Ireland	-26.544	0.663	1.005	0.026	-0.340	---	0.365	0.005	0.000	0.004	0.171	0.881
	$(4.644\cdot10^8)$	(0.000)	(0.000)	(0.000)	(0.000)	(---)	(0.000)	(0.000)	(0.003)	(0.000)	(0.003)	(0.000)
Italy	-25.503	-3.993	2.637	1.171	5.135	0.603	0.302	0.005	0.000	0.006	0.112	0.722
	$(4.239\cdot10^8)$	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.050)	(0.000)	(0.007)	(0.002)
Netherlands	-27.558	-9.929	2.432	-144.99	55.365	1.429	0.627	0.005	0.000	0.006	0.068	0.765
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.034)	(0.000)	(0.003)	(0.002)
Portugal	-30.077	-0.223	0.071	0.938	0.912	---	0.495	0.005	0.000	0.004	0.152	0.877
	$(1.685\cdot10^8)$	(0.000)	(0.000)	(0.000)	(0.000)	(---)	(0.000)	(0.000)	(0.000)	(0.000)	(0.005)	(0.001)
Denmark	-26.485	-0.451	0.496	0.369	0.670	1.333	0.106	0.005	0.000	0.006	0.070	0.758
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.029)	(0.000)	(0.003)	(0.001)
Sweden	-26.247	-3.007	0.931	2.368	0.718	2.440	0.044	0.005	0.000	0.006	0.070	0.758
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.029)	(0.000)	(0.003)	(0.001)
U.K.	-29.729	-1.376	-0.783	61.766	1.209	1.555	0.049	0.005	0.000	0.004	-0.0751	0.916
	$(5.712\cdot10^9)$	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.518)	(0.000)	(0.0010)	(0.002)

Note: We estimate a system of equations [(2), (3), (4) jointly with (6) and (8)] using the Maximum Likelihood method for each of the local Government bond markets jointly with the Eurozone bond market. Note: Standard errors are displayed in parentheses.

Table 4. Summary statistics for the standardized residuals of the model estimates for each of the local Government bond markets jointly with the world (United States) Government bond market

	Maximum likelihood function value	Bera-Jarque	Q(20)	ARCH(20)
World		3.440 (0.17)	26.025 (0.16)	38.346 (0.01)
Germany	3275.91	17.130 (0.00)	13.368 (0.86)	26.738 (0.14)
Austria	3260.24	20.214 (0.00)	15.209 (0.76)	25.992 (0.16)
Belgium	3282.51	31.298 (0.00)	17.739 (0.60)	33.663 (0.03)
Spain	3280.08	23.861 (0.00)	14.933 (0.78)	22.021 (0.34)
Finland	3269.00	20.520 (0.00)	18.063 (0.58)	27.672 (0.12)
France	3241.14	21.373 (0.00)	14.720 (0.79)	20.281 (0.44)
Ireland	3262.75	29.471 (0.00)	18.990 (0.52)	17.461 (0.62)
Italy	3241.14	21.373 (0.00)	14.720 (0.79)	20.282 (0.44)
Netherlands	3277.97	26.494 (0.00)	17.739 (0.60)	22.818 (0.30)
Portugal	3262.68	27.641 (0.00)	22.062 (0.34)	24.180 (0.23)
Denmark	3235.70	11.115 (0.00)	16.032 (0.17)	36.092 (0.01)
Sweden	3218.97	74.456 (0.00)	16.815 (0.66)	19.232 (0.51)
U.K.	3279.11	71.439 (0.00)	19.273 (0.50)	19.331 (0.50)

Note: The Bera-Jarque statistic tests for the normal distribution hypothesis and has an asymptotic distribution $\chi^2(2)$. Q(20) is the Ljung-Box test for twentieth order serial correlation in the standardized residuals. ARCH(20) is Engle's test for twentieth order ARCH, distributed as $\chi^2(20)$. The p-values of these tests are displayed in parentheses. In all cases the necessary conditions for the stationarity of the process are satisfied.

Table 5. **Summary statistics for the standardized residuals of the model estimates for each of the local Government bond markets jointly with the Eurozone (Germany) Government bond market**

	Maximum likelihood function value	Normal	Q(20)	ARCH(20)
Germany		15.972 (0.00)	13.645 (0.85)	28.597 (0.09)
Austria	4012.35	23.970 (0.00)	16.769 (0.00)	23.676 (0.26)
Spain	4000.07	21.298 (0.00)	15.820 (0.73)	25.067 (0.20)
Belgium	3977.91	31.645 (0.00)	19.903 (0.46)	42.087 (0.00)
France	3872.16	20.988 (0.00)	14.468 (0.80)	18.372 (0.56)
Finland	4017.46	13.476 (0.00)	18.871 (0.53)	31.067 (0.05)
Ireland	3862.88	27.662 (0.00)	19.039 (052)	16.452 (069)
Italy	3929.65	20.439 (0.00)	13.481 (0.85)	29.673 (0.07)
Netherlands	4008.65	24.039 (0.00)	18.870 (0.53)	27.132 (0.131)
Sweden	3867.52	22.629 (0.00)	19.068 (0.50)	26.124 (0.113)
Portugal	3935.75	24.281 (0.00)	22.758 (0.30)	25.679 (0.18)
Denmak	3712.16	11.435 (0.00)	16.994 (0.65)	41.173 (0.00)
U.K.	3519.85	59.361 (0.00)	13.927 (0.83)	32.623 (0.04)

Note: The Bera-Jarque statistic tests for the normal distribution hypothesis and has an asymptotic distribution $\chi^2(2)$. Q(20) is the Ljung-Box test for twentieth order serial correlation in the standardized residuals. ARCH(20) is Engle's test for twentieth order ARCH, distributed as $\chi^2(20)$. The p-values of these tests are displayed in parentheses. In all cases the necessary conditions for the stationarity of the process are satisfied.