European sovereign bond spreads: monetary unification, market conditions and financial integration.

Dimitris A. Georgoutsos
Athens University of Economics & Business,
Department of Accounting & Finance

Tel.: +30 210 8203441
Email: dgeorg@aueb.gr

Petros M. Migiakis
Bank of Greece,
Economic Research Department

Tel.: +30 210 3203587
Email: pmigiakis@bankofgreece.gr

Abstract

In the present paper we examine the European sovereign bond yield spreads focusing on issues related to financial integration. Our results indicate that, contrary to previous literature findings, European sovereign bonds achieved only partial integration even before the recent financial crisis. Existence of near-unit-root effects in the spreads indicates the need for thorough investigation of the deterministic process of the spreads, under the proper econometric framework. Thus we examine sovereign bond yield spreads, for eleven EMU countries against the Bund for the period 1992:1-2009:12, as AR(1) deterministic processes. Furthermore we incorporate exogenous explanatory variables by taking into account regime switching effects, on the grounds of Markovian probabilistic specification of the regimes, thus examining, rather than assuming, the effects of the monetary unification in the deterministic processes of the sovereign bond yield spreads, allowing for states of higher and lower interactions to be revealed. Overall our results indicate that financial integration and financial stability are interconnected. Specifically, evidence of differences existing in the effects exercised by the same deterministic factors on sovereign bond yield spreads indicate that sovereign bond markets in Europe were only partially integrated even before the credit crisis. However, low volatility conditions resulted in 'hiding' these differences, as we find a negative relation between low-volatility conditions and the effects exercised by idiosyncratic risk factors and home-bias on bond yield spreads.

Keywords: financial integration; sovereign bond spreads; near unit root; regime shifts
JEL classification: F3, G1

1. Introduction

An official aim of the system of euro area central banks[1], the integration of European financial markets constitutes a very interesting research topic. Until present reported empirical results have, in a great extent, attributed enhanced interactions among EMU sovereign bonds to the monetary unification (see among others Baele *et al.*, 2004, ECB, 2005 and European Commission, 2007). In this context differences between yields of European sovereign bonds and the Bund have been one of the most popular proxies for the state of European bond markets' integration. However, we deem that the question on the determinants of the European financial integration process remains to be answered. During the recent crisis, European sovereign bond spreads experienced a widening and reached levels comparable to the ones existing in the pre-EMU period, thus updating the need to provide a viable answer to the question of the determinants of financial integration in the European bond markets.

Previous empirical literature on the determinants of European sovereign bond spreads has argued that bond spreads are related to risk factors; a relation explained thoroughly in Cochrane and Piazzesi (1995). Additionally, other empirical findings on bond spreads (e.g. Codogno *et al.*, 2003 and Ehrmann *et al.*, 2005) are associated to the degree of financial integration existing in European bond markets. In this context, without questioning the hypothesis of full integration in the European bond markets, remaining differences among sovereign bond yields have been attributed mainly to liquidity and credit risk factors (see among others Codogno *et al.*, 2003, Goméz-Puig, 2006 and Manganelli and Wolswijk, 2009). Credit risk variables are used to capture fiscal discipline effects on European sovereign spreads, while liquidity risk variables are interpreted as capturing market infrastructure and institutional divergences. Furthermore, this topic has great importance for broader economic policy as previous literature relates European sovereign bond spreads to the public debt's cost of borrowing and fiscal discipline. Bernoth, von Hagen and Schuknecht (2004) have agued that fiscal imbalances in EMU member-countries are among the major determinants of the European sovereign bond spreads, while Manganelli and Wolswijk (2009, p. 193), argue that 'even small variations in bond prices may entail significant costs for the tax payer'.

[1] We refer to the specific provision introduced in the Statutory statement of the European Central Bank.

The present paper contributes to the relevant literature by reporting several new aspects concerning the dynamics of European sovereign bond yield spreads; most importantly, we adopt the perspective of Neal (1985) on the non-permanent effects of financial integration. To the best of our knowledge this view has not, yet, been incorporated in the relevant empirical research, as works on the topic of determinants of European sovereign bond spreads have not allowed for a changing degree of financial integration. Specifically, the empirical frameworks employed, so far, either ignored changing market and economic conditions or incorporate dummies (e.g. Schuchknecht *et al.*, 2009) in order to separate the sample exogenously, thus allowing for a single, *ex ante* known, break point, i.e. 1999. However, this perspective relies on the assumption that after the monetary unification the deterministic structure of European sovereign bond spreads has not been altered.

On the other hand, under our perspective the effects of shifts, e.g. the European monetary unification, are not permanent but are permitted to vary according to unobserved state dependent variables. This way we allow for changes in the effects exercised by the explanatory variables, varying with market or economic conditions, to be reflected. As a result, the underlying relations of the system are distributed endogenously to different regimes, allowing for a changing degree of interactions to be revealed even in the aftermath of the monetary unification. Overall the results reported herein indicate that monetary unification has enhanced linkages among European sovereign bond markets, although they are not characterized by full financial integration, in line with Hartmann *et al.* (2003). However, this convergence has been reversed, in a great extent, in the aftermath of the credit crisis indicating the need for closer institutional integration of remaining differences in Euro-area economic policies.

Furthermore, we find that market volatility is negatively related to the European bond markets' integration process, while there is a need for elimination of differences in the pricing processes that are found to exist even in normal periods. Specifically, our results indicate that there exists an association between the low volatility characteristics in the period after the monetary unification and the close co-movements of European sovereign bond spreads. Additionally, significant differences exist in the effects exercised by the deterministic variables on spreads of different sovereign issuers, even under low volatility conditions. In our view this last outcome provides a strong motivation for policy-makers to work on the synchronization of fiscal policies or even on fiscal integration.

Additionally, we incorporate factors whose deterministic effects on European sovereign bond spreads have not yet been reported in the relevant empirical literature. This way, the categorization of the information incorporated in European sovereign bond spreads according to their driving factors is examined more thoroughly. More informative results are extracted by comparing findings that differ across member-countries, wile we categorize the effects according to their origins, as well; be they idiosyncratic or systemic.

The present paper is organized as follows. In section 2 we review a part of the literature that has dealt, so far, with European bond markets and the existing empirical literature of deterministic factors of sovereign bond spreads. Section 3 discusses the relations explored in the model and provides a rule for the interpretation of the results. Then, in section 4, we introduce the empirical investigation framework by describing data used and the methodology employed. The discussion of empirical results, in section 5, is categorized according to the aim of the assessment and section 6 discusses potential policy implications of the findings. Finally, section 7 concludes.

2. Previous literature

The issue of European bond markets integration has concentrated increased interest in empirical research. Overall sovereign bond markets in the euro area have been reported to share an elevated degree of financial integration. Baele *et al.* (2004) provide a formal definition of the financial integration process in European markets. Under their perspective in order for a system of financial markets to be integrated, the factors causing movements of prices in the markets under examination should result to equal and unidirectional effects. Pagano and von Thadden (2004) argue that the homogenization of institutional frameworks and efficiency of the market infrastructure in Europe is positively related to the deepening of European bond markets' integration.

However, Hartmann *et al.* (2003) reported findings indicating that European bond markets were only partial integrated in the period after the European monetary unification, while Kiehlborn and Mietzner (2005) argue that European bond markets are segmented. More recently, Abad, Chulia and Goméz-Puig (2009) argue that although the monetary unification has resulted in enhanced integration of European sovereign bonds, the latter still cannot be seen as perfect substitutes. A more complex answer on the effects of financial integration is provided by Schulz and Wolff (2008); using daily data on European sovereign bond yields, they argue that homogenization of trading platforms has enhanced integration effects in the ultra-high to high frequency spectrum, whereas in frequencies lower than daily, causal effects stemming from the Bund are still low, indicating the existence of the need for further financial integration in European bond markets.

Furthermore, findings reported in Goméz-Puig (2008) indicate that, in the run-up of EMU, a lower than expected fall in the cost of borrowing in European sovereign bonds, has been experienced. Specifically, in the first three years after EMU an increase of approximately 12 basis points in sovereign bond spreads, when adjusted for the exchange rate risk, is evident. The author attributes these effects to risk factors related to domestic rather than international developments while being associated to core-periphery effects related to market size. As a result, these findings directly challenge the financial integration assumption. Furthermore, although bond markets share an increased degree of financial integration, significant divergences, reflected in non-zero sovereign bond spreads, still need to be explained.

Previous literature examining the deterministic factors of European sovereign bond spreads' movements, has mainly focused on whether these factors are related to systemic, as opposed to idiosyncratic risk, in order to approximate the degree of financial integration in European bond markets. The empirical assessment, to reveal the information incorporated in bond spreads' movements, is mainly performed by decomposing them to deterministic factors; most frequently to credit and liquidity risk premia. Additionally member countries' fiscal policies and, more precisely, violations of the Stability and Growth Pact have also been referred to in the literature as sources of deviations reflected in bond spreads.

In their work, Codogno *et al.* (2003) have argued that the Euro area sovereign bond spreads are mainly driven by international risk factors, while effects stemming from the liquidity component are larger than those stemming from the credit risk one. Arguing that small but significant credit risk components impose market discipline, their results are interpreted as not raising ambiguity on the process of European bond markets' financial integration. Similarly, Bernoth *et al.* (2004) find that European sovereign bond spreads incorporate both liquidity and default risk premia, while the latter are shown to be related to fiscal conditions in EMU countries. Their findings, however, indicate that these factors are diminished after the launch of EMU, thus not affecting the European financial integration process.

In this context a strand of the relevant literature examines the relation between the spreads' movements to fiscal policy in the European countries. The conclusions drawn in these empirical examinations are interpreted in relation to discipline imposed by markets to each country's government debt according to the limits set by the Stability and Growth Pact. In this aspect, Manganelli and Wolswijk (2009) relate financial integration to fiscal discipline in the EMU; they report results indicating that the higher the credit quality of the (sovereign) issuer, the higher are the effects stemming from the liquidity component. They interpret these findings by stating that although European sovereign bond spreads are driven by a common factor[2], market pricing of credit risk, as subject to countries' fiscal policies, imposes discipline to European sovereign bonds. Additionally, Schuknecht *et al.* (2009) examine the variation of sovereign bond spreads according to EMU countries' fiscal performance. Their results indicate that the 'no bail-out clause' of the Maastricht Treaty is perceived by markets as a credible one. Consequently, according to their results, the tighter the fiscal policy of an EMU country, the more integrated, financially, its bond market is. In this aspect, the inclusion of Italy, by Pozzi and Wolswijk (2008), in a system of markets exhibiting essential elimination of the idiosyncratic component in bond spreads against the Bund reveals a latent debate on the issue. Of course, the composition of the system of markets, including spreads of sovereign bonds by the Netherlands, Italy, Belgium and France against the German benchmark, leaves room for investigation of the rest of the EMU countries, as well.

In our view, existing literature dealing with the causal effects reflected in European sovereign bond spreads' movements, has neither been exhaustive, concerning the factors examined, nor has it provided a robust answer to the question of the state of financial integration in European bond markets. Herein, we expand this empirical literature by relating the degree of European sovereign bonds integration to changes in the underlying market and economic conditions and by allowing the system to reflect effects not previously reported in existing empirical literature. Specifically, we incorporate some of the 'omitted variables', in terms used by Manganelli and Wolswijk (2009). Furthermore, we deem that the question is raised,

[2] A finding existing in Codogno *et al.* (2003), Geyer *et al.* (2004) and Favero *et al.* (2010).

again, on whether the monetary unification in Europe, by its own, is adequate for the aim of a single capital market to be achieved.

Most papers exploring the determinants of European sovereign bond spreads, use panel regressions (see Codogno *et al.* 2003, Manganelli and Woswijk 2009 and Goméz-Puig 2008, among others). Although, panel data analysis allows the reflection of cross-sectional differences, enabling i.e. the examination of differences existing in different credit quality segments, it does not allow efficient illustration of effects produced by time variation, such as regime shifts. As a result, the effects of regime shifts are ignored, while, in case such effects are examined this is performed by introducing state variables that categorize the system, exogenously, to separate states (e.g. Schuchknecht *et al.*, 2009). However, as referred to in Krolzig (1997), this perspective does not allow for timely capturing of changes in the underlying conditions that eventually will be reflected, once the data observations categorized in the new regime will be enough. In order to perform this task we question the steady-state hypothesis of the effects of monetary union, as far as the sovereign bond spreads are concerned. In this context, we adopt the framework of Georgoutsos and Migiakis (2010), that allows for endogenous shifts to be revealed.

Adopting this perspective, we estimate the causal effects incorporated in European sovereign bond spreads as subject to regime shifts. Specifically, we follow recent empirical literature that reports results motivating the examination of the effects of equity returns on European sovereign bond spreads. Specifically, Baele, Bekaert and Inghelbrecht (2009) investigate the factors explaining the dynamics of the correlation between stock and bond returns. They incorporate several factors that capture either risk aversion or economic fundamentals. Their results indicate that the most effective shocks on the correlation between stock and bond returns stem from the proxy they use to capture fundamental risk aversion. As a result, they indicate that there exists a relation of the risk exposure investors are willing to take to their portfolio holdings in bonds and stocks. Thus, in our opinion, this strand of empirical research provides the rationale under which the effects of equity markets' returns on the dynamics of sovereign bond spreads should be examined. In this context, we aim at decomposing the information incorporated in sovereign bond spreads which is associated not only to credit and liquidity risk factors, but to market variations, inflation expectations and yield curve dynamics as well.

Taking note of the above, we examine the explanatory effects from factors not previously reported, such as equity returns and inflation dynamics, while we further differentiate our work form previous literature by introducing unobserved state-dependent variables; a technique that renders efficiency in the system by reflecting effects that would be otherwise ignored. Specifically, instead of introducing a dummy variable capturing the period after the monetary unification, which would imply that the system remains in the new state ever since, we allow the system's causal relations to shift across regimes. As a result, the system is enabled to shift towards strengthening of the effects originating, for example, from idiosyncratic factors, even if the monetary union has not been resolved. This specific feature of our methodological framework enables the extraction of results indicating the inadequacy of the monetary union for financial integration.

3. Motivation of the empirical investigation

The present paper reports, for the first time, several effects related to the determinants of the European sovereign bond spreads. Specifically, here we adopt a different perspective as far as the effects of the monetary unification are concerned; the empirical formulation employed lifts the assumption that they were permanent. Clarifying this argument we adopt Baele *et al.* (2004)'s thesis that in case a system of financial markets is fully integrated, exogenous shocks should produce equal effects in the underlying assets. Under this perspective and by taking note that it is common ground that financial markets' turbulence during the 2007-2009 crisis, although exogenous to the monetary union, did not affect all European bond yields equally, we deem that the proper empirical framework for the examination of the spreads' determinants should allow for relations to vary between different states even after the monetary unification.

Thus, we revisit the integration hypothesis of the European bond markets because we deem that the monetary unification did not result to the accomplishment of the target of financial integration in European bond markets. Specifically, although it strengthened interactions among European bond markets (see among others, Georgoutsos and Migiakis, 2009) the recent financial and economic conjunction motivates the examination of the relation among financial markets' stability conditions and the financial integration process in Europe. As a result, we formulate the relation between spreads and their determinants as subject to regime shifts that follow the Markov ergodic chain probabilistic distribution, in order to allow the system to be classified endogenously to separate states. Furthermore, by incorporating regime switching behaviour in the variance-covariance matrix we permit the classification to different regimes to be related to states of high and low volatility.

Herein, following previous empirical literature (see among others Codogno *et al.*, 2003 and Manganelli and Woslwijk, 2009) we formulate the spread of each European sovereign bond against the German benchmark as a function of several explanatory variables. Most importantly, we examine several factors that have been found, in previous relevant research, to be related to the bonds' pricing process but their effects on the European sovereign bond spreads have not yet been reported. Specifically, we examine the effects related to capital allocation between different segments of the market and the information that can be retrieved by the relevant variables, while we also incorporate effects stemming from market's expectations, European money market conditions relative to the US money market and inflation rates. Equation 1, below, illustrates the relation examined:

$$\begin{aligned}(i_X^{10} - i_{DE}^{10})_t &= a_0 + a_1(i_X^{10} - i_{DE}^{10})_{t-1} + a_2(i_{AAA} - i_{DE}^{10})_{t-1} + a_3(i_{BBB} - i_{DE}^{10})_{t-1} + a_4(i_X^{10} - i_X^{3m})_{t-1} + \\ &+ a_5(i_{DE}^{10} - i_{DE}^{3m})_{t-1} + a_6(i_{US}^{10} - i_{US}^{3m})_{t-1} + a_7(i_X^{s} - MRO)_{t-1} + a_8(\pi_X - \pi_{DE})_{t-1} + a_9 r_{X\ t-1}^{S} + \\ &+ a_{10} r_{DE\ t-1}^{S} + a_{11} r_{US\ t-1}^{S}\end{aligned} \quad (1)$$

Specifically, i_X^T represents the bond yield or interest rate of the sovereign issuer x ($x \in$ {AT, BE, FI, FR, GR, ES, IE, IT NT, PT}), with a term to maturity, at issuance, equal to T. Following tests for unit and near-unit roots, reported in detail in the empirical results section, we formulate the spread as a first order autoregressive process (AR(1)), in order to deal with issues of high persistence. As far the rest of the explanatory variables are concerned the following paragraphs provide a brief discussion.

First, as a natural follow up of previous literature, we examine the effects exercised by the Euro-area corporate bond spreads against the Bund. Our analysis takes into account differences in the credit conditions between the high quality and the high yielders sectors by introducing the spreads among yields of highly liquid corporate bond indices (iBoxx), separating results for high (AAA $(i_{AAA} - i_{DE}^{10})$) and lower (BBB $(i_{BBB} - i_{DE}^{10})$) credit quality bonds.

Additionally, we examine the effects exercised on sovereign bond spreads by the slope of the yield curve $(i_X^{10} - i_X^{3m})$, that is the difference between short term (3-month) bill rates and long term (10-year) bond yields. This variable has been reported to have significant information content for expected growth and inflation (see among others, Estrella and Hardouvelis, 1991, Estrella and Mishkin, 1997, Stock and Watson, 2003). As a result, we expect that by introducing the yield curve's slope market participants' expectations for future economic conditions are captured in relation (1).

Next, we introduce the variable $(\pi_X - \pi_{DE})$ that captures differentials between inflation of country *X* and Germany's inflation. The reasoning behind this assessment is that since bond yields are priced as 'money sold forward' (Marsh and Rosenfeld (1983, p.683), the pricing of a bond issued by a sovereign entity relative to a bond of another sovereign may be reflect their inflation differences.

Furthermore, we also incorporate differences between short term (1-week) interest rates formulated in country's *X* interbank market (i_X^s) and the central bank's main rates (MRO). Of course after the monetary unification, this variable is the same for all countries. The reason behind the introduction of this variable is to capture banking liquidity effects; in case the interbank rate diverges away from the main refinancing rate this should reflect tighter liquidity conditions and vice versa.

Finally, we introduce the equity returns (r_X^S) estimated as $r_X^S = \left[\left(d_{t-1} \big/ P_{t-2} \right) + \left((P_{t-1} - P_{t-2}) \big/ P_{t-2} \right)\right]$ the sum of the dividend yield (d stands for the weighted average dividend paid in *X*'s stock market) and the growth rate of the market's index value (*P*). We examine whether stock market's conditions affect sovereign spreads in line with recent literature reporting common pricing factors existing for bonds and equities.[3] Furthermore, according to Fama and French (2002), after subtracting the respective risk free rate from r_X^S, we acquire the equity premium. Thus, following Semenov (2009), we deem that investors' beliefs on economic prospects and risk aversion shall be captured by this relation; the author argues that

[3] See Fama and French (1993), Campbell and Ammer (1993), Baur and Lucey (2008), Baele, Ang and Inghelbrecht (2009) and Yang *et al.* (2009). In brief, diversification of risks has been a rational explanation of divergences between the returns of bonds and stocks, as it has been related to decoupling effects also known as 'flight-to-quality'. On the other hand stock-bond returns' co-movements have also been explained in the grounds of common pricing factors.

the equity premium puzzle is resolved according to investors departure from rationality.

The yield curve slope and the equity premium enter the equation as variables stemming from the country examined each time, Germany and the United States. In this way effects stemming from the domestic, European and international sectors are captured. Specifically, home-bias effects are captured by examining the explanatory power of domestic variables, while systemic intra Euro area effects are reflected by the incorporation of the German variables and effects stemming from the rest of the world are approximated by incorporating the variables stemming from the United States.

4. Empirical investigation framework

4.1 Description of the data

Our data set comprises of yields of on-the-run benchmark bonds of the eleven countries –members of the European monetary union– at the time of introduction of the common currency. Specifically, we examine yields of bonds with a term to maturity of ten years of the countries, Austria (AT), Belgium (BE), Finland (FI), France (FR), Germany (DE), Greece (GR), Ireland (IE), Italy (IT), Netherlands (NT), Portugal (PT) and Spain (ES). Spreads are derived by differencing bond yields of each country against yields of the Bund. In this way we align our work to previous research and render comparability in our results. Source of the data set that we use is Thomson Financial-Datastream, while our sample covers the period 1992:1-2009:1.[4]

Thus, the present paper is the first to report results covering the period that extends from the Maastricht Treaty till the latest period after the eruption of the credit crisis in 2007. Additionally, our data set contains the group of EU-11 countries that initially comprised the EMU with the addition of Greece and the exclusion of Luxembourg.[5] This composition is useful in many aspects; mainly because it covers almost the whole of the potential investment grade credit ratings' categorizations, thus enabling the extraction of comparisons under both a cross-country and a cross-rating category perspective.

4.2 The empirical examination framework

[4] The sample's starting point differs for Portugal (1993:5) and Greece (1994:4) due to data constraints.
[5] Following previous literature Luxembourg is excluded because its total public debt issue size is small.

First we examine the data, emphasizing on stationarity properties. This task is critical in order to specify the proper deterministic formulation for the European sovereign bond spreads. Taking into account the low power of conventional Dickey-Fuller and Philips-Perron tests, in the presence of near-unit root effects that have been found to characterize interest rates, we also employ unit root tests with higher power, provided by Elliott *et al.* (1996) and Ng and Perron (2001) (Table 1, DF-GLS and PP-GLS, respectively).

Furthermore, we take into account regime that interest rates have also been reported as regime dependent autoregressive processes, (e.g. Ang and Bekaert, 2002). As a result, we regress the dependent variable to its autoregressive parameter by taking into account unobserved regime switching effects. Equation 2, below, represents the estimated Markov switching AR(1):

$$(i_X^{10} - i_{DE}^{10})_t = c(s) + \theta(s)(i_X^{10} - i_{DE}^{10})_{t-1} + u_t \text{, with } u_t \sim N\big(0, \sigma(s_t)\big) \tag{2}$$

where, s is the unobserved state dependent variable specified as a Markov ergodic probabilistic distribution, θ is the autoregressive coefficient and c is a constant term. In case $\theta < 1$ then the dependent variable is better specified as an autoregressive process subject to regime switching effects.

In order to take into account regime switching effects that may distort unit root test results we employ the MS-AR technique of Hamilton (1989), estimating the different regimes through the Expectations Maximization algorithm. Specifically, we denote the probability that s belongs to regime *j*, by the relation $p_{ij} = \Pr ob[s_{t+1} = j \mid s_t = i], \quad \sum_{j=1}^{M} p_{ij} = 1 \quad \forall i, j$. Under this specification, we can estimate the transition frequencies between the two alternative regimes, as defined by the probabilistic distribution of the state dependent variable. The matrix containing the transition probabilities is illustrated, below:

$$P = \begin{bmatrix} p_{11} & p_{12} \\ p_{21} & p_{22} \end{bmatrix} \tag{4}$$

where,

$$\begin{aligned} p_{11} &= \Pr ob[s_t = 0 | s_{t-1} = 0] = p \qquad & p_{12} &= \Pr ob[s_t = 0 | s_{t-1} = 1] = 1 - p \\ p_{21} &= \Pr ob[s_t = 1 | s_{t-1} = 0] = 1 - q \qquad & p_{22} &= \Pr ob[s_t = 1 | s_{t-1} = 1] = q \end{aligned} \tag{5}$$

By estimating the probabilities' transition matrix above the regime switching effects imposed in the relation between the spreads and their explanatory variables are specified. The smoothed probabilities, estimated by the EM algorithm, are the main criterion in our analysis and we demand $p_{ij} > 0.5$ in order to accept that an observation belongs to one of the two regimes. In this context, by allowing the error term to vary across regimes, the different states are related to different volatility states in European sovereign bond markets.

In this context, adjusting equation (1) to the aforementioned results, requires the use of the Markov switching framework of Krolzig (1997). Under the specification of obtained by equations (2)-(4) we estimate (1) as subject to regime switching effects on the coefficients of the explanatory variables and the variance-covariance matrix are subject. Equation (6) illustrates the Markov switching specification, examined herein:

$$\begin{aligned}(i_X^{10} - i_{DE}^{10})_t &= a_0(s) + a_1(s)(i_X^{10} - i_{DE}^{10})_{t-1} + a_2(s)(i_{AAA} - i_{DE}^{10})_{t-1} + a_3(s)(i_{BBB} - i_{DE}^{10})_{t-1} + a_4(s)(i_X^{10} - i_X^{3m})_{t-1} + \\ &+ a_5(s)(i_{DE}^{10} - i_{DE}^{3m})_{t-1} + a_6(s)(i_{US}^{10} - i_{US}^{3m})_{t-1} + a_7(s)(i_X^{s} - MRO)_{t-1} + a_8(s)(\pi_X - \pi_{DE})_{t-1} + a_9(s)r_{X\ t-1}^{S} + \\ &+ a_{10}(s)r_{DE\ t-1}^{S} + a_{11}(s)r_{US\ t-1}^{S} + e_t\end{aligned} \tag{6}$$

where $e_t \sim N(0, \sigma(s_t))$.[6]

As a result we lift the assumption of linearity, imposed in previous works, in the structure of the deterministic process of the European sovereign bond spreads. To highlight the difference between our specification and those provided by previous literature, we note that the exogenous separation of the sample to pre and post EMU periods, a technique used in Manganelli and Woslwijk (2009), carries the assumption that the intra-European in sovereign bonds have remained the same ever since the monetary unification. On the other hand under our probabilistic classification of the sample to the two different regimes, observations belonging in the period before or after the EMU are allowed to be classified to either of the two formulations. As a result, the Markov switching formulation allows for potential links between different volatility states and changes in the deterministic process of the European bond spreads to be revealed. Thus, a different perspective is adopted, herein, relating volatility conditions to different degrees of interactions between European sovereign bonds.

[6] Errors have been estimated robustly by applying the Newey-West filter for serial correlation.

Overall, results are interpreted under the prism of the information contained regarding the process of financial integration. We deem that in case European sovereign bonds have reached the state of full integration, at some point in the period examined, the underlying deterministic process of the dependent variables will, ultimately, remain unchanged through the rest of the sample; thus a steady-state in European bond markets would have been found in line with Hartmann *et al.* (2009). Additionally, in this case, the effects exercised by the explanatory variables should be homogenous for all dependent variables.

Furthermore, we estimate the relative deterministic power (C) of the effects exercised by the explanatory variables by employing the 'contribution' technique described in Beber *et al.* (2008):

$$C_i = \frac{\left| \hat{a}_i \cdot \frac{\sum_{t=1}^{T} (x_{it} - \bar{x})}{T} \right|}{\sum_{i=1}^{6} \left| \hat{a}_i \cdot \frac{\sum_{t=1}^{T} (x_{it} - \bar{x})}{T} \right|} \tag{7}$$

where, x stands for the explanatory variable examined each time, $\bar{x}$ is the sample average of the variable, $\hat{a}_i$ is the corresponding coefficient of relation (3) and T stands for the total of observations. Note that the average and the coefficient are regime-dependent; that is they take the values acquired with the estimation of relation (3) which change according to the regime the observation t belongs to.

5. Empirical results

5.1 The AR(1) and MS-AR(1) process

Unit root test results reported in Table 1 indicate that the autoregressive processes driving the European sovereign bond spreads can not be, clearly, stated to be stationary ones; they rather approximate near-unit-root processes. This result may be interpreted in the lines of Lanne (2000) and (2001), arguing for interest rates' processes as having autoregressive roots near but smaller than unity. Recalling that integration characteristics require the parity hypothesis to hold, this result raises the question whether the European sovereign bond yields relations comply with parity if stationarity is, even marginally, rejected for their one-to-one linear combinations.[7] Furthermore these results confirm, the appropriateness of specifying relation (1) as subject to persistent autoregressive effects.

Next, we turn to the results of the specification of the European sovereign bond spreads as MS-AR(1) processes. Table 2 presents the findings, while figures' panel A illustrates the periods captured by the different regime specifications. Note that the two specifications are found to be separated according to the different volatility characteristics of the dependent variable; high and low volatility, respectively. The first shift, from a high to a low volatility state, is found to occur in a period close to the accession to the single monetary policy state while the second shift, from a low to a high volatility state, is found to occur in the period of the recent credit crisis. However, in the first case differences exist across countries regarding the timing of the shift.

Specifically, the earliest shift point from the high to the low volatility specification is found for the Austrian sovereign bond yield spread as it had already shifted to a low volatility regime in 1995:3; although a transition to a high volatility regime is found soon after the Mexican peso crisis of 1994-1995[8], lasting till 1996:6. In the broad majority of cases the spreads' formulation is found to belong to a low volatility regime since late 1997; a date coinciding with the adoption of the Stability and Growth Pact. However, exceptions stand in the Italian and Greek cases (shift dates specified at 1999:2 and 2000:1, respectively). These results, indicate that monetary policy unification did not have simultaneous effects on all European sovereign bond spreads; as a result the accession process is found to be a more natural candidate to justify the close convergence of European sovereign bond yields. On the other hand the second –reverse– shift, transiting from the low to the high volatility regime, is found to occur during the 1st semester of 2008, for almost all countries examined, indicating that the deterioration of market conditions exercised simultaneous effects on all underlying markets.[9]

[7] Readers interested on the difference between high persistent and stationary processes should refer to Lima and Xiao (2007).
[8] Interested readers may refer to Gil-Diaz and Carstens (1996) among others.
[9] With the exception of Finland.

Furthermore, the results reported in Table 2 indicate that, in every case, the autoregressive coefficients are smaller than unity, thus motivating the re-estimation of unit root tests under the regime switching effects estimated. These results are reported in Table 3. In all cases there exists at least one specification in which the spread's process is clearly a stationary one. On the technical side, these results indicate the significance of taking into account the regime switching properties of the deterministic process governing the European sovereign bond spreads. Additionally, the unit root hypothesis is found to be rejected more frequently in the low volatility regime, giving support to the intuition that financial integration and financial stability are positively related.

5.2 The effects exercised by the explanatory variables

Next we turn to the results of the specification of the European sovereign bond as subject to the explanatory variables of equation (6); these are contained in tables 4 (high volatility regime) and 5 (low volatility regime). These results indicate that significant differences in the deterministic specification of the European sovereign bond spreads exist, even under the low volatility regime.

Specifically, in every case the effects exercised by the exogenous variables are not homogenous across the dependent variables. Even in the low volatility regime, capturing the period after the monetary unification, there exist significant differences in the direction of the effects of the explanatory variables. In the cases of the German term spread and the German equity return, positive and negative effects are equally distributed across the dependent variables; these findings indicate that if, for example, the German term spread rises this will have a negative impact on the sovereign spread of Spain and a positive effect on Finland and Belgium, under the low volatility specification, or Greece, under the high volatility specification. Furthermore, the magnitude of the deterministic effects is not the same for all sovereign spreads examined, even if the coefficients carry the same sign, while domestic variables are indicated to exercise more powerful and significant effects than equivalent non-domestic variables. Again, these findings do not comply with the case of full integration in the underlying markets even under the low volatility specification, because, as stated in Baele *et al.* (2004), same events should have the same impact, in an integrated market.

Next, the regime switching formulation enables the reflection of the different effects exercised by the credit conditions on the spreads of European sovereign bond yields with the yields of the Bund. Specifically, the spread of yields of the European corporate bonds with a AAA rating against the Bund exercises, in the majority of the cases, negative and significant effects on the European sovereign bond spreads under the high volatility regime and positive under the low volatility one. On the other hand the spread between BBB European corporate bonds and the Bund exercise positive effects, in most cases, on the dependent variables, under the high volatility specification and positive under the low volatility one. These results indicate that, under high volatility conditions, most of the European sovereign and high credit quality corporate bonds are seen as substitutes while a deterioration of credit conditions reflected in corporate bond yields of the lower bound of the investment category leads to increases in European sovereign bond yields as well. However, in the limited significance of these effects under low volatility conditions indicates that corporate credit conditions are not always a determinant of sovereign bond yields' movements.

On the other hand, expectations on domestic growth and inflation, reflected by the respective spread between long and short term rates, are found to exercise significant but not homogenous effects on the dependent variables. The sign of this explanatory variable is mostly positive, indicating that dynamics of the European sovereign bond spreads increase with higher inflation and growth expectations; especially for spreads of France and Spain the significance and positive direction of the term spread on the sovereign spreads are confirmed in both regimes. On the other hand effects exercised by the German term spread are not similarly homogenous across the dependent variables, in either regime. The finding of higher significance of this variable under low volatility, complies with the notion of higher integration under stable market conditions as it may be argued that it reflects market participants' focus on European aggregates only under the respective specification.

Next, liquidity conditions in the banking sector(s) have only limited effect on European sovereign bond spread, as a whole for both regimes. The results indicate that the spread among the interbank weekly rate and the main refinancing rate of the ECB exercises mixed effects on the dependent variables in both regimes, again highlighting the idiosyncratic characteristics of the spreads' movements. However, a worth-noting finding is the stability of the effects exercised by the banking liquidity variable, as their signs do not change, while, in most cases, their magnitude is very similar across regimes.

On the effects exercised by the difference of domestic and German inflation, they are indicate to have limited significance for the dependent variable. Evidently, this variable is more significant under the high volatility regime while the effects exercised on the dependent variables are, once again, not homogenous.

Finally, the equity return, be it domestic or not, is found to have limited significance for the European sovereign bond spreads' movements. Under the low volatility regimes the effects of domestic equity returns are mostly positive; a result that may be interpreted in the lines of Semenov (2009), arguing for the positive relation of pessimism and the equity premium's movements. However, the increase of respective negative effects, under high volatility, may be explained as a flight-to-quality effect in the sense of Baur and Lucey (2009) and Beber *at al.* (2009).

5.3 The spreads' deterministic components

In Tables 4 and 5, in the bottom line, we report the adjusted r-squared coefficients. In every case they are indicated to be very high, thus highlighting the efficiency of the formulation under relation 6. Additionally, in every case, except for Finland, we find that this specification captures a greater component of the dependent variables' movements under the high volatility regime. As a result, the European sovereign bond spreads are found to contain increased information under high volatility conditions.

Additionally, Table 6 contains the decomposition of the deterministic component of the dependent variables to their determinants, while the dynamics of the explanatory variables' deterministic power are illustrated in figures' panel B illustrates. Overall, these results provide arguments on for the idiosyncratic characteristics of the spreads' deterministic processes, as the distinction to different specifications according to high and low volatility conditions does not lead to homogenous changes in the effects exercised by the explanatory variables. Furthermore, the shift is found to strengthen the impact of credit risk variables and weaken the impact of the equity returns and the term spreads.

Specifically, an interesting finding is that only spreads of France, Italy and Spain are subject to lower impact from corporate credit conditions, in the high volatility regime, while the difference of the bond yields of Netherlands against the German ones experience a decrease of the impact the AAA corporate bond spread exercises on it. These results may be indicative of a categorization of European bond markets according to their inherent risk characteristics, as the spreads found to be subject to smaller credit conditions' effects during the high volatility regime stem from markets largely complying with those categorized by Dunne *et al.* (2006)'s as benchmarks.

6. Policy implications

In brief, the results indicate that there existed divergences in the pricing process of European sovereign bonds relative to the pricing of the Bund even in the period captured by the low volatility regime. Taking into account that the beginning of this period largely coincides with the establishment of the monetary unification this finding indicates that the deterministic process of the sovereign bond spreads 'suffered' from underlying causal differences. Of course, under the low volatility regime, there exist significantly more similarities in the effects exercised on European bond spreads but nevertheless there are found to be subject to opposite effects from the same explanatory variables. As a result, the interpretation of the decline of the sovereign bond spreads, during this period, as indicative of integration in European bond markets needs precaution. This finding, combined with the timing of the first shift, which in large coincides with the adoption of the Stability and Growth Pact, indicates the existence of a link of the spreads dynamics with market participants' perception on prospective, rather than actual, economic fundamentals.

Furthermore, the link between the sovereign bond spreads and credit risk is found to be subject to two presumptions; first the underlying market conditions and, second, the status of the underlying market. Specifically, we find that sovereign spreads reflect movements in underlying credit variables more closely under high volatility conditions. On the other hand, the strengthening of the link among credit risk and sovereign bond spreads' dynamics is not confirmed for markets that have been reported to carry benchmark characteristics; thus giving further support to existence of segmentation effects in the European bond markets.

As a result, we deem that the process of financial integration in the European bond markets' sector should be viewed as interconnected to the stability conditions in European financial markets. On the other hand researchers and analysts should be precautious when interpreting spreads' dynamics, solely in the ground of credit risk reflections; much more information is reflected in them which is also subject to market conditions.

7. Concluding remarks

Overall, we conclude that the European sovereign bond spreads' dynamics may not be interpreted as entirely related to credit risk conditions. Specifically, we find that expectations on prospective macroeconomic conditions, banking liquidity and investment sentiment are also reflected in their dynamics. Additionally, we find that the proper deterministic formulation should take into account high persistence effects. As a result, we deem that the spreads should rather be inspected as subject to various deterministic effects, while this information is also different under different volatility conditions in the underlying markets.

On the technical side, we deem that our results underline the regime switching and persistent nature of the European sovereign bond spread and as such support our argument for a precautious interpretation of the dependent variables' dynamics. Of course, our investigation's results may be improved, by future research, as additional deterministic effects may be found especially for the low volatility specification.

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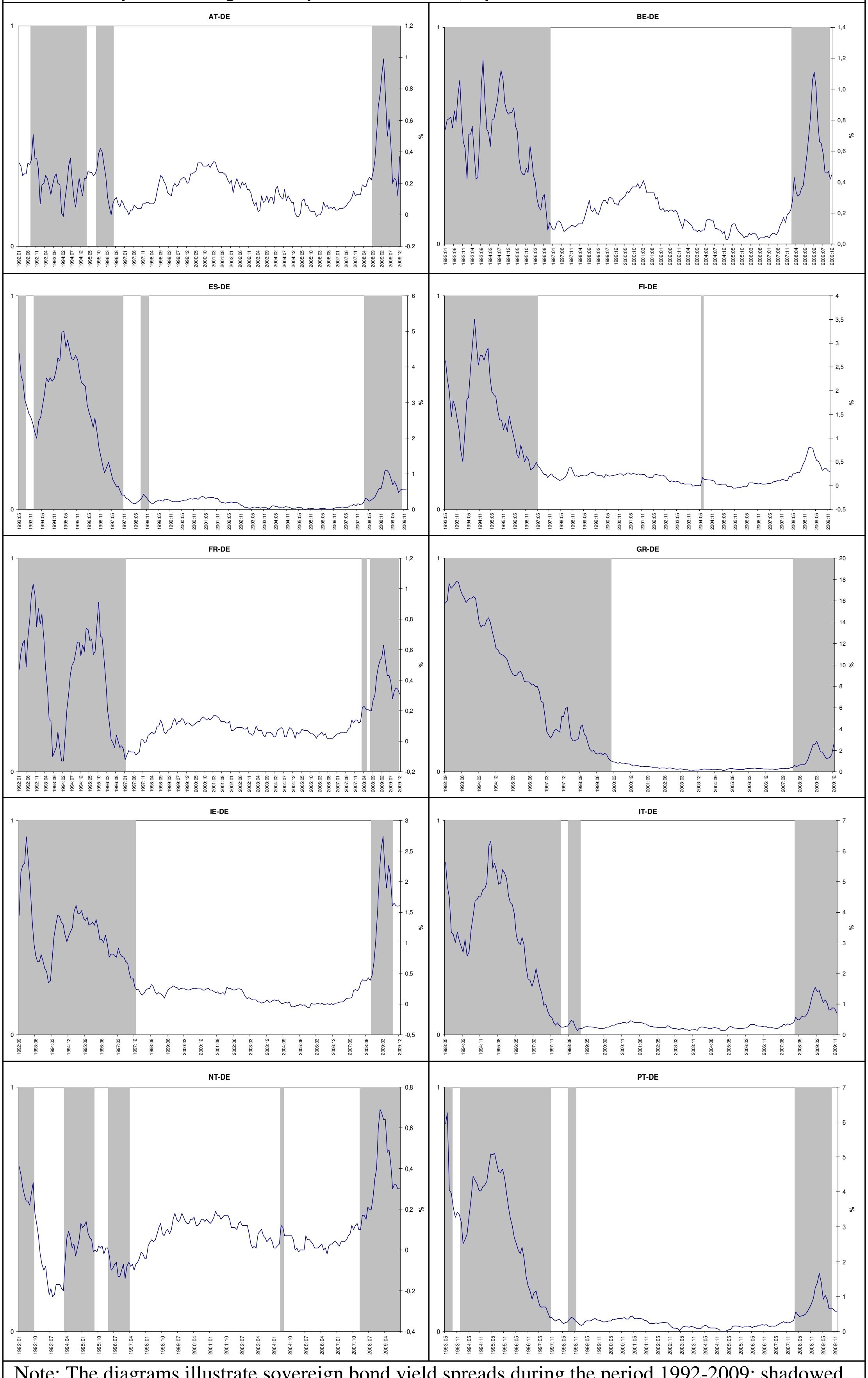
Table 1: Sovereign bond spreads' properties						
	Mean	Std. dev.	DF-test	DF-GLS	PP-test	PP-GLS
AT	0.185	0.153	-2.969**	-2.503**	-3.454**	-2.358**
BE	0.351	0.290	-2.249	-1.801*	-2.366	-0.965
ES	1.169	0.157	-1.914	-1.062	-1.584	-1.179
FR	0.199	0.249	-3.106*	-2.283**	-2.841*	-2.177**
FI	0.772	1.161	-2.584*	-0.142	-2.609*	-0.254
GR	4.049	5.379	-3.736**	0.093	-2.592*	0.221
IE	0.580	0.645	-2.199	-2.189**	-2.109	-2.233**
IT	1.553	1.956	-1.692	-0.401	-1.720	-0.363
NT	0.086	0.151	-3.029**	-1.263	-3.000**	-1.224
PT	1.424	1.924	-2.184	-0.107	-2.120	0.307

Note: The table presents results of Augmented Dickey Fuller (DF) and standard Philips and Perron (PP) tests, as well as their GLS-modified versions provided by Elliott *et al.* (1996) and Ng and Perron (2001), respectively. Asterisks (*,**) denote rejection of the null of a unit root in the data (in a confidence band of 10% and 5%, respectively).

Table 2:	The spreads under the Markov switching AR(1) formulatioon			
X	θ		X's std. deviation	
	s= 1	s= 2	s= 1	s= 2
AT	0.953 (0.026)	0.867 (0.067)	0.031	0.106
BE	0.975 (0.020)	0.904 (0.051)	0.023	0.117
ES	0.941 (0.005)	0.992 (0.018)	0.026	0.275
FI	0.895 (0.032)	0.949 (0.031)	0.031	0.362
FR	0.912 (0.029)	0.954 (0.038)	0.019	0.103
GR	0.927 (0.018)	0.987 (0.008)	0.030	0.493
IE	0.992 (0.011)	0.924 (0.043)	0.031	0.226
IT	0.922 (0.011)	0.989 (0.017)	0.028	0.347
NT	0.891 (0.026)	0.972 (0.031)	0.022	0.061
PT	0.904 (0.005)	0.975 (0.026)	0.036	0.439

Table 3:	Sovereign bond spreads' properties under the regime switching formulation					
	Mean	Std. dev.	DF-test	DF-GLS	PP-test	PP-GLS
High volatility regime						
AT	0.078	0.169	-2.405	-2.087**	-3.191**	-2.382**
BE	0.649	0.259	-2.576*	-2.813**	-2.199	-3.008
ES	1.028	1.623	-1.812	-0.956	-1.897	-1.991**
FR	0.151	0.271	-2.695*	-1.595*	-2.655*	-1.651*
FI	0.644	1.223	-2.169	-0.073	-2.552*	-0.081
GR	3.824	5.444	-3.819**	0.059	-2.745**	0.295
IE	0.231	0.534	-2.651*	-1.837*	-2.531*	-1.937**
IT	1.077	1.715	3.049**	-0.007	-2.681*	0.076
NT	0.052	0.141	-2.579*	-0.992	-2.804**	-0.998
PT	1.162	2.003	-3.033**	-0.070	-3.033**	-0.043
Low volatility regime						
AT	0.106	0.106	-3.511**	-1.372	-3.511**	-1.351
BE	0.110	0.119	-1.591	-0.881	-1.688	-1.869*
ES	0.140	0.367	-4.501**	-4.127**	-4.814**	-4.122**
FR	0.048	0.061	-3.338**	-2.657**	-3.052**	-2.532**
FI	0.130	0.159	-2.394	-1.878*	-2.269	-1.982**
GR	0.168	0.223	-2.501*	-2.128**	-2.449	-2.086**
IE	0.290	0.422	1.629	-1.635*	-1.907	-1.629*
IT	0.149	0.142	-2.339	-1.776*	-2.129	-1.749*
NT	0.035	0.081	-2.747*	-2.591**	-2.801**	-2.517**
PT	0.261	0.546	-4.604**	-4.271**	-4.909**	-3.939**
Note: As in table 1.						

Panel A: European sovereign bond spreads as MS-AR(1) processes



Note: The diagrams illustrate sovereign bond yield spreads during the period 1992-2009; shadowed regions indicate periods belonging in the high-volatility regimes.

Table 4: High volatility regime										
	AT	BE	ES	FI	FR	GR	IE	IT	NT	PT
a_0	0.006** (0.003)	0.002 (0.002)	0.052 (0.038)	0.019 (0.017)	0.004 (0.052)	0.113 (0.109)	0.005 (0.004)	0.053 (0.041)	0.001 (0.002)	0.019 (0.016)
a_1	0.558** (0.096)	0.834** (0.074)	0.799** (0.089)	0.968** (0.239)	0.943** (0.052)	0.955** (0.066)	0.821** (0.055)	0.845** (0.072)	0.618** (0.134)	1.008** (0.178)
a_2	-0.247** (0.104)	-0.195** (0.101)	-0.071 (0.124)	0.820 (0.605)	-0.024 (0.072)	-1.199** (0.399)	-0.400** (0.169)	0.012 (0.102)	-0.105 (0.079)	-0.741* (0.416)
a_3	0.169** (0.049)	0.090** (0.043)	-0.017 (0.056)	-0.977** (0.494)	0.015 (0.030)	0.573** (0.206)	0.274** (0.090)	-0.127** (0.054)	0.087* (0.054)	0.239 (0.191)
a_4	-0.043 (0.074)	0.045 (0.041)	0.247** (0.091)	0.085 (0.021)	0.030** (0.015)	-0.241** (0.102)	0.013 (0.021)	0.206** (0.041)	-0.036 (0.045)	-0.278 (0.291)
a_5	0.050 (0.076)	-0.037 (0.044)	-0.100** (0.040)	0.022 (0.144)	-0.024 (0.016)	0.145** (0.106)	-0.009 (0.041)	-0.043 (0.036)	0.020 (0.051)	0.063 (0.172)
a_6	0.015 (0.017)	0.023 (0.019)	-0.036 (0.054)	0.017 (0.084)	-0.015 (0.020)	0.247** (0.109)	0.098** (0.022)	-0.004 (0.064)	0.009 (0.009)	0.351 (0.222)
a_7	-0.012 (0.035)	-0.056** (0.026)	0.158 (0.128)	-0.205 (0.220)	0.008 (0.018)	-0.108* (0.067)	0.008 (0.006)	0.201 (0.144)	-0.034 (0.036)	0.110 (0.372)
a_8	-0.009 (0.044)	0.027 (0.015)	0.189** (0.081)	-0.293** (0.089)	-0.026 (0.023)	-0.059 (0.089)	0.131** (0.029)	0.082** (0.041)	0.022 (0.021)	-0.079 (0.255)
a_9	-0.007** (0.003)	-0.002 (0.003)	0.005 (0.008)	0.002 (0.006)	0.001 (0.002)	-0.005 (0.005)	-0.001 (0.006)	0.019** (0.007)	-0.001 (0.002)	0.003 (0.028)
a_{10}	0.003 (0.005)	-0.002 (0.003)	-0.005 (0.012)	-0.023** (0.011)	-0.004 (0.003)	-0.022** (0.011)	-0.003 (0.006)	-0.012 (0.013)	0.002 (0.002)	0.027 (0.026)
a_{11}	0.002 (0.004)	0.001 (0.004)	-0.0031 (0.016)	0.011 (0.015)	0.001 (0.004)	0.015 (0.014)	0.005 (0.007)	-0.012 (0.011)	-0.003 (0.002)	-0.026 (0.016)
$\tilde{R}^2$	0.869	0.953	0.909	0.917	0.935	0.919	0.960	0.932	0.942	0.904

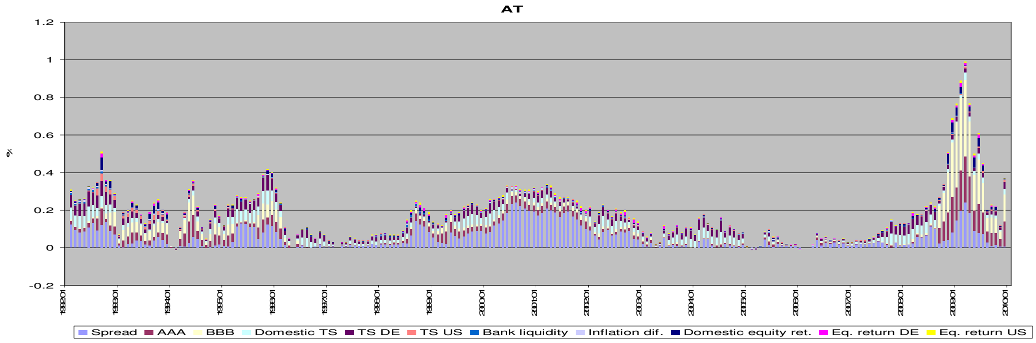
<u>Note:</u> Figures report the coefficients of the explanatory variables under the specification of relation 6, while figures in parenthesis report their std. deviations. Asteriosks * and ** denote significance in a 10% and 5% confidence interval, respectively.

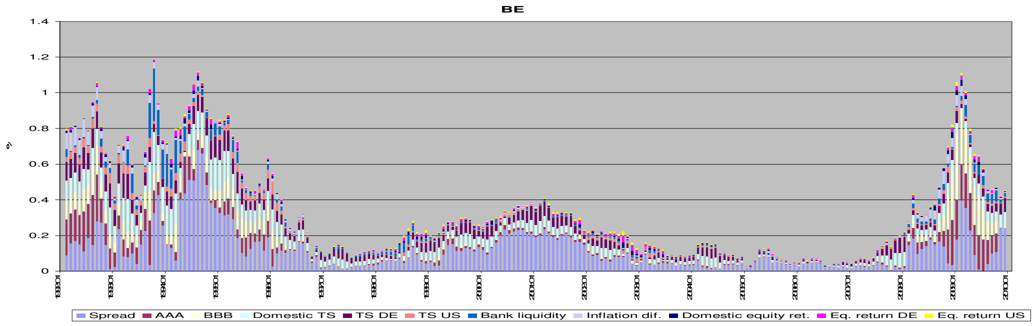
Table 5: Low volatility regime										
	AT	BE	ES	FI	FR	GR	IE	IT	NT	PT
a_0	0.006 (0.005)	0.007 (0.005)	0.055 (0.039)	0.013* (0.008)	0.006 (0.005)	0.011 (0.070)	0.023 (0.019)	0.005 (0.003)	0.003 (0.004)	0.149 (0.101)
a_1	0.924** (0.101)	1.033** (0.052)	0.762** (0.303)	1.125** (0.078)	0.601** (0.131)	0.947** (0.063)	0.987** (0.022)	0.789** (0.105)	0.779** (0.064)	0.852** (0.051)
a_2	0.031 (0.023)	0.022 (0.031)	0.017 (0.044)	-0.006 (0.013)	0.049** (0.022)	-0.001 (0.031)	0.007 (0.020)	0.029 (0.031)	0.008 (0.012)	0.122 (0.086)
a_3	-0.013 (0.016)	-0.016 (0.019)	-0.029 (0.031)	0.009 (0.009)	-0.030** (0.013)	-0.002 (0.022)	-0.014 (0.015)	-0.012 (0.021)	-0.002 (0.009)	-0.122* (0.067)
a_4	0.044 (0.116)	-0.055* (0.033)	0.120** (0.059)	-0.231** (0.072)	0.111** (0.049)	0.021 (0.037)	0.003 (0.008)	0.032 (0.026)	0.008 (0.029)	0.054 (0.031)
a_5	0.043 (0.113)	0.062** (0.033)	-0.095** (0.043)	0.219** (0.071)	-0.118** (0.049)	0.017 (0.014)	0.004 (0.005)	-0.027 (0.029)	-0.006 (0.029)	-0.071 (0.054)
a_6	-0.001 (0.004)	-0.004* (0.002)	-0.011 (0.009)	0.004 (0.003)	0.003 (0.002	-0.014 (0.014)	-0.004 (0.004)	-0.002 (0.004)	-0.004** (0.001)	0.003 (0.013)
a_7	-0.011 (0.017)	-0.026** (0.013)	0.042 (0.059)	-0.006 (0.012)	0.003 (0.016	-0.019 (0.021)	0.003 (0.023)	0.057* (0.032)	-0.014* (0.008)	0.034 (0.031)
a_8	-0.007 (0.005)	-0.006 (0.006)	0.023 (0.019)	0.016** (0.005)	-0.001 (0.004)	-0.008 (0.007)	0.001 (0.003)	0.003 (0.007)	0.011** (0.004)	-0.006 (0.023)
a_9	0.001 (0.001)	0.001 (0.001)	0.007 (0.006)	0.001 (0.001)	0.002** (0.001)	0.001 (0.001)	0.001 (0.002)	-0.001 (0.001)	-0.001 (0.001)	-0.001 (0.001)
a_{10}	-0.001 (0.001)	-0.001 (0.001)	-0.004 (0.004)	0.001 (0.001)	-0.001 (0.001)	0.001 (0.001)	-0.001 (0.002)	0.002 (0.002)	0.001 (0.001)	0.002 (0.002)
a_{11}	-0.001 (0.001)	0.001 (0.001)	0.001 (0.002)	-0.001 (0.001)	-0.002** (0.001)	-0.001 (0.002)	-0.001 (0.001)	-0.002 (0.002)	0.001 (0.001)	-0.001 (0.002)
$\tilde{R}^2$	0.822	0.897	0.523	0.929	0.698	0.874	0.738	0.906	0.885	0.646

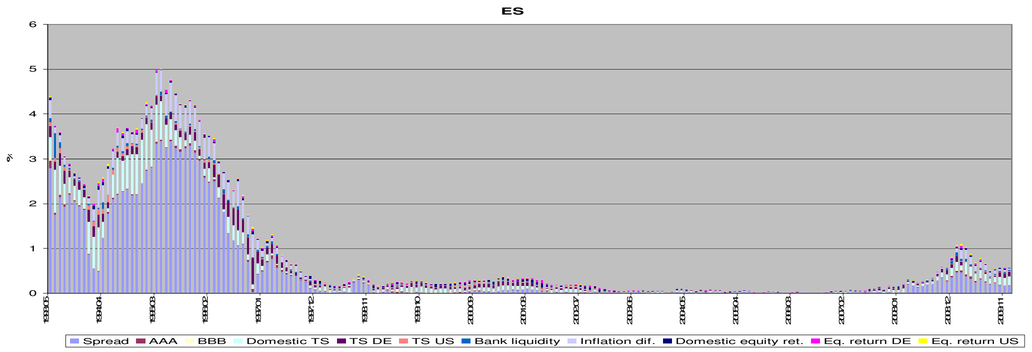
<u>Note:</u> Figures report the coefficients of the explanatory variables under the specification of relation 6, while figures in parenthesis report their std. deviations. Asteriosks * and ** denote significance in a 10% and 5% confidence interval, respectively.

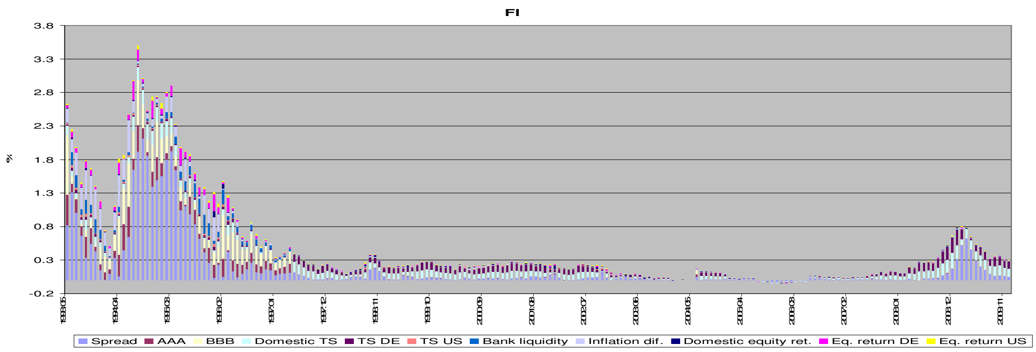
Table 6: Decomposition of the spreads' deterministic copmponent										
	AT	BE	ES	FI	FR	GR	IE	IT	NT	PT
High volatility regime										
$(i_X^{10} - i_{DE}^{10})_{t-1}$	14.2%	29.6%	57.4%	37.8%	51.2%	50.5%	30.5%	60.6%	15.1%	48.4%
$(i_{AAA} - i_{DE}^{10})_{t-1}$	23%	14.0%	1.7%	12.9%	3.1%	11.2%	15.6%	0.3%	0.6%	12.3%
$(i_{BBB} - i_{DE}^{10})_{t-1}$	28.7%	13.1%	0.8%	16.5%	3.8%	9.6%	16.6%	5.5%	12.0%	10.4%
$(i_X^{10} - i_X^{3m})_{t-1}$	9.3%	13.3%	13.9%	4.9%	12.2%	9.8%	2.1%	10.3%	30.8%	7.5%
$(i_{DE}^{10} - i_{DE}^{3m})_{t-1}$	11.2%	10.6%	7.8%	1.4%	9.8%	2.9%	1.5%	3.0%	6.8%	2.6%
$(i_{US}^{10} - i_{US}^{3m})_{t-1}$	4.2%	4.2%	1.6%	1.0%	3.7%	3.5%	10.3%	0.2%	0.4%	4.8%
$(i_X^s - MRO)_{t-1}$	0.7%	5.9%	2.3%	6.9%	1.3%	4.3%	1.4%	4.1%	8.8%	1.8%
$(\pi_X - \pi_{DE})_{t-1}$	0.7%	4.6%	10.8%	11.9%	6.4%	2.1%	17.6%	3.7%	5.3%	3.4%
$r_{X\,t-1}^S$	5.3%	1.4%	1.6%	0.7%	1.2%	0.9%	0.5%	7.0%	8.7%	0.5%
r_{DEt-1}^S	1.8%	1.5%	1.4%	4.7%	4.9%	2.6%	1.3%	3.0%	5.5%	4.4%
r_{USt-1}^S	0.9%	0.5%	0.7%	1.3%	0.9%	1.4%	1.4%	2.4%	4.3%	3.9%
Low volatility regime										
$(i_X^{10} - i_{DE}^{10})_{t-1}$	35.4%	43.9%	30.5%	27.5%	12.6%	57.4%	69.3%	34.8%	31.3%	43.2%
$(i_{AAA} - i_{DE}^{10})_{t-1}$	9.4%	3.6%	1.9%	0.5%	7.6%	0.2%	2.3%	8.0%	8.0%	11.6%
$(i_{BBB} - i_{DE}^{10})_{t-1}$	5.6%	3.2%	3.5%	1.0%	5.7%	0.4%	4.6%	3.4%	3.9%	12.5%
$(i_X^{10} - i_X^{3m})_{t-1}$	18.9%	15.6%	20.3%	31.8%	27.9%	8.2%	2.2%	15.0%	15.2%	9.7%
$(i_{DE}^{10} - i_{DE}^{3m})_{t-1}$	19.1%	17.9%	16.2%	29.8%	30.7%	6.1%	2.2%	12.7%	13.3%	13.2%
$(i_{US}^{10} - i_{US}^{3m})_{t-1}$	0.8%	3.4%	5.4%	1.6%	2.7%	15.7%	5.4%	3.0%	2.4%	1.3%
$(i_X^s - MRO)_{t-1}$	1.7%	3.7%	1.4%	0.3%	0.1%	1.2%	0.4%	4.3%	9.5%	1.8%
$(\pi_X - \pi_{DE})_{t-1}$	1.7%	1.5%	4.1%	2.6%	0.3%	2.8%	0.9%	1.3%	2.0%	1.4%
$r_{X\,t-1}^S$	2.3%	2.2%	9.7%	2.4%	5.4%	2.9%	4.5%	3.5%	3.2%	1.3%
r_{DEt-1}^S	2.6%	2.9%	6.0%	1.5%	3.2%	3.2%	4.7%	8.6%	7.0%	2.9%
r_{USt-1}^S	1.8%	1.9%	1.0%	1.0%	3.9%	1.9%	3.3%	5.4%	4.3%	1.0%

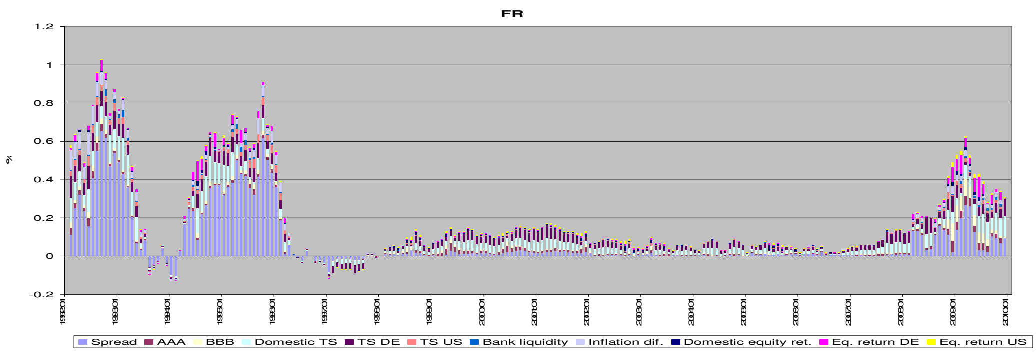
Panel B: Decomposition of the spreads to their determinants











Panel B (continued): Decomposition of the spreads to their determinants