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Have the determinants of the sovereign spreads changed from 1993 until 2014? A panel data analysis for the Eurozone

¿Han cambiado los factores determinantes de la prima de riesgo desde 1993 a 2014? Estudio de la zona Euro con datos de panel

ALVAREZ-FERNÁNDEZ, Silvia M.[1]
ALVAREZ-GARCÍA, Begoña[2]
BOEDO-VILABELLA, Lucía[3]
MOURELLE ESPASANDÍN, Estefanía[4]

Abstract
This paper explores the determining factors of the Eurozone sovereign yields and the manner they have changed over the last twenty years. In this time period, ranging from 1993 to 2014, the Euro area has gone through different phases and economic cycles that we divide into: EMU antecedents (1993-1998), EMU creation (1999-2007) and debt crisis (2008-2014). Using a panel data approach, we observe that the different sovereign risk drivers change over time and the market does not act rationally.
Key words: risk premium, sovereign debt, Eurozone government bonds, panel analysis

Resumen
Este artículo analiza cuáles han sido los factores determinantes de la evolución de la prima de riesgo de la Eurozona desde 1993 hasta 2014. A lo largo de ese período, la zona Euro ha pasado por diversas fases y ciclos económicos que se pueden estructurar en: antecedentes UEM (1993-1998), creación UEM (1997-2007) y crisis de la deuda hasta su estabilización (2008-2014). Con la ayuda de datos de panel, se ha podido observar cómo cambiaron esos factores determinantes con el tiempo y la reacción del mercado.
Palabras clave: prima de riesgo, deuda soberana, bonos públicos de la Eurozona, datos de panel

1. Introduction

Sovereign bonds risk premium has become a basic indicator of the solvency and financial stability of a country or, from another point of view, a measure of the crisis' severity and extent (Afonso *et al*., 2015). Governments, analysts, investors and even general public are aware of its value and evolution. There are also numerous studies

[1] Investigadora de la Facultad de Economía y Empresa de la Universidad de A Coruña. silvia.m.alvarez.fernandez@udc.es
[2] Profesora del Departamento de Empresa, área de Economía y Empresa, de la Universidad de A Coruña. Doctora Europea en Economía. balvarez@udc.es
[3] Profesora del Departamento de Empresa, área de Economía y Empresa, de la Universidad de A Coruña. Doctora en Economía. lboedo@udc.es
[4] Profesora del Departamento de Economía, área de Economía Aplicada, de la Universidad de A Coruña. Doctora en Economía. emourelle@udc.es

on Euro area risk premium determinants (Manganelli and Wolswijk, 2009; Haugh, Ollivaud, and Turner, 2009; Aßmann and Boysen-Hogrefee, 2012). These works focus on identifying which factors and variables play a key role on sovereign bond yields. Some other papers have focused on knowing how these factors have changed over time taken different periods. Thus, on the pre-Economic and Monetary Union (pre-EMU) period (Codogno, Favero, and Missale, 2003; Bernoth, Von Hagen, and Schuknecht 2004; Gómez-Puig, 2005), others on the post-EMU period (Manganelli and Wolswijk, 2009; Alessandrini *et al*., 2012; Afonso and Nunes, 2015; Afonso *et al*., 2015), and others have looked at the crisis (Barrios *et al*., 2009; Cáceres, Guzzo, and Segoviano, 2010; Arce, Mayordomo, and Peña, 2011; Giordano, Linciano, and Soccorso, 2012).

The papers covering the pre-crisis period focus more on the variables related to economic growth, credit risk and risk aversion (Codogno, Favero, and Missale, 2003, Bernorth, Von Hagen, and Schuknecht, 2004), while the ones covering the crisis show that global risk, liquidity risk and the macro-imbalances of the countries are more penalized in comparison with the pre-crisis period (Afonso *et al*., 2015). More recent papers seek to develop comprehensive approaches by taking into account larger periods of time related to different economic contexts and more explanatory variables, as Afonso, Arghyrou, and Kontonikas (2014) use samples from 1999 to 2010 and Gómez-Puig, Sosvilla-Rivera, and Ramos-Herrera (2014) from 1999 to 2012.

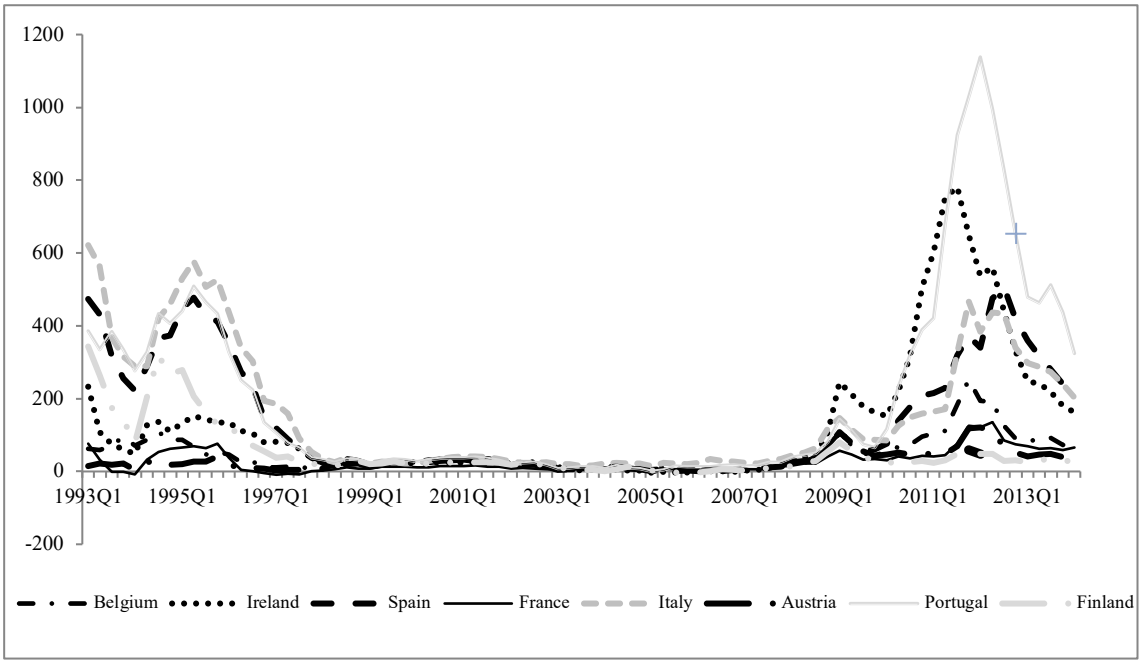
From 1993 to 2014, the European Union (EU) has gone through different phases in its integration and through different economic cycles as well, where three sub-periods can be distinguished. The first one, 1993-1998, corresponds to the years before the creation of the EMU. It is a phase of transition in which countries needed to make great adjustments in their economies and policies. In the second one, from 1999 to 2007, the EU economies achieved a greater level of integration. It was a phase of general economic growth that was interrupted at the end of the period. The final sub-period, from 2008 to 2014, is characterized by a major economic and financial crisis as well as the onset of the recovery.

This research aims to analyze how the drivers of the risk premium have varied over time (by referring to the different sub-periods indicated) and geographically (by taking into account two kind of countries of the Eurozone, some more developed or economically stronger and some less developed). This is why this paper covers the period 1993-2004 and takes into account 8 countries of the Eurozone (4 countries economically stronger, where the risk premium has varied little, and 4 countries less developed or peripheral, where the risk premium has suffered more fluctuations). The first 4 countries will be called “core countries or economies” and the last 4 countries will be called “peripheral countries or economies”.

1.1. Risk premium evolution

The Maastricht convergence criteria (1992) imposed quantitative limits on some macroeconomic variables that were considered crucial for a real and sustainable convergence: inflation stability, exchange rate stability, convergence of interest rates, budgetary deficit and public debt. These criteria have determined the evolution of the risk premium, especially during the first period, being the risk premium defined as the difference between the ten-year bond yield of each country and the ten-year German bond yield (Alessandrini *et al.*, 2012). Figure 1 depicts the behavior of this variable along the period under consideration for four countries considered as “core economies” (Austria, Belgium, Finland, and France) and for countries considered as “peripheral economies” (Ireland, Italy, Portugal, and Spain).

Figure 1
Risk premium evolution for eight European countries from 1993 to 2014
(own elaboration from the European Central Bank database)



Between 1993 and 1998, countries carried out structural reforms in order to observe these rules. Initially, capital requirements notably increased and countries achieved important deficits. This caused an increase in sovereign-debt price of the European countries and the subsequent increase in their risk premium (Codogno, Favero, and Missale, 2003). This process of adjustment lasted until the beginning of 1995. As the decade progressed, the different countries improved their parameters and their sovereign bonds spread over Germany began to decrease. This was primarily due to the opening of trade barriers in the second half of the decade, which allowed an improvement of the current-account balance in most European countries. Another causal factor was the utilization of the monetary and exchange policies which were still decided nationally (Barrios *et al*., 2009). During this first sub-period, risk premium was determined by the expectations concerning the possibility for each country of reaching the initial objectives in function of its domestic characteristics. Since investors assumed an effective future homogenization of economies and the arrival of a period of growth and stability in the entire region, a generalized risk premium decrease was granted during the second half of the nineties.

The second phase (1999-2007) constitutes a period of integration of the different countries in the EMU. It started with the irrevocable fixing of the conversion rates of the currencies of the eleven member states initially participating and with the introduction of the euro as the single currency (Manganelli and Wolswijk, 2009). During this second period, the perception of homogenization continued (Barrios *et al*., 2009). The risk perceived for all countries was the same, since they will finally become similar in most of its parameters (Codogno, Favero, and Missale, 2003). Restrictions in monetary policies contributed to increasing the confidence of achieving this integration. The public bonds of different countries were considered as almost interchangeable and risk premiums took null values and even negative values in some years and for some countries. Throughout this period, international factors were the relevant ones, relegating to a second place the economic fundamentals of each country (Bernoth, Von Hagen, and Schuknecht, 2004; Manganelli and Wolswijk, 2009). Indeed, the data of each country relative to current-account balance, deficit and debt level showed that convergence was not that strong, but this was justified as a logical consequence of the adaptation process (Bernoth, Von Hagen, and

Schuknecht, 2004). During this period of growth, the same monetary policy was implemented for the Euro area, with divergent consequences depending on the country. In most of them this policy allowed an expansion of public expenditure, a high private consumption and fed the development of speculative processes (Barrios *et al*. 2009). The financial deregulation process that was taking place at international level allowed a blurring of severe financial imbalance between countries and contributed to sustaining the perception of continuity of good economic times (Bernoth, Von Hagen, and Schuknecht, 2004; Barrios *et al*., 2009). The market did not make the pertinent and gradual risk correction for each country.

In September 2008, the bankruptcy of Lehman Brothers raised the alarm. A cross-border contagion occurred and sovereign spreads in Europe began to increase (Cutrini and Galeazzi, 2015). A period of volatility and risk premium began, caused not only by the economic and financial situation of each country, but by other aspects like speculative movements, the rating agencies decisions, the depreciation of the euro, the consideration of German bonds as safe assets or the necessity of some important countries to request a financial rescue from the EU.

1.2. Risk premium determinants: theoretical factors and measurement variables

Based on the sovereign-risk literature (Barrios *et al.*, 2009; Aßmann and Boysen-Hogrefee, 2012; Arghyrou and Kontonikas, 2012; Afonso *et al*., 2015) the changes in the Eurozone risk premium may be mainly explained by factors such as credit risk, liquidity risk, risk aversion, economic growth, other macroeconomic variables and contingent factors.

The first theoretical factor considered is credit risk. It reflects the domestic variables affecting an economy´s capacity to meet its debt obligations. Foremost among these variables are: public deficit, sovereign debt and current account balance, all of them in ratio to GDP (Arghyrou and Kontonikas, 2012; Di Cesare *et al*., 2012; Maltritz, 2012; Afonso *et al*., 2015). The first two variables show the fiscal situation of a country and its vulnerability to the financial turbulences; the latter approximates the competitiveness of each economy. Following the reasoning of Barrios *et al*. (2009) and Arghyrou and Kontonikas (2012), data on debt, public deficit and current account deficit are expressed as divergences from German values. The higher the spread of sovereign debt vis-à-vis Germany is, the higher the bond yield spread will be. The opposite is true for public deficit and current account balance.

The second theoretical factor is liquidity risk. This factor is directly related to the degree of liquidity of each country´s debt, understood as its greater ease of opting out of a debt position in the different markets (Gómez-Puig, 2005; Manganelli and Wolswijk, 2009). An increase in liquidity-premium spread implies a reduction in risk premium spread. It should be noted that the argument for liquidity as a key determinant of risk is discordant among authors. Whereas Gómez-Puig (2005) and Manganelli and Wolswijk (2009) underline the important effect of this variable, other researchers like Codogno Favero, and Missale (2003), Bernoth, Von Hagen, and Schuknecht (2004) or Arghyrou and Kontonikas (2012) question its influence and even warn of a high degree of co-linearity between liquidity measures and global risk factor. A valid measurement for liquidity risk is the relative size of a country´s debt (Maltritz, 2012). In this vein, the ratio between the outstanding market domestic debt securities and the total outstanding debt securities in the EMU can be used as a proxy of the relative size of a country's debt (e.g. Bernoth, Von Hagen, and Schuknecht 2004; Gómez-Puig, 2005; Manganelli and Wolswijk, 2009, and Attinasi, Checherita, and Nickel, 2009).

The third theoretical factor is risk aversion. It indicates the greater or lesser predisposition of an investor to take on risk (Attinasi, Checherita, and Nickel, 2009; Barrios *et al.*, 2009; Sgherri and Zoli, 2009; Arghyrou and Kontonikas, 2012). Investors can change their expectations depending on the volatility of the global market

portfolio and the risk-tolerance of marginal investors (Favero, Pagano, and Von Thadden, 2005). Preference for risk is higher when stability floods the markets, whereas at times of uncertainty portfolios are restructured towards low-risk assets. The most commonly used indicator in literature to measure the global risk is the Chicago Board Options Exchange Market Volatility Index or VIX index. This index is a measure of the implied volatility of S&P 500 index options, over the next 30-day period. For this reason, VIX index is an approximation of global financial instability and international risk aversion (Remolona, Scatigna, and Wu, 2007). Other risk aversion measurements proposed in the literature (Barrios *et al*., 2009; Gerlach, Schulz, and Wolff, 2010; Favero and Missale, 2012) are: 1) the difference between the yield of ten-year corporate US AAA bonds and the yield of US government bonds for the same maturity (an increase in this difference involves a perception of the corporate bonds as more risky and the government ones as more secure, indicating a greater risk aversion of investors), 2) short-term interest rate level (a low value of this rate increases incentive to take on risk with the objective of obtaining a higher profitability), and 3) the volatility of the euro/yen exchange rate (an appreciation of the yen, and the subsequent weakness of the euro, is interpreted as a greater risk aversion in the market).

The fourth factor is the economic growth. The traditional indicator for economic growth is GDP growth rate (Arghyrou and Kontonikas, 2012; Di Cesare *et al.*, 2012; Maltritz, 2012). Another illustrative measurement is the Industrial Production Index (IPI), which measures the monthly evolution of the production activities: extractive industries, manufacturing industries, production and distribution of electrical energy, and water and gas industries. The IPI can be used as a measure of the production cycle (Arghyrou and Kontonikas, 2012). There is a negative relationship between these two variables (GDP and IPI growth rates) and the risk premium, and a positive relationship between the difference from the German values and the risk premium.

As macroeconomic factors it is possible to include the domestic factors that might affect the capacity of a country to meet its financial obligations due to its economic internal situation, such as an increase in inflation or unemployment (Barrios *et al*., 2009; García-Vaquero and Casado, 2011; Alenssandrini *et al*., 2012; Maltritz, 2012). An economy not providing employment or having an inflation rate that increases over time and not offering signs of prosperity will be unsustainable and will contribute to an increasing risk premium. Domestic factors are more important in periods of financial stress because in those moments investors increase discrimination between economies (Barrios *et al*., 2009). For this reason, during the last debt crisis, the deterioration of the macroeconomic framework was accompanied by a risk premium increase, especially in those economies with worse macroeconomic outlook, as the peripheral countries (García-Vaquero and Casado, 2011).

Finally, we consider the contingent factors of the analyzed period. We refer to those particular circumstances or contingencies that only have sense at a given time and in specific economic conditions (Favero, Giavazzi, and Spaventa, 1996; De Santis, 2012). The difficulties of the Greece´s economy can be considered as a contingent factor. The inadequacy of Greece to contain the rising risk premium exposes the Eurozone to a crisis of confidence and to greater turbulences. This fact had a negative effect on the sovereign spreads of the entire EMU.

It should be highlighted that some variables, as debt to GDP, deficit to GDP and GDP growth appear in all previous investigations; consequently, it can be said that credit risk and economic growth are fundamental factors to study the sovereign bond yields. Risk aversion is incorporated in nearly all studies, although each researcher uses different variables to measure this factor. For example, Gerlach, Schulz, and Wolff (2010) just consider the spread of seven to ten-year US corporate bond and the US BBB treasuries bonds; Favero and Missale (2012) use the spread between the ten-year yield of US BAA corporate bonds and ten-year US AAA corporate bonds; and Borgy *et al*. (2011) only take into account the log of the VIX Index. Liquidity risk is also an important factor. Several variables like the yield bid/ask spreads or the total amount of outstanding bonds (Gerlach, Schulz, and Wolff,

2010) are used as proxies of this factor. However, there are authors, as Remolona, Scatigna, and Wu (2007), Bernoth and Erdogan (2012), or Alessandrini *et al*. (2012), who do not take into consideration the liquidity risk. Macroeconomic variables are also important to many authors; some of them, as is the case of Maltriz (2012), only use the inflation, while others like Alessandrini *et al*. (2012) incorporate inflation and labor productivity growth. Finally, there are some researchers that use different contingent factors like, for example, the years from last default (Remolona, Scatigna, and Wu, 2007) or some dummies for crises (Alessandrini *et al*., 2012).

With the aim of making a more comprehensive analysis, we carry out a theoretical and empirical analysis of the factors that influence public debt yield in the Euro area over the period 1993-2014 for eight countries, four "core countries" and four "peripheral countries". This research takes into account this whole period and both the different variables and determining factors identified as important in the literature covering both the pre-crisis and the post-crisis periods. This comprehensive analysis, based on panel data techniques, enables us to make comparisons, draw more enlightening conclusions, and approach the risk premium from two perspectives: first, we can analyze its evolution before the worst years of the financial crisis, when the risk premium became a widespread topic and, second, we can study how its determining factors have evolved over time.

2. Methodology

2.1. Context of application and data

In order to analyze how the drivers of the risk premium have varied over time and geographically, eight EMU countries are included in this study: Austria, Belgium, Finland, France, Ireland, Italy, Portugal, and Spain. The first four countries are core economies. They are more solvent and economically stable. Likewise, their risk premiums have remained in lower average values over the period 1993-2014 and with fewer oscillations than those of the other four countries . The last four countries are peripheral economies. They are considered less developed economies and have registered a greater average risk premium over the period considered. In this group, all countries except Italy have required financial rescue from EU. Greece, the first country to have applied for assistance, has not been deliberately included in the study because its exceptional circumstances would have distorted the overall results. Germany is not directly included because is the country which serves as a reference for assessing risk premium and the other variables under consideration, and the other two countries among the first EMU founding fathers (Luxembourg and Netherlands) have not been included to maintain a proper balance between core and peripheral countries. The number of countries studied is in line with other previous works (e.g. Barrios *et al*., 2009, Gómez-Puig, Sosvilla-Rivera, and Ramos-Herrera, 2014). It should be noted that the differences in the risk premium between the core and peripheral countries included in this research have remained after 2014, and have even increased further since mid-2018.

Concerning the factors that explain the changes in the Eurozone risk premium, it should be noted that all the ones that have been presented in section 1.2 are considered in this research. We present below how these factors are incorporated and the definition of each proxy variable. These variables, homogenized in a quarterly basis, are summarized in table 1.

Table 1
Definitions of the variables

Endogenous variable	Risk premium	Difference between the yield of the 10-year sovereign bonds of a country and the German value	ECB database
F1 Credit risk	Sovereign debt	Difference between the public debt (in proportion to GDP) of a country and the German value	Eurostat database Reinhart and Rogoff (2014)
	Current account balance	Difference between the current account balance (in proportion to GDP) of each country and the German value	Eurostat database Author's own estimations
	Public deficit	Difference between the estimated public deficit (in proportion to GDP) of each country and the German value	Eurostat database IMF-WEO database National Central Banks and Statistical Offices
F2 Liquidity risk	Liquidity premium	Difference between the domestic debt securities outstanding (in relation to the total outstanding debt securities in the EMU) and the German value	ECB database
F3 Risk aversion	VIX index (Risk aversion)	Logarithm of the VIX index	Chicago Board Options Exchange database
	Difference between the yield of the private and public bonds	Logarithm of the difference between the 10-year yield of US AAA corporate bonds and the US government bonds for the same maturity	Federal Reserve
	Short-term interest rate	Logarithm of the money market interest rates	Eurostat database
	Euro-Yen exchange rate	Logarithm of the Euro-Yen exchange rate	National Statistics Institute Website"tematicas.org"
F4 Economic growth	GDP	Difference between the GPD growth rate of each country and the German value	OECD database
	Industrial Production Index	Difference between the Industrial Production Index growth rate of a country and the German value	Eurostat database
F5 Macroeconomic factors	Unemployment	Differential of the unemployment rate and the German value	Eurostat database OECD database
	Inflation	Difference between the inflation rate of a country and the German value (based on Harmonized Indexes of Consumer Prices)	Eurostat database OECD database National Statistical Offices
F6 Contingent factors	Greek risk premium	Difference between the 10-year Greek sovereign bonds and the German value	ECB database

2.2. The proposed model

The analysis has been carried out on the basis of panel data methodology, for a better group result. Panel data techniques are used with "N" cross-sectional data (in our case, the eight countries) along a "T" time period (the quarters ranging from 1993Q1 to 2014Q1). The resulting model has the following expression:

$$y_{it} = \alpha_i + \beta x_{it} + u_{it}\,, \qquad i=1,..,N, \quad t=1,...,T, \qquad (1)$$

where subscript *i* denotes the cross-sectional unit (in our case, country) and *t* denotes the period (in our case, quarter). The dependent variable (y_{it}) is a measure of risk premium for country *i* in quarter *t*; x_{it} is a 1 x *k* vector of explanatory variables observed for country *i* in period *t* that reflects the measures of the different theoretical determinants of the risk premium explained and defined in section 3; β is a *k* x 1 vector of parameters; α_i is a country-specific and time-invariant component; and u_t is the error term. The data set is balanced.

In this work, we account for the possibility that the current behavior of the risk premium could be determined, to a lower or a larger extent, by its own recent history. Then, equation (1) transforms into:

$$y_{it} = \varphi y_{i,t-1} + \beta x_{it} + \alpha_i + \varepsilon_{it} , \qquad (2)$$

where ε_{it} is the idiosyncratic error term.

Nevertheless, an endogeneity problem arises because the regressors and the error term are correlated. In order to overcome this situation, regression model (2) has been estimated by means of instrumental variables, as primarily proposed by Anderson and Hsiao (1981). These authors used a version of the two-stage least-squares first-differenced estimator in order to fit a panel data specification that includes the lagged dependent variable as a regressor.

The Anderson and Hsiao (1981) solution is to first-differentiate equation (1) in order to eliminate the individual effects:

$$\Delta y_{it} = \varphi \Delta y_{i,t-1} + \Delta\beta x_{it} + \eta_{it} , \qquad (3)$$

where $\Delta x_{it}=x_{it}- x_{i,t-1}$, and to substitute the difference of the lagged dependent variable with an POR instrumental variable that is not correlated with the error term. Two types of valid instruments are the lags of $y_{i,t-1}$ and those of $\Delta y_{i,t-1}$ (Anderson and Hsiao, 1981; Castellanos, 2010); in addition, if the regressors are assumed to be exogenous, they are their own instruments (Ciocchini, 2006). Following Roodman (2009), we consider a smaller number of instruments than the number of individual units (in our case, countries).

We consider the same model structure, in general terms, for the whole sample and for each of the three mentioned sub-periods; it takes the following form:

$$\begin{aligned} RP_{it} = {} & \alpha_i + \beta_1 \cdot RP_{i,t-1} + \beta_2 \cdot F1_{it}\,(credit\ risk) + \beta_3 \cdot F2_{it}\,(liquidity\ risk) + \\ & + \beta_4 \cdot F3_{it}\,(risk\ aversion) + \beta_5 \cdot F4_{it}\,(economic\ growth) + \\ & + \beta_6 \cdot F5_{it}\,(macroeconomic\ factors) + \beta_7 \cdot F6_{it}\,(contingent\ factors) + \varepsilon_{it} \end{aligned} \qquad (4)$$

In equation (4), RP_{it} denotes the risk premium, notations $F1_{it}$, $F2_{it}$, …, $F6_{it}$ refer to its different theoretical determining factors and ε_{it} denotes the error term. As it has been described in section 1.2, for almost all the theoretical determinants of the risk premium, we can find more than one suitable measurement variable.

The procedure we use so as to determine the factors influencing the risk premium in each sub-period is the use of dummy variables. In particular, we consider one for representing the time period 1999-2007 (D9907) and another for 2008-2014 (D0814); these dummies take value 1 in the corresponding years and 0 otherwise. Accounting for these dummies, the effect of each regressor in equation (1), named vector , would be decomposed as follows (Gómez-Puig, Sosvilla-Rivera, and Ramos-Herrera, 2014):

$$\beta = \beta_1 + \beta_2 D_{9907} + \beta_3 D_{0814} \qquad (5)$$

As a result, we can obtain the marginal effect of the variables (in each sub-period) by following the rule:

$$\beta = \beta_1 \text{ in } 1993\text{-}1998$$
$$\beta = \beta_1 + \beta_2 \text{ in } 1999\text{-}2007$$
$$\beta = \beta_1 + \beta_3 \text{ in } 2008\text{-}2014 \qquad (6)$$

In short, at a first stage we carried out an estimation for the whole period 1993-2014; after that, we estimated the model that includes dummies so as to find out potential different factors in each sub-period. These estimations incorporate all the variables considered in table 1.

3. Results

We carried out a two-stage-least-squares estimation, according to the model framework described in subsection 2.2. We presumed fixed effects in the estimation process regarding the small number of units in the panel. The resulting models are displayed in table 2. According to the panel model with instrumental variables method we used, variables are in first differences. The second column reflects the estimation for the entire sample period, while the third column refers to the model that incorporates dummies to identify the three sub-periods we considered.

Table 2
Panel data estimation

	Model without dummies	Model with dummies
Constant	0.2006	-8.9635**
Dummy 9907	-	9.3421*
Dummy 0814	-	9.6393*
AR (1)	0.3788***	0.3563***
Sovereign debt	-0.7506	-0.4971
Sovereign debt×D_{9907}	-	-0.0481
Sovereign debt×D_{0814}	-	0.0023
Current account balance	0.5235	0.5140
Current account balance×D_{9907}	-	-0.5906
Current account balance×D_{0814}	-	0.5603
Public deficit	-0.0593	0.2343
Public deficit×D_{9907}	-	-0.3040
Public deficit×D_{0814}	-	-0.6474
Liquidity premium	2.6646	3.3293
Liquidity premium×D_{9907}	-	-0.0214
Liquidity premium×D_{0814}	-	-0.3482
VIX index	19.8265***	8.3775
VIX index×D_{9907}	-	-6.8970
VIX index×D_{0814}	-	30.4338*
US bond	-2.1494	28.8092
US bond×D_{9907}	-	-23.1515
US bond×D_{0814}	-	-11.2563
Short-term interest rate	32.2061***	117.7670**

	Model without dummies	Model with dummies
Short-term interest rate×D_{9907}	-	-119.1460**
Short-term interest rate×D_{0814}	-	-87.6811*
Euro-Yen exchange rate	-60.6034**	-39.0515
Euro-Yen exchange rate×D_{9907}	-	37.3775**
Euro-Yen exchange rate×D_{0814}	-	6.9005
GDP growth	0.9181	2.1498
GDP×D_{9907}	-	-1.9067
GDP×D_{0814}	-	-1.3815
IPI growth	0.6530*	0.7294
IPI×D_{9907}	-	-0.5914
IPI×D_{0814}	-	-0.4954
Unemployment	13.4667	6.1062
Unemployment×D_{9907}	-	-0.2540
Unemployment×D_{0814}	-	10.2183*
Inflation	3.7603	12.8004**
Inflation×D_{9907}	-	-11.9149*
Inflation×D_{0814}	-	-8.4829
Greek risk premium	0.0409***	-0.0332
Greek risk premium×D_{9907}	-	0.0156
Greek risk premium×D_{0814}	-	0.0790**
R^2	0.40	0.45
$\bar{R}^2$	0.39	0.41
Number observations	624	623

Significance level: 10% (*), 5% (**) and 1% (***). The number of instruments used is seven (combination of lags for $y_{i,t-1}$ and for $\Delta y_{i,t-1}$).

Table 2 incorporates all the possible risk premium determinants under study, as well as the dummy variables for each sub-period and a measure of the (absolute and relative) goodness-of-fit of the estimated model. The second column reflects the influence of each factor on the risk premium considering the entire sample; the third column refers to the influence in the different sub-periods. Regarding the third column, the first coefficient for each factor corresponds to β1 in equation (5), the second coefficient denotes β2*D9907 and the third coefficient is β3*D0814, so as to identify the different sub-periods. As it is appreciated, the specification with dummies shows a better goodness of fit in comparison with the one that does not differentiate the sub-periods. In addition, the dummies themselves (the terms without interactions) prove to be significant. Therefore, the consideration of different phases provides relevant information to the analysis.

For a better understanding of the results from an economic point of view, we derived the marginal effects of each factor from table 2; they denote the impact of the different variables on the behavior of the risk premium depending on the time period. According to the rule captured in (6), we calculated these marginal coefficients and displayed them in table 3, joint with the coefficients for the entire period (i. e., without dummies); the comparison of whole and marginal effects allowed us to identify potential differences in the risk premium determinants linked to the moment they take place.

Table 3
Model summary

	1993-2014	1993-1998	1999-2007 *(Marginal effects)*	2008-2014
Constant	0.2006	-8.9635**	-8.9635**	-8.9635**
Dummy 9907	-	-	9.3421(*)	-
Dummy 0814	-	-	-	9.6393 (*)
AR (1)	0.3788***	0.3563***	0.3563(***)	0.3563(***)
Sovereign debt	-0.7506	-0.4971	-0.5453	-0.4948
Current account balance	0.5235	0.5140	-0.0766	1.0743
Public deficit	-0.0593	0.2343	-0.0697	-0.4131
Liquidity premium	2.6646	3.3293	3.3080	2.9811
VIX index	19.8265***	8.3775	1.4805	38.8113 (*)
US bond	-2.1494	28.8092	5.6577	17.5529
Short-term interest rate	32.2061***	117.7670**	-1.3790 (**)	30.0859 (*)
Euro-Yen exchange rate	-60.6034**	-39.0515	-1.6740 (**)	-32.1510
GDP growth	0.9181	2.1498	0.2431	0.7683
IPI growth	0.6530*	0.7294	0.1379	0.2340
Unemployment	13.4667	6.1062	5.8522	16.3245(*)
Inflation	3.7603	12.8004**	0.8855 (*)	4.3175
Greek risk premium	0.0409***	-0.0332	-0.0176	0.0458 (**)
R^2	0.40		0.45	
$\overline{R^2}$	0.39		0.41	
Number observations	624		623	

Significance level: 10% (*), 5% (**) and 1% (***). Following Gómez-Puig, Sosvilla-Rivera, and Ramos-Herrera (2014), we considered a significant effect of the independent variables on the risk premium when entering 1999-2007 and 2008-2014 if β_2 and β_3, respectively, showed significance. Accordingly, we indicated the same significance level with asterisks reported in table 2 but between parentheses.

We dedicate section 4 to describe and discuss in full detail the results obtained in Tables 2 and 3.

4. Discussion

We followed a chronological order with the objective of affording an understanding of the risk premium evolution throughout the whole period considered.

Sub-period 1993-1998: EMU antecedents

After testing the model with all the variables defined in table 1, the significant variables in the period before EMU creation are: the recent history of the risk premium, the short-term interest rate and inflation (in relative terms to the German rate). Relationships between the explicative variables and the dependent one present the expected sign. According to these empirical results, the most important factors to drive the Euro area sovereign spreads would be: the recent behavior of the risk premium, risk aversion and macroeconomic factors. The short-term interest rate is the only risk aversion variable which has significant influence on risk premium in 1993-1998 and it is worth noting that this influence holds in all other sub-periods under consideration. This outcome is in line with the conclusions of Manganelli and Wolswijk (2009). Additionally, inflation is the only macroeconomic variable determining the government bond yield spread.

These results demonstrate the role played by the particular circumstances of the period previous to the EMU integration. The different countries had to make important adjustments to achieve the objectives of the Maastricht Treaty and the market valuation has been conditioned by a favorable expectation about this convergence process.

Sub-period 1999-2007: EMU integration

The key elements for understanding the risk premium spread during the second sub-period are: the recent history of risk premium, the short-term interest rate, the euro/yen exchange rate and inflation. Some determining factors are recurrent, though in this period of integration in the EMU the relationship between the new single currency and other strong currencies, such us the yen, gains importance.

Relationships between the explicative variables and the risk premium present the expected sign, except for the short-term interest rate. A fall in the short-term interest rate means lower risk aversion and reduces the risk premium. In 1999-2007, the short-term interest rate evolved in a haphazard manner: going up in 2000 and 2006-2007, and falling steadily in the period 2001-2006. Nevertheless, the risk premium had continuously decreased to very low levels, reaching negative values in 2005 in certain countries. This lack of coinciding performance between the two variables in some years is reflected with a negative sign in the estimated coefficient. Alternatively, credit risk, liquidity risk and economic growth remain without exerting significant influence on decisions about buying up government bonds.

The results of this phase, taken as a whole, confirm that the market sees the different countries as belonging to a homogeneous group; in other words, the market attributes a similar low default risk to the different economies. These are years of macroeconomic stability and growth, and the market considers that this situation is going to continue. As Cecchetti, Mohanty, and Zampolli (2011) points out it was set up the sensation that the world was a safe place and it will continue to be safe in the future.

Sub-period 2008-2014: debt crisis and start of the recovery

In the last stage of this study the significant variables are: the recent history of the risk premium, the VIX index, the short-term interest rate, the unemployment rate (in relative terms to the German rate) and the Greek risk premium. It is important mentioning that, once again, relationships between the independent variables and the dependent one present the expected sign. Like in previous periods, the recent history of the risk premium has a remarkable influence in its current values. As it might be expected, risk aversion re-appears again in the model, although in this stage the short-term interest rate is not the only variable driving the Euro area sovereign bond yields spreads. The VIX Index also becomes a key variable to explain the sharp increase in the risk premium (see Klepsch and Wollmershäuser, 2011).

In this last sub-period there is a change in the risk assessment and the investor perception also changes due to the reappearance of new doubts about the Union feasibility. There exist significant cross-country contagion effects across Euro area government bond markets, especially on peripheral countries (as pointed out by Cáceres, Guzzo, and Segoviano, 2010; Giordano, Linciano, and Soccorso, 2012; or Afonso, Arghyrou, and Kontonikas 2014). The contagion effect of the Greek risk premium is noticeable and becomes a relevant factor in the spread determination process.

The impact of macroeconomic variables also changes in this period; inflation no longer influences sovereign debt but the differential of the unemployment rate in relation to Germany becomes a determining factor to explain changes in risk premium. The behavior observed in inflation is in accordance with the conclusions of Scharnagl and Staptf (2015), who note that inflation expectations for the Euro area show a decreasing mean through the period 2009-2013. The unemployment rate increased in a considerable manner in almost all countries under study and, consequently, it become an important driver of Eurozone government bond yields.

Whole period: 1993-2014

When considering the whole period, the risk premium determinants are: the recent history of the risk premium, the VIX index, the short-term interest rate, the euro/yen exchange rate, the IPI, the unemployment rate and the Greek risk premium. Once again, relationships between the explicative variables and the dependent one present the expected sign.

These results evidence that all the variables which have been significant for explaining the risk premium in at least one of the above-mentioned sub-periods remain highly influential when looking at the twenty-one years jointly. Some of them, as the past values of the risk premium and the short-term interest rate, appear in all the sub-periods taken into account. This strong correlation between the spreads and the short-term interest rate has also been proved in previous works like Manganelli and Wolswijk (2009). Other variables, as VIX Index, unemployment and the Greek risk premium, have only become important during the debt crisis but its impact remains significant over the total period. In contrast, the IPI is a variable that does not show a particular influence when we consider the sub-periods in a separate manner, but becomes relevant when the entire period is taken into account. Finally, it should be noted that all the factors other than credit risk and liquidity risk have proved to be important in the entire period under consideration. The low influence of liquidity risk is in accordance with some previous works like Codogno, Favero, and Missale (2003) or Maltritz (2012), although other researchers like Favero, Pagano, and Von Thadden (2005), Gómez-Puig (2005) or Afonso *et al*. (2015) confirm the important role of liquidity when it interacted with an aggregate risk factor. The low influence of credit risk should not be seen as a lack of capacity of the market to discriminate the national fiscal policies, but as a prevalence of other variables.

4. Conclusions

The empirical results indicate that the formation of the EMU supposed a great institutional and economic transformation, which led to a sense of confidence and optimism. The market valuation was based on the favorable expectations of the total region as a single group. The market considered that in the (near) future economies were going to converge and, even if investors take into account internal factors, the differences among countries do not presupposed harsh penalties for those with worse values. Investors paid less attention to the domestic factors and rather focused on the recent evolution of risk premium, the short-term interest rate and inflation. This positive future expectation, as an element of market decision, increased notably during the integration phase (1999-2007), the second period of the study. These were years of macroeconomic stability and growth, and the market considered that this situation will continue.

These favorable conditions of constant growth suddenly stopped in 2008, when the bankruptcy of Lehman Brothers raised the alarm. As a consequence, risk evaluation underwent an abrupt change: the investors´ perception of risk was modified, showing doubts about the viability of the EU. The VIX index became a main driver of government bond spreads and the risk aversion factor took on additional significance. Additionally, the Hellenic spread gained influence on market decisions. Unemployment also grew sharply, particularly in peripheral economies, and it appears as a relevant macroeconomic variable.

This paper demonstrates that the market did not take the same risk factors as determinants in its valuation of the sovereign debt risk premium and that the relative importance assigned to the different factors had changed over time. This reinforces the fact, highlighted by previous studies that the market does not behave in a rational way: in periods of growth it undervalues risk, while in periods of uncertainty it overreacts. This way of acting has negative consequences for the Euro area countries and contributes to worsening the economic situation, in particular for peripheral countries.

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