Instituto Superior de Ciências do Trabalho e da Empresa

ISCTE Business School
Instituto Universitário de Lisboa

THE DETERMINANTS OF EURO ZONE GOVERNMENT CREDIT SPREADS

Carlos Alberto Alves de Jesus

Dissertation submitted as partial requirement to obtain the degree of
Master in Finance

Supervisor:
João Pedro Nunes, Professor associado,
ISCTE Business School, Finance and Accounting Department

Co-supervisor:
Luis Oliveira, Professor auxiliar,
ISCTE Business School, Finance and Accounting Department

June 2010

ABSTRACT

This paper studies the determinants of the Euro Zone government credit spreads. We analyzed the sensitivity of credit spread changes to financial and macroeconomic variables. We used the popular parameterization of the zero-coupon yield curve introduced by Nelson and Siegel (1987) in order to estimate the term structure of interest rates for seven EMU countries from January 2000 to December 2005. Sovereign credit spreads are computed from each of the countries against Germany, which was considered as the EMU benchmark. Subsequent analysis is made following Van Landschoot (2004) and Dullmann et al. (2000). Results suggest that the level of spot interest rates and the slope of the yield curve are statistically significant explanatory variables of credit spread changes, whereas other macroeconomic and market related variables present mixed conclusions. Panel data analysis shows that there is no evidence of different responses to credit spread changes across countries.

Key words: Credit spreads, Euro Zone, Nelson-Siegel.
JEL Classification: G14, G15

RESUMO

Esta tese tem por objectivo estudar quais os determinantes dos *spreads* de dívida soberana da Zona Euro. Neste sentido, foi analisada a sensibilidade dos *spreads* de crédito de dívida soberana a variações em variáveis de natureza financeira e macroeconómica. Para estimar a estrutura temporal de taxas de juro para sete países pertencentes à união económica e monetária, entre Janeiro de 2000 e Dezembro de 2005, foi usado o modelo de parametrização desenvolvido por Nelson and Siegel (1987). Os *spreads* de dívida soberana foram calculados face à dívida alemã, considerada aqui como benchmark da Zona Euro. Análise posterior respeita a metodologia seguida por Van Landschoot (2004) e Dullmann et al. (2000). Os resultados sugerem que o nível das taxas de juro *spot* e a inclinação da curva de taxas de juro são variáveis estatisticamente significativas para a explicação das variações dos *spreads* de dívida soberana, enquanto que as variáveis de natureza macroeconómica e de mercado apresentam resultados mistos. A análise de dados em painel não mostra nenhuma evidência de respostas diferentes a variações dos *spreads* de dívida soberana entre os diferentes países.

Palavras-chave: Spreads de crédito, Zona Euro, Nelson-Siegel.

Classificações do JEL: G14, G15

ACKNOWLEDGEMENTS

I dedicate this study to my family. I would like to thank my supervisors in this study, Professor João Pedro Nunes and Luis Oliveira for their orientation. A special thanks for the help provided by Professor José Dias Curto. I would also like to acknowledge Caixa Banco de Investimento for the financing and support.

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1. Introduction

The creation of a pan-European single currency zone (Euro Area), in which the currency effect has been eliminated, allows for the study of how sovereign debt prices relate within this currency union. It is especially relevant to analyze how the perceived risk premiums inside the Euro Area evolved since its creation and which are the main determinants of credit spreads. After the birth of the European single currency, markets expected sovereign risk premiums to narrow, namely in the long end of the yield curve. Investors also started to believe that with a standardization of a large Euro-denominated bond market and the elimination of country specific risk, the different government debt issues would become perfect substitutes. This would tend to eliminate liquidity risk and narrow even further sovereign credit risk.

A spread differential is usually interpreted as compensation over the riskless interest rates. If there is no currency risk, we can identify two kinds of risk: default risk and liquidity risk, which usually are very hard to analyze separately. Therefore, most studies do not distinguish between default and liquidity risk. The literature usually presents two major measures of default risk: spreads between sovereign yields and corporate yields and the difference between yields in domestic and foreign currency. Given that the US economy has the largest and most mature bond market in the world, the majority of empirical studies on the determinants of credit spreads are focused on the US bond market; see Longstaff and Schwartz (1995), Duffee (1998), Lemmen and Goodhart (1999), Collin-Dufresne, Goldstein and Martin (2001), Elton, Gruber, Agrawal and Mann (2001), and Huang and Kong (2003). The scope of empirical studies on the determinants of European credit spreads is more limited: see Van Landschoot (2001), Boss and Scheicher (2002), Van Landschoot (2004), and Bernoth, Von Hagen and Schuknecht (2004).

Various studies have analyzed the determinants of credit spread changes of corporate and sovereign debt, mainly through the use of yields-to-maturity of coupon bonds rather than from the term structure of interest rates. This paper analyzes the determinant factors of Eurozone sovereign credit spreads, which are determined against the German benchmark. All countries have the same currency and are highly interconnected in terms of trade movements, budget restrictions and other macroeconomic variables. It is therefore expectable to find similar patterns of behaviour across the different countries regarding credit spreads of euro sovereign bonds.

Prices of Eurozone government bonds from seven countries (Austria, Belgium, Spain, France, Italy, Netherlands and Portugal) ranging from 2000 to 2005 were analyzed and compared against German sovereign debt. Credit spreads were computed following the fit of yield curves for each country via the Nelson and Siegel (1987) function. Following Van Landschoot (2004), three in-sample measures are estimated in order to test how well the Nelson and Siegel (1987) model describes the underlying data. The procedures used by Dullmann et al. (2000) in order to study the shape and evolution of credit spreads were adopted. As confirmed by Dullmann et al. (2000), credit spreads and volatility are found to narrow over time and along the term structure. Changes in credit spreads are then regressed against several variables, from changes in the spot interest rate, changes in the slope of the yield curve through changes in a number of economic and market related variables.

This paper proceeds as follows. Section 2 examines the OLS methodology used and describes each of the explanatory variables and their expected sign in the regression. Section 3 describes the data which supports the study and the extraction method (Nelson and Siegel model) used to estimate each sovereign yield curve. Section 4 examines how well the Nelson and Siegel model describes the underlying data. Section 5 studies the shape and evolution of credit spreads. Section 6 presents the results of the regression analysis. Section 7 concludes.

2. Model and determinants of credit spread performance

We have related changes in credit spreads, acting as the dependent variable and computed as the difference between the sovereign yield curves of each country in analysis and the German benchmark, with a number of independent variables. Therefore, for each country *j* at date *t* the following regression is estimated:

$$\Delta CS_{j,t} = \alpha + \beta\theta_{j,t} + \varepsilon_{j,t} \qquad (1)$$

where $\Delta CS_{j,t}$ is the change to the previous month of the credit spread against the German benchmark for country *j* at date *t*, $\theta_{j,t}$ is a k-vector of explanatory variables and $\beta = (\beta_1, ..., \beta_k)'$. The constant α represents the EMU common market level of default risk. It is assumed that the explanatory variables influence the country default risk measure in a similar way, implying that the reaction coefficients are the same for all countries. The $\varepsilon_{j,t}$ are the error terms of the $j = 1,2,...,7$ countries for the $t = 1,2,...,T$ periods.

We analyzed the factors that could be expected to influence the behaviour of credit spreads, following the structural model approach. These models are build on the contributions of Black and Scholes (1974), Merton (1974), Black and Cox (1976), Leland (1994), Longstaff and Schwartz (1995), Bryis and Varenne (1997) and Collin-Dufresne et al. (2001). Under this approach, the process for the asset value follows an assumed path and default happens when the asset value falls below a benchmark. Structural models of sovereign default started with Kulatilaka and Marcus (1987) and later contributions from Gibson and Sundaresan (1999) and Westphalen (2001). Structural models of sovereign default propose a number of factors that could explain changes in spreads of sovereign bonds, i.e. changes in the spot interest rate, changes in the slope of the yield curve and changes in economic variables.

We investigate a set of factors, displayed in Table 1, in order to explain changes in credit spreads against the German benchmark.

(Insert Table 1 about here)

Next, the explanatory variables of credit spreads movements are described, their expected sign in the regression is presented along with the reason for their inclusion in the study.

2.1 Level of spot interest rates

Under equation (2), the level of spot interest rates is defined as $\beta_0 + \beta_1$. Other proxies of level of spot interest rates include both short and long-term risk free interest rates (generally in the 3-month or 10-year maturities).

Longstaff and Schwartz (1995) described a negative relation between changes in spot interest rates and changes in credit spreads, a dynamic confirmed by Duffee (1996) and Duffee (1998) for the US market. An increase in spot interest rates increases the drift of the risk neutral process for the total value of the assets of a firm, making the risk neutral probability of default, and credit spreads, lower (see Longstaff and Schwartz (1995)). Duffee (1996) uses the business cycle story to explain this negative relation, given that when spot interest rates rise the economy is expanding and the probability of default narrows. Thus, a negative sign is expected for the θ_1 coefficient of Table 1 in the regression results.

The relationship between changes of credit spreads and changes in the risk-free term structure is investigated through proxies that, as Duffee (1996) mentioned, summarize the information contained in the latter. Litterman and Scheinkman (1991) and Chen and Scott (1993) show that a significant part of the changes in the risk-free term structure can be explained by changes in the level and the slope.

2.2 Slope of the yield curve

Under equation (2), the slope of the yield curve is defined as $-\beta_1$. Another proxy of the slope of the yield curve is the difference between the long and short ends of the yield curve.

We can relate changes in the slope of the yield curve and changes in credit spreads with the business cycle. When the slope decreases we can expect a weakening economic performance going forward. On the other hand, when the opposite occurs (increase of the slope) one can expect an improvement of economic conditions, resulting in an also improved scenario for the growth rate of corporations and a decrease in their default probabilities. Estrella and Hardouvelis (1991), Estrella and Mishkin (1995) and Bernard and Gerlach (1998) refer the importance of the slope of the yield curve in assessing future economic performance.

As in the case of the level of spot interest rates, a negative relation is expected between the slope and credit spreads.

2.3 Hump of the yield curve

Under equation (2), the hump (curvature) of the yield curve is defined as β_2. There is no indication of the expected sign of the coefficient, leading to a fall or rise in credit spreads given an increase or decrease in the hump of the yield curve. Collin-Dufresne et al. (2001) described the influence of the square yield of the 10-year government bonds (used as a proxy for the convexity of the term structure), where an increase in the yield has a negative effect on the credit spreads of short maturity bonds and a positive effect on long maturities. We expect the same relationship.

2.4 GDP growth

One can relate the link between changes in gross domestic product in each of the countries and changes in credit spreads using the argument explained in introducing the level and slope of the yield curve earlier. In this sense it should be redundant in an *a priori* reasoning to include this variable in the equation, as the effect of an increase or decrease in the wealth created in each of the countries in the analysis is already present in both the level and slope variables. Albeit this rationale, the variable is included in order to assess its effect on credit spread changes. It is expected a negative relationship between changes in GDP and credit spreads.

2.5 External balance

An increase of a surplus position in the external balance indicates an increase of wealth created in each country as exports surpass imports. An increase of a deficit position has the opposite effect. Thus, the sign expected for this variable in the regression depends on the original state of the external balance position.

2.6 Consumer Price Index

Generally, an increase in the level of consumer prices (CPI) is an indication of an expanding economy, where the creation of wealth is visible through an increase of consumption that feeds the rise in consumer prices and in corporate profitability (at least in an initial stage, as later on the costs of production inputs will also rise). This effect can also be perceived in the level of spot interest rates variable. To capture the evolution of prices in each country, we use monthly changes of the Harmonized Index of Consumer Prices (2005=100) provided by Eurostat. A negative relation between increases in consumer prices and credit spreads is thus expected.

2.7 Budget deficit

An increase of the budget deficit decreases the ability of each government to use fiscal policy in order to stimulate the economy if necessary and is the sign of deterioration in public accounts. An expansion of the budget deficit is expected to produce an increase in credit spreads.

2.8 Level of government debt

As in the case of the budget deficit, an increase of the debt stock in each country reduces the flexibility of each government to borrow in the future in order to invest. It increases the amount of taxes collected used to pay interests and capital and decreases the amount available to invest and produce wealth. Consequently, an increase in credit spreads is expected to follow a rise in the level of government debt.

2.9 Unemployment rate

A rising unemployment rate signals a worsening economy and should anticipate a decrease in GDP, as consumers refrain from spending in response to a decrease in available income. A positive relationship between changes in the unemployment rate and credit spreads is expected.

2.10 Equity market return (Euro Stoxx)

Positive returns in the equity market, using the Dow Jones Euro Stoxx 50 index[1] as the benchmark, reflect positive corporate fundamentals and an overall wealthier economy. Hence, we expect a negative correlation between the market returns and credit spreads.

2.11 Equity market volatility (Euro Stoxx)

The proxy used for measuring changes in equity volatility is the first differences of implied average volatilities of at-the-money options traded on Eurex with the DJ Eurostoxx 50 index as the underlying asset and reflected by the Dow Jones Euro Stoxx 50 Volatility Index (VSTOXX)[2]. A rise in volatility increases the probability of default in each country, leading to an increase in credit spreads.

2.12 European Commission Business Climate Indicator

This indicator is based on monthly business surveys and is designed to deliver a clear and timely assessment of the cyclical situation within the Euro Area. Its movement is linked to the industrial production of the Euro Area. This should act as a proxy for GDP performance, which means that it should have similar consequences in what concerns credit spreads. We expect a negative sign for this variable.

2.13 ZEW

The ZEW index reflects the difference between the share of analysts that are optimistic and the share of analysts that are pessimistic for the expected economic development in Germany in six months. An increase signals an improvement in the assessment of economic conditions. As in the case of the EC Business climate indicator, a negative relationship is expected between the index and credit spreads.

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[1]The Dow Jones Euro Stoxx 50 index is a free-float market capitalization weighted index of 50 European blue-chip stocks from those countries participating in EMU. Each component's weight is capped at 10% of the index total free float market capitalization.

[2]The volatility is calculated as the average of the puts and calls implied volatilities at a fixed time to maturity of 30 days. For specific details on the VSTOXX index methodology, please see STOXX (2005).

2.14 Bid-ask spread

Collin-Dufresne et al. (2001), Perraudin and Taylor (2003) and Houweling and Vorst (2002) identify evidence that liquidity influences credit spread changes, with investors requiring a higher premium in order to invest in less liquid assets. Amihud and Mendelson (1986) argue that the bid-ask spread is the natural measure of illiquidity. As in Van Landschoot (2004), in this paper the bid-ask spread is used as a proxy for liquidity risk.[3]

[3]Astrid Van Landschoot (2004) find that liquidity risk, as measured by the bid-ask spread, significantly affects all rating categories and becomes more important for lower rating categories.

3. The data and methodology

The sample period spans from January 2000 to December 2005, using end-of-the-month values as the monthly observations on seven EMU countries (the original sample is constructed using daily observations and then restricted to 72 monthly values). The lack of liquid government bond issues in some Eurozone countries (Ireland, Luxembourg, Finland), which prevents a robust estimation of the term structure of interest rates for these single countries, led to a narrowing of the sample to Austria, Belgium, Spain, France, Italy, Netherlands and Portugal. Greece was not considered given that the country adopted the single currency only on January 1, 2001, meaning that in the beginning of the sample period (January 2000) there was no Greek euro denominated issues. Germany was the benchmark country used in order to compare and establish credit spreads.

Government bond prices were supplied by Bloomberg. Both live and matured issues ranging from January 2000 to December 2005 were included in the original sample. Issues with no prices within the sample were excluded. Issues with call and/or put options were excluded from the sample in order to neutralise any effects in credit spread behaviour coming from embedded options and from add-on covenants included in the issues.

Bid and ask Euro Zone government bond prices were collected from Bloomberg, with subsequent computation of mid prices and bid-ask spreads. These spreads were used in order to filter off less liquid observations. In each day the bid-ask spread is checked to see if it ranges significantly from the median of the sample, following the procedure exemplified by Rousseeuw (1990). Prices from issues with less than 90 days to maturity are disregarded in order to avoid any perturbation coming from a decrease in liquidity caused by the approach of the redemption date.

The following step is to compute the values of the coefficients β_0, β_1, β_2 and β_3 used in the Nelson and Siegel fitting function:

$$R_t = \beta_0 - \beta_2 e^{-\frac{t}{\beta_3}} + \frac{1}{t}\beta_3(\beta_1 + \beta_2)\left(1 - e^{-\frac{t}{\beta_3}}\right) \tag{2}$$

in order to generate the continually compounded spot rate R_t of each country for each maturity t and on a daily basis. $\beta_0, \beta_1, \beta_2$ and β_3 are free parameters need to be estimated. β_0 represents the long-term level of interest rates, β_1 and β_2 represent, respectively, the short-term and the curvature of the yield curve. If the time to maturity goes to infinity, the spot rate converges to β_0. If the time to maturity goes to zero, the spot rate converges to the instantaneous interest rate ($\beta_0 + \beta_1$). In order to avoid negative interest rates, β_0 and ($\beta_0 + \beta_1$) should be positive. Therefore, -β_1 can be interpreted as the slope of the yield curve. β_2 determines the magnitude and the direction of the hump of the yield curve. β_3 is a scale parameter that should be positive in order to ensure convergence to the long-term spot rate β_0. In practice, β_3 measures the rate at which the short and medium-term components decay to zero.

Posterior analysis of credit spreads is restricted to maturities 1, 2.5, 5, 7.5, 10, 15 and 30 years, and further on, in regression analysis, only to four maturities (5, 10, 15 and 30 years). Again, under the Nelson and Siegel (1987) extraction method (equation (2)), the $\beta_0 + \beta_1$, $-\beta_1$ and β_2 are assumed to be the level, slope and hump, respectively, of the default-free term structure.

After the calculation of government bond yields for each country, credit spreads against Germany were computed.

4. Goodness of fit statistics

Following the procedures taken in Van Landschoot (2004), three in-sample measures are estimated in order to test how well the Nelson and Siegel (1987) (NS) model describes the underlying data: (i) the average absolute yield errors (AAE), (ii) the percentage of bonds that have pricing errors outside a 95% confidence interval (hit ratio) and (iii) the conditional and unconditional frequency of pricing errors.

4.1 Average absolute yield errors (AAE)

$$AAE_{j,t} = \frac{1}{N_t}\sum_{j=1}^{N_t}\left|\left(y_{j,t}^{NS} - y_{j,t}\right)\right| = \frac{1}{N_t}\sum_{j=1}^{N_t}\left|\varepsilon_{j,t}\right| \tag{3}$$

Estimated and observed yields-to-maturity at time t in country j are represented by $y_{j,t}^{NS}$ and $y_{j,t}$, respectively. N_t is the number of bonds at time t. The higher the $AAE_{j,t}$ the worst the quality of the fit. Results are showed in Table 2.

(Insert Table 2 about here)

The results depicted in Table 2 do not show the same linear positive relationship found by Van Landschoot (2004) between the mean and standard deviations, adjusted by rating category, of absolute yield errors. The differences of credit rating amongst the countries under analysis is not significant, with Italy, Portugal and Belgium holding AA status (from Standard & Poors) throughout the period under analysis (from January 2000 to December 2005) and the rest of the countries with AAA ratings (Spain had AA ratings until December 2004 and AAA afterwards). This could explain the lack of significant differences between the volatility and mean of absolute yield errors as observed by Van Landschoot (2004). Even so, results show that Germany and France, the two cornerstones of the Euro Area, present the lowest means of absolute yield errors and some of the lowest standard deviation figures. Figure 1 shows the performance of absolute yield errors from January 2000 to December 2005.

(Insert Figure 1 about here)

As shown in Figure 1, absolute yield errors decline over time, following the same performance of credit spreads, as displayed in Figures 4, 5 and 6 and also tracking the decrease in volatility visible in Table 5.

4.2 Hit ratio

The hit ratio gives us the percentage of bonds which have pricing errors outside a 95% confidence interval around the mean of each bond. Results are presented in Table 3.

(Insert Table 3 about here)

Between 2% and 7% of pricing errors are outside a 95% confidence interval, with the only outlier being Italy. In fact, Italy has 16.11% of pricing errors outside a 95% confidence interval, namely due to a high percentage of errors below the said confidence interval. With the exception of Italy, our results are above the findings of Van Landschoot (2004) and are closer to the results of Oliveira (2007), although presenting a wider range.

4.3 Conditional and unconditional frequency of pricing errors

Bliss (1997) and Diebold and Li (2002) find that there is a persistence in the differences between fitted and market prices. But if the pricing equation is correctly specified and pricing errors are random, then there should be no relationship between pricing errors for a given bond in two consecutive periods. Next, we have tested whether or not pricing errors are random. Pricing errors of each individual bond at time t are classified in three categories: positive, zero or negative. If the absolute value of the error is below the bid-ask spread then they are classified as zero. Changes of pricing errors between $t+1$ and t are then computed. Pricing errors are classified as white noise if no clear pattern is observed. Results per country are showed in Table 4.

(Insert Table 4 about here)

As stated by Oliveira (2007), the probability of a positive (negative or null) error being followed by another positive (negative or null) error should be the same as the unconditional probability of a positive (negative or null) error. Failure to comply with this means that there is evidence of non-randomness in the time series of pricing errors.

Column 2 of Table 4 gives the percentage of fitted price errors in a certain category (unconditional frequency). The last three columns present the percentage of pricing errors in each category at time $t+1$ conditional on the category at time t (conditional frequency). We confirmed the findings of Van Landschoot (2004) and Oliveira (2007), which showed evidence that the classification of pricing errors persists over time.

5. Spread analysis

Following Düllmann et al. (2000), credit spreads, i.e. differences between government bond yields of each country against Germany, are grouped by country and time to maturity. As explained in Section 3, credit spreads are computed for seven Euro Zone countries (Austria, Belgium, Spain, France, Italy, Netherlands and Portugal) in seven maturity slots and over 72 months.

5.1 Shape and evolution of credit spreads

Figures 2 and 3 represent the term structure of credit spreads, comprising the entire sample, i.e. from January 2000 to December 2005 and only the most recent year of 2005, respectively.

(Insert Figure 2 about here)

As time to maturity increases, credit spreads also increase. It is visible that countries with lower credit ratings show higher spreads over the German benchmark. Italy has the highest credit spreads, namely from the 5-year maturity bucket.

(Insert Figure 3 about here)

Focusing on the last year of the sample, 2005, we can observe a decrease in the average credit spreads in all maturity buckets (this is visible when comparing Figures 2 and 3). Shorter maturities also show negative credit spreads. Given that we are analyzing cross-country data, which goes beyond the risk-free argument that prevents negative credit spreads against the benchmark, one explanation lays in the supply and demand factors that may affect each market. The evolution of credit spreads can be seen in Figure 4 (and again in Figures 5 and 6).

(Insert Figure 4 about here)

In line with the results reported by Dullmann et al. (2000), the difference between credit spreads narrows over time (as seen in Figures 4, 5 and 6) and along the term structure. Also, the volatility of credit spreads decreases over time in all countries analyzed (Table 5) and throughout the period in analysis.

(Insert Table 5 about here)

6. Empirical Results

The results of the regression analysis are displayed on Table 6, where the p-values for the β coefficients are also shown. The expected sign of the explanatory variables Level and Slope are broadly confirmed by the results of the regressions. Coefficients are significant in both Level and Slope mainly in medium and long term maturities. The Curvature of the term structure present positive and statistical significant coefficients along the term structure, not confirming the findings of Collin-Dufresne et al. (2001) that presented coefficients with negative signs in the short term and positive in the long term.

The coefficients that relate changes in credit spreads of each of the countries and GDP growth of the Euro Area are positive and significant. These results are inconsistent with the expected sign of the regression coefficients. One possible explanation for the fact that the coefficients are positive is arguing that GDP growth rate for the Euro Area is highly dependent on GDP growth for Germany and thus the sensitivity of German yields is stronger, which is to say that German yields should decline more than yields for other countries. This leads to an increase of credit spreads between each of the countries in analysis and Germany.

Regression results are inconclusive in what concerns inflation. We regressed credit spread changes against (i) CPI All-items, (ii) CPI ex. energy and (iii) CPI ex. energy and other items, as explained in Table 1. Only the coefficients related to the CPI ex. energy have the expected sign and are statistical significant across de term structure of interest rates.

None of the other explanatory variables produced consistent statistical results in the sense that the number of significant results is not enough to warrant valid conclusions.

The next step taken was to see if there were significantly different responses to credit spread changes across countries. Panel data analysis was performed as the data has a two-dimensional space, i.e. cross-sectional (countries) and time-series, where the hypothesis of the existence of no significant country effects was tested. This analysis was made for the four maturity buckets of 5 years, 10 years, 15 years and 30 years.

Panel data analysis, also referred as longitudinal data analysis, pertains to a cross-section that is repeatedly surveyed over a time period. The next equation refers to a linear model that characterizes the behaviour in a panel:

$$y_{jt} = \alpha_i + x_{jt}\beta + u_{jt} \tag{4}$$

for $j = 1,...,7$ countries over $t = 1,...,T$ time periods. We have worked with a balanced panel where T is the same for all $j = 1,...,7$.

Using STATA software, we have tested the null hypothesis that α_i are fixed and common across countries (cross-section) yielding $\alpha_i = \alpha$ for all $j = 1,...,7$. If this is valid then there are no significant different responses to credit spread changes across countries and a common OLS regression can be produced. This model, known as pooled least squares model, assumes that both intercepts and slopes in the regression equation are constant for all countries. The other possibility was the existence of significant differences of responses to credit spread changes across countries. For example, the fixed-effects model (least squares dummy variable model) assumes that slopes are constant but intercepts vary across the cross-section (countries).

(Insert Figure 6 about here)

In order to compare the F-test decision (if p-value >0.10 the null hypothesis is not rejected) we also performed the Breusch-Pagan Lagrange Multiplier test, where in the null hypothesis the pooled model is stated against the fixed effects model. As the significance associated with the Breusch-Pagan test ranges between 5% and 10% in cases of the 10-years, 15-years and 30-years maturities, we reject the pooled regression in favour of random effects regression when 10% is considered for significance level. Thus, due to these results, we estimated both pooled and random effects regressions (Table 6 shows the results of the pooled regressions). As the estimation results are very similar (the regression coefficients are identical) we decided to base our comments and conclusions in the pooled regression results.

7. Conclusion

This paper analyzes the determinants of changes in sovereign credit spreads in seven EMU countries. We have investigated the explanatory power of market related and economy driven variables, some of which are country specific while others have a broader scope, in order to study their impact in credit spreads versus German sovereign debt. Using a dataset of government bonds from Austria, Belgium, Spain, France, Italy, Netherlands and Portugal, we have computed the sovereign credit spread against Germany, using the Nelson and Siegel fitting function in order to estimate the term structure of interest rates.

Using equation (1), we examine the economic and statistical significance of a number of explanatory variables. For each regression model we analyze four maturity series of credit spread monthly changes: 5 years, 10 years, 15 years and 30 years. We find that market related variables, such as Level of spot interest rates and the Slope of the yield curve have high explanatory power and produce regression coefficients with the anticipated sign, namely in long-term maturities. These results confirm the findings of Longstaff and Schwartz (1995), Duffee (1996), Litterman and Scheinkman (1991), Chen and Scott (1993) and also by Estrella and Hardouvelis (1991), Estrella and Mishkin (1995) and Bernard and Gerlach (1998). Most of economic variables do not produce consistent results in terms of the expected coefficient signs and statistical significance.

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Table 1: Explanatory Variables of Credit Spread Changes

θ_1	Level of spot interest rate: under equation (2) defined as $\beta_0 + \beta_1$
θ_2	Slope of the yield curve: Under equation (2) defined as $-\beta_1$
θ_3	Hump: under equation (2) defined as β_2
θ_4	GDP growth in the Euro Area: quarterly data from Eurostat with linear interpolation to yield monthly observations
θ_5	External balance on each country: quarterly data from Eurostat with linear interpolation to yield monthly observations
θ_6	CPI all items in the Euro Area: monthly data from Eurostat
θ_7	CPI ex. energy in the Euro Area: monthly data from Eurostat
θ_8	CPI ex. energy, food, alcohol and tobacco in the Euro Area: monthly data from Eurostat
θ_9	Budget deficit in each country: yearly data from Eurostat with linear interpolation to yield monthly data
θ_{10}	Debt stock in each country: yearly data from Eurostat with linear interpolation to yield monthly data
θ_{11}	Unemployment rate in the Euro Area: monthly data from Eurostat
θ_{12}	Eurostoxx: monthly observations of the Euro Stoxx 50 index from Bloomberg
θ_{13}	EC Business Climate Indicator: monthly observations from Bloomberg
θ_{14}	ZEW expectations: monthly observations from Bloomberg
θ_{15}	ZEW current: monthly observations from Bloomberg
θ_{16}	Eurostoxx volatility
θ_{17}	Bid-ask spread

Table 1 presents the set of variables analyzed in order to investigate their explanatory power in describing credit spread changes.

Table 2: Absolute Yield Errors

	Mean	Standard Deviation
Germany	0.0645%	0.0439%
France	0.0662%	0.0446%
Netherlands	0.1073%	0.0618%
Austria	0.1056%	0.0456%
Spain	0.1033%	0.0639%
Belgium	0.0841%	0.0325%
Portugal	0.0889%	0.0535%
Italy	0.1180%	0.0521%

Table 2 presents the relationships between estimated and observed yields-to-maturity at time t in the country j, which are represented by $y_{j,t}^{NS}$ and $y_{j,t}$ in equation (3).

Table 3: Hit Ratio

	Above	Below	Total
Germany	3.22%	2.44%	5.66%
France	3.09%	1.65%	4.74%
Netherlands	3.12%	3.81%	6.93%
Austria	1.26%	0.99%	2.26%
Spain	3.29%	1.94%	5.24%
Belgium	1.31%	2.27%	3.57%
Portugal	1.55%	1.71%	3.26%
Italy	3.57%	12.54%	16.11%

Table 3 presents the hit ratio. This returns the percentage of bonds which have pricing errors outside a 95% confidence interval around the mean of each bond.

Table 4: Transition matrices for pricing errors

	Unconditional	Conditional		
		$\varepsilon_{t+1} > 0$	$\varepsilon_{t+1} = 0$	$\varepsilon_{t+1} < 0$
Germany				
$\varepsilon_t > 0$	18%	89%	11%	0%
$\varepsilon_t = 0$	64%	3%	95%	2%
$\varepsilon_t < 0$	18%	0%	8%	92%
France				
$\varepsilon_t > 0$	23%	78%	22%	0%
$\varepsilon_t = 0$	53%	10%	90%	0%
$\varepsilon_t < 0$	24%	1%	17%	82%
Netherlands				
$\varepsilon_t > 0$	33%	84%	16%	0%
$\varepsilon_t = 0$	32%	16%	72%	12%
$\varepsilon_t < 0$	34%	1%	12%	87%
Austria				
$\varepsilon_t > 0$	24%	80%	20%	0%
$\varepsilon_t = 0$	48%	10%	83%	7%
$\varepsilon_t < 0$	27%	1%	13%	86%
Spain				
$\varepsilon_t > 0$	31%	83%	16%	1%
$\varepsilon_t = 0$	37%	13%	75%	12%
$\varepsilon_t < 0$	32%	0%	15%	85%
Belgium				
$\varepsilon_t > 0$	34%	89%	11%	0%
$\varepsilon_t = 0$	35%	11%	75%	14%
$\varepsilon_t < 0$	31%	0%	16%	83%
Portugal				
$\varepsilon_t > 0$	29%	82%	17%	1%
$\varepsilon_t = 0$	44%	11%	79%	10%
$\varepsilon_t < 0$	28%	1%	16%	83%
Italy				
$\varepsilon_t > 0$	35%	89%	11%	0%
$\varepsilon_t = 0$	31%	12%	78%	10%
$\varepsilon_t < 0$	34%	1%	9%	90%

Table 4 presents the pricing errors (ε_t) resulting from the term structure estimation using the Nelson-Siegel fitting function. Pricing errors of each individual bond at time t are classified in three categories: positive, zero or negative. If the absolute value of the error is below the bid-ask spread then they are classified as zero. Changes of pricing errors between $t+1$ and t are then computed. Pricing errors are classified as white noise if no clear pattern is observed.

Table 5. Annualized Standard Deviation of 5-year credit spreads

	2000	2001	2002	2003	2004	2005
Austria	0.117%	0.143%	0.082%	0.134%	0.057%	0.037%
France	0.051%	0.106%	0.069%	0.061%	0.049%	0.027%
Italy	0.113%	0.186%	0.100%	0.107%	0.057%	0.046%
Portugal	0.117%	0.144%	0.087%	0.112%	0.064%	0.038%
Belgium	0.051%	0.125%	0.066%	0.100%	0.051%	0.028%
Netherlands	0.063%	0.102%	0.105%	0.079%	0.044%	0.027%
Spain	0.062%	0.101%	0.081%	0.088%	0.048%	0.034%

Table 5 presents the standard deviations of credit spreads in the 5-year maturity bucket for the different countries throughout the period under analysis.

Table 6. Pooled regression on a panel dataset of seven EMU countries

	Regression	
Panel A_1 : Dependent variable is the 5 Years maturity sovereign spread		
Intercept	-0.000179	(0.150)
θ_1	0.002104	(0.865)
θ_2	-0.001352	(0.781)
θ_3	0.006742	(0.004)
θ_4	0.102838	(0.002)
θ_5 Austria	0.001121	(0.541)
θ_5 Belgium	-0.000599	(0.281)
θ_5 Spain	-0.000915	(0.289)
θ_5 France	0.000057	(0.276)
θ_5 Italy	-0.000177	(0.003)
θ_5 Netherlands	-0.000944	(0.133)
θ_5 Portugal	-0.000172	(0.794)
θ_6	0.000337	(0.000)
θ_7	-0.000557	(0.029)
θ_8	0.000207	(0.278)
θ_9 Austria	-0.000030	(0.902)
θ_9 Belgium	-0.000326	(0.173)
θ_9 Spain	-0.001342	(0.102)
θ_9 France	-0.000248	(0.755)
θ_9 Netherlands	0.000003	(0.990)
θ_9 Portugal	-0.000393	(0.453)
θ_{10} Austria	-0.000001	(0.981)
θ_{10} Belgium	-0.000067	(0.109)
θ_{10} Spain	-0.000198	(0.439)
θ_{10} France	0.000172	(0.340)
θ_{10} Italy	-0.000049	(0.458)
θ_{10} Netherlands	-0.000031	(0.584)
θ_{10} Portugal	-0.000261	(0.000)

continued

Table 6: continued

Regression		
Panel A_2 : Dependent variable is the 5 Years maturity sovereign spread		
θ_{11}	0.103508	(0.000)
θ_{12}	-0.000762	(0.133)
θ_{13}	-0.000033	(0.746)
θ_{14}	-0.000002	(0.330)
θ_{15}	-0.000000	(0.996)
θ_{16}	-0.000411	(0.334)
θ_{17} Austria	-0.000946	(0.515)
θ_{17} Belgium	-0.006088	(0.000)
θ_{17} Spain	0.006087	(0.000)
θ_{17} France	-0.000075	(0.164)
θ_{17} Italy	-0.005299	(0.001)
θ_{17} Netherlands	0.001092	(0.395)
θ_{17} Portugal	0.002129	(0.008)
R-squared	0.423	
Adjusted R-squared	0.369	
Nr. Observations	469	
F-statistic	7.830	
Prob(F-statistic)	(0.000)	
Durbin-Watson	2.614	
F-Test	0.18	
(Pooled vs. Fixed Effects)		
(p-value)	(0.983)	
Breush-Pagan-Test	2.47	
(Pooled vs. Random Effects)		
(p-value)	(0.116)	

continued

Table 6: continued

	Regression	
Panel B_1 : Dependent variable is the 10 Years maturity sovereign spread		
Intercept	0.000451	(0.077)
θ_1	-0.223031	(0.000)
θ_2	-0.184560	(0.000)
θ_3	0.023345	(0.000)
θ_4	0.309203	(0.000)
θ_5 Austria	-0.010349	(0.006)
θ_5 Belgium	-0.004435	(0.000)
θ_5 Spain	-0.002826	(0.110)
θ_5 France	0.000034	(0.753)
θ_5 Italy	-0.000375	(0.002)
θ_5 Netherlands	-0.008376	(0.000)
θ_5 Portugal	0.003311	(0.014)
θ_6	0.000324	(0.092)
θ_7	-0.002102	(0.000)
θ_8	0.001604	(0.000)
θ_9 Austria	-0.001457	(0.003)
θ_9 Belgium	0.002874	(0.000)
θ_9 Spain	0.002182	(0.193)
θ_9 France	0.001209	(0.456)
θ_9 Netherlands	-0.000600	(0.182)
θ_9 Portugal	-0.000467	(0.662)
θ_{10} Austria	-0.000064	(0.397)
θ_{10} Belgium	0.000216	(0.011)
θ_{10} Spain	0.001548	(0.003)
θ_{10} France	-0.000397	(0.282)
θ_{10} Italy	-0.000359	(0.008)
θ_{10} Netherlands	0.000187	(0.110)
θ_{10} Portugal	-0.000295	(0.008)

continued

Table 6: continued

Regression		
Panel B_2 : Dependent variable is the 10 Years maturity sovereign spread		
θ_{11}	0.006971	(0.862)
θ_{12}	-0.000964	(0.352)
θ_{13}	0.000654	(0.002)
θ_{14}	-0.000002	(0.731)
θ_{15}	-0.000014	(0.060)
θ_{16}	0.000368	(0.672)
θ_{17} Austria	-0.001510	(0.612)
θ_{17} Belgium	-0.004041	(0.144)
θ_{17} Spain	0.014832	(0.000)
θ_{17} France	-0.000093	(0.401)
θ_{17} Italy	-0.007838	(0.018)
θ_{17} Netherlands	0.004049	(0.123)
θ_{17} Portugal	-0.003887	(0.017)
R-squared	0.719	
Adjusted R-squared	0.692	
Nr. Observations	469	
F-statistic	27.320	
Prob(F-statistic)	(0.000)	
Durbin-Watson	2.410	
F-Test	0.05	
(Pooled vs. Fixed Effects)		
(p-value)	(1.000)	
Breush-Pagan-Test	3.25	
(Pooled vs. Random Effects)		
(p-value)	(0.071)	

continued

Table 6: continued

	Regression	
Panel C_1 : Dependent variable is the 15 Years maturity sovereign spread		
Intercept	0.000782	(0.069)
θ_1	-0.399573	(0.000)
θ_2	-0.337451	(0.000)
θ_3	0.027970	(0.001)
θ_4	0.459960	(0.000)
θ_5 Austria	-0.018403	(0.004)
θ_5 Belgium	-0.006954	(0.000)
θ_5 Spain	-0.004141	(0.164)
θ_5 France	0.000040	(0.824)
θ_5 Italy	-0.000458	(0.025)
θ_5 Netherlands	-0.012984	(0.000)
θ_5 Portugal	0.005358	(0.019)
θ_6	0.000509	(0.116)
θ_7	-0.003186	(0.000)
θ_8	0.002541	(0.000)
θ_9 Austria	-0.002093	(0.012)
θ_9 Belgium	0.005289	(0.000)
θ_9 Spain	0.004949	(0.080)
θ_9 France	0.001772	(0.517)
θ_9 Netherlands	-0.000849	(0.262)
θ_9 Portugal	-0.000540	(0.765)
θ_{10} Austria	-0.000168	(0.186)
θ_{10} Belgium	0.000460	(0.001)
θ_{10} Spain	0.002702	(0.002)
θ_{10} France	-0.000560	(0.369)
θ_{10} Italy	-0.000548	(0.016)
θ_{10} Netherlands	0.000300	(0.128)
θ_{10} Portugal	-0.000265	(0.155)

continued

Table 6: continued

Regression		
Panel C_2 : Dependent variable is the 15 Years maturity sovereign spread		
θ_{11}	-0.041542	(0.540)
θ_{12}	-0.000814	(0.641)
θ_{13}	0.000999	(0.005)
θ_{14}	0.000001	(0.920)
θ_{15}	-0.000021	(0.106)
θ_{16}	0.001208	(0.410)
θ_{17} Austria	-0.000330	(0.948)
θ_{17} Belgium	-0.000674	(0.885)
θ_{17} Spain	0.019026	(0.001)
θ_{17} France	-0.000076	(0.683)
θ_{17} Italy	-0.007746	(0.164)
θ_{17} Netherlands	0.005441	(0.219)
θ_{17} Portugal	-0.008500	(0.002)
R-squared	0.705	
Adjusted R-squared	0.677	
Nr. Observations	469	
F-statistic	25.540	
Prob(F-statistic)	(0.000)	
Durbin-Watson	2.606	
F-Test	0.07	
(Pooled vs. Fixed Effects)		
(p-value)	(0.999)	
Breush-Pagan-Test	3.11	
(Pooled vs. Random Effects)		
(p-value)	(0.078)	

continued

Table 6: continued

	Regression	
Panel D_1 : Dependent variable is the 30 Years maturity sovereign spread		
Intercept	0.001103	(0.123)
θ_1	-0.627070	(0.000)
θ_2	-0.539054	(0.000)
θ_3	0.032858	(0.014)
θ_4	0.619410	(0.001)
θ_5 Austria	-0.027479	(0.009)
θ_5 Belgium	-0.010140	(0.002)
θ_5 Spain	-0.005965	(0.228)
θ_5 France	0.000086	(0.776)
θ_5 Italy	-0.000556	(0.101)
θ_5 Netherlands	-0.018204	(0.000)
θ_5 Portugal	0.007754	(0.041)
θ_6	0.000915	(0.089)
θ_7	-0.004601	(0.002)
θ_8	0.003715	(0.001)
θ_9 Austria	-0.002775	(0.045)
θ_9 Belgium	0.008285	(0.000)
θ_9 Spain	0.008201	(0.081)
θ_9 France	0.002032	(0.655)
θ_9 Netherlands	-0.001009	(0.423)
θ_9 Portugal	-0.000795	(0.791)
θ_{10} Austria	-0.000344	(0.103)
θ_{10} Belgium	0.000805	(0.001)
θ_{10} Spain	0.003902	(0.008)
θ_{10} France	-0.000549	(0.596)
θ_{10} Italy	-0.000757	(0.044)
θ_{10} Netherlands	0.000322	(0.325)
θ_{10} Portugal	-0.000242	(0.434)

continued

Table 6: continued

	Regression	
Panel D_2 : Dependent variable is the 30 Years maturity sovereign spread		
θ_{11}	-0.080319	(0.476)
θ_{12}	-0.000164	(0.955)
θ_{13}	0.001452	(0.013)
θ_{14}	0.000001	(0.917)
θ_{15}	-0.000026	(0.225)
θ_{16}	0.002731	(0.263)
θ_{17} Austria	0.000543	(0.948)
θ_{17} Belgium	0.003622	(0.640)
θ_{17} Spain	0.023685	(0.009)
θ_{17} France	-0.000038	(0.903)
θ_{17} Italy	-0.006837	(0.460)
θ_{17} Netherlands	0.007575	(0.303)
θ_{17} Portugal	-0.014670	(0.001)
R-squared	0.662	
Adjusted R-squared	0.630	
Nr. Observations	469	
F-statistic	20.920	
Prob(F-statistic)	(0.000)	
Durbin-Watson	2.717	
F-Test	0.09	
(Pooled vs. Fixed Effects)		
(p-value)	(0.997)	
Breush-Pagan-Test	2.96	
(Pooled vs. Random Effects)		
(p-value)	(0.085)	

In Table 6, Panels A, B, C and D present the regression models using as dependent variable the sovereign credit spread compared to the German benchmark for the maturities under 5 years, 10 years, 15 years and 30 years, respectively; θ_1 is the change of the level of spot interest rate (under equation (2) defined as $\beta_0 + \beta_1$); θ_2 is the change of the slope of the yield curve (under equation (2) defined as $-\beta_1$); θ_3 is the curvature of the yield curve (under equation (2) defined as β_2); θ_4 is the change in GDP growth in the Euro Area; θ_5 is the change in the external balance figure on each country; θ_6 is the change in CPI all items in the Euro Area; θ_7 is the change in CPI ex. energy in the Euro Area; θ_8 is the change in CPI ex. energy and other items in the Euro Area; θ_9 is the change in the budget deficit in each country; θ_{10} is the change in the debt stock in each country; θ_{11} is the change in unemployment rate in the Euro Area; θ_{12} is the change of the Euro Stoxx 50 index; θ_{13} is the change of the EC Business Climate indicator; θ_{14} is the change of the ZEW expectations index; θ_{15} is the change of the ZEW current conditions index; θ_{16} is the change of the Euro Stoxx 50 volatility and θ_{17} is the change of the bid-ask spread of each country. The p-values coefficients are reported (in parentheses).

Figure 1: Average Absolute Yield Errors

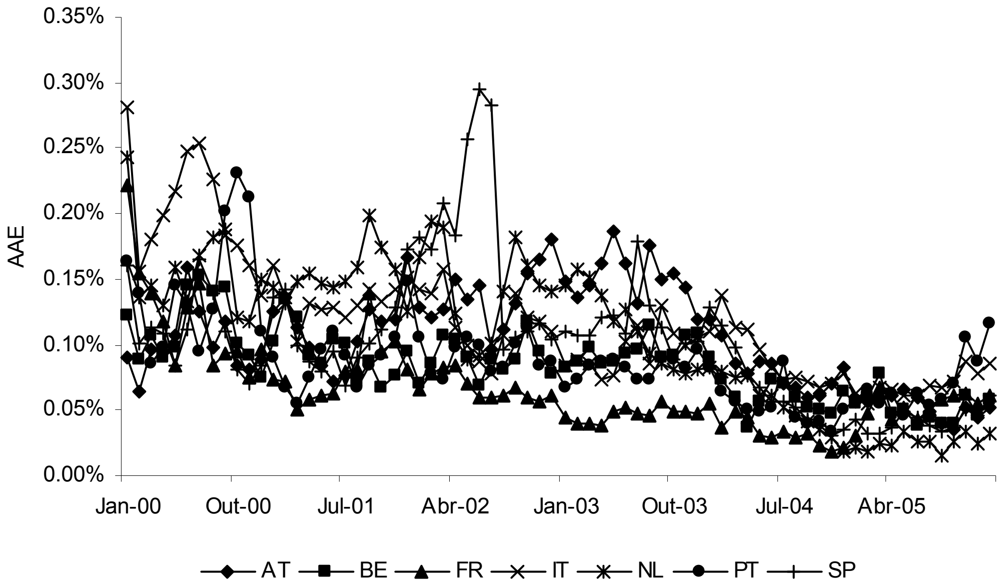

Figure 1 represents the performance of absolute yield errors as computed from equation (3) since January 2000 to December 2005.

Figure 2: Average Term Structure of Credit Spreads 2000-2005

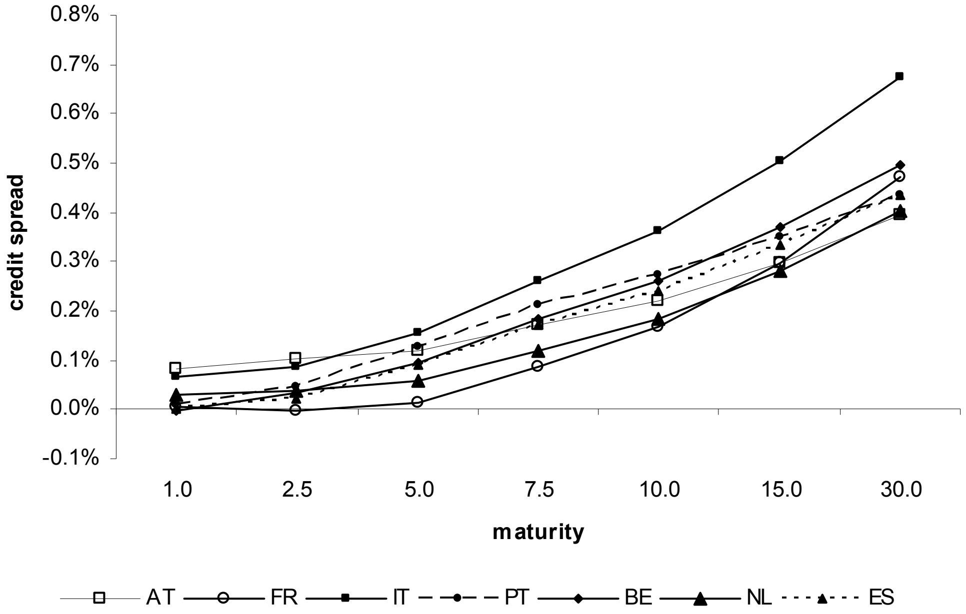

Figure 2 represents the term structure of credit spreads, comprising the entire sample, i.e. from January 2000 to December 2005.

Figure 3: Average Term Structure of Credit Spreads 2005

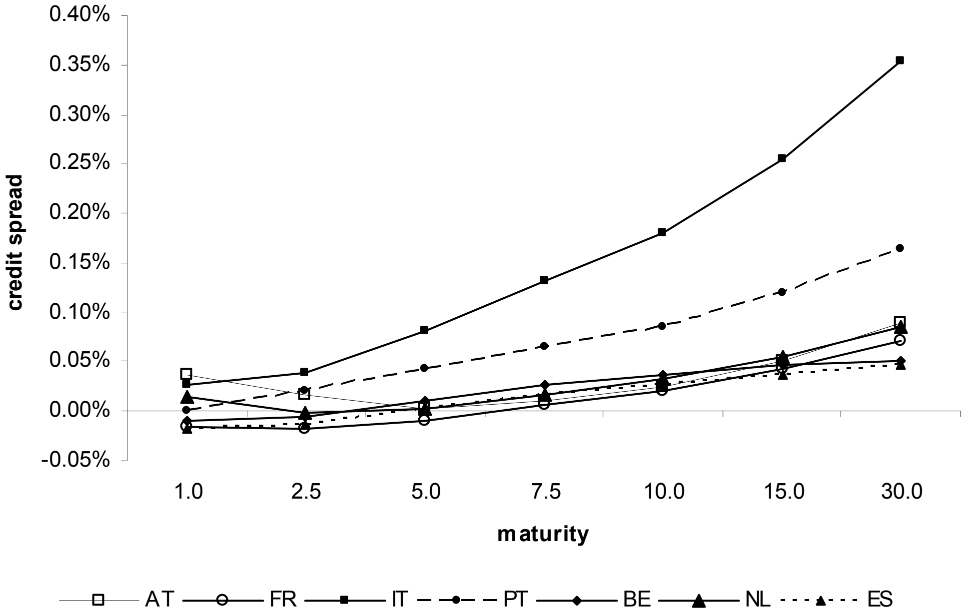

Figure 3 shows the term structure of credit spreads in the last year of the sample (2005).

Figure 4: Credit Spread Performance (10-year bucket)

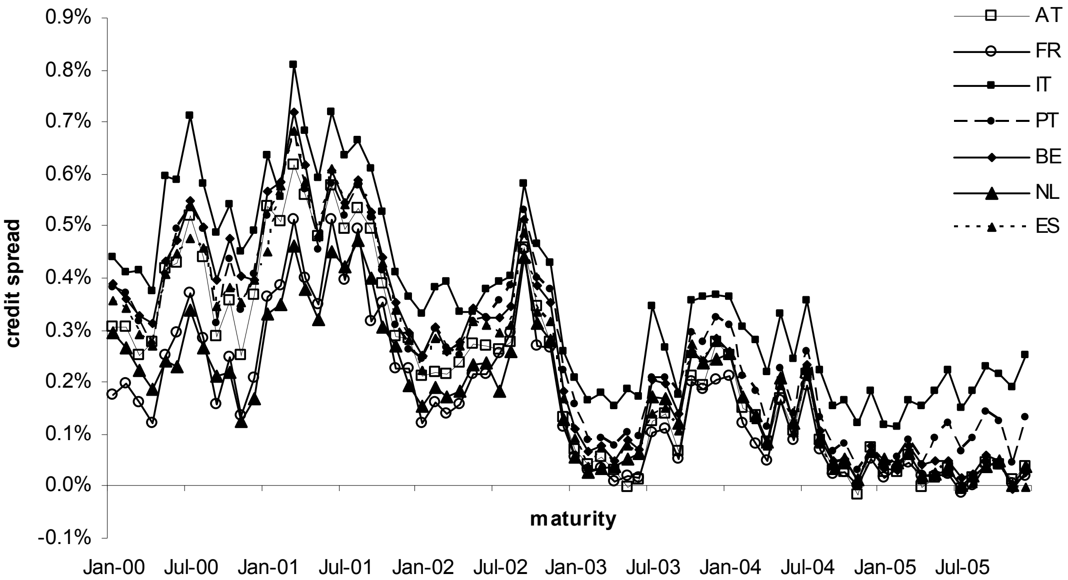

Figure 4 shows the performance of credit spreads throughout the sample, from January 2000 to December 2005, in the 10-year maturity bucket.

Figure 5: Credit Spread Performance (5-year bucket)

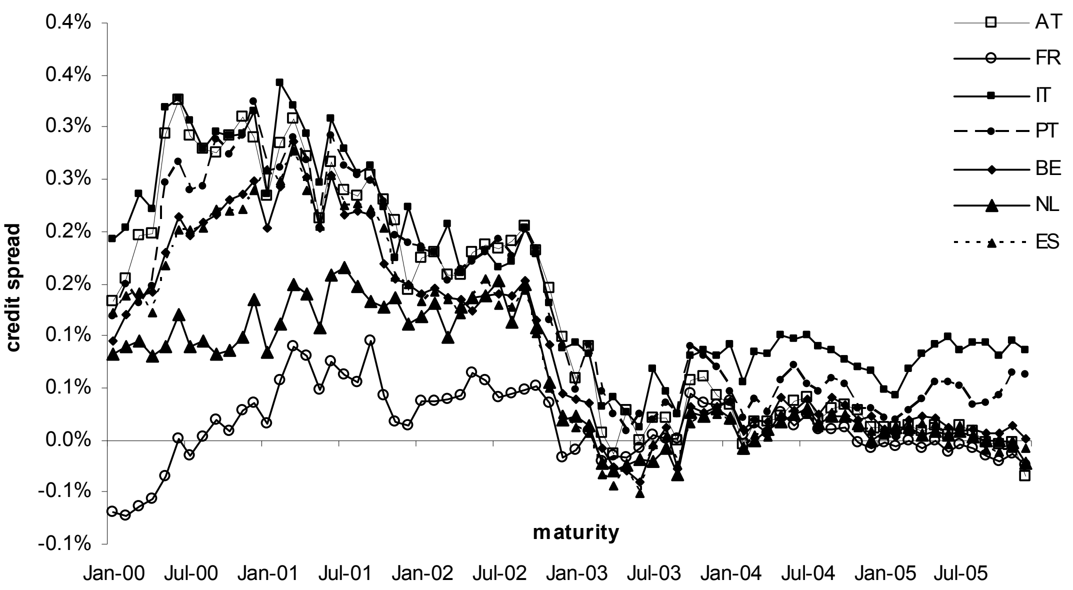

Figure 5 shows the performance of credit spreads throughout the sample, from January 2000 to December 2005, in the 5-year maturity bucket.

Figure 6: Credit Spread Performance (2-year bucket)

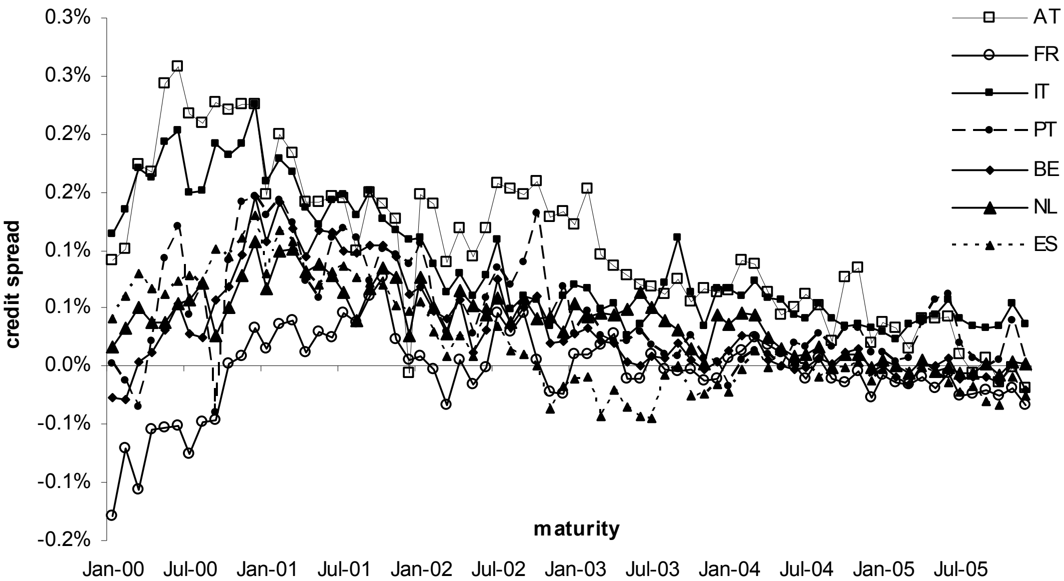

Figure 6 shows the performance of credit spreads throughout the sample, from January 2000 to December 2005, in the 2-year maturity bucket.