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THE DETERMINANTS OF THE PORTUGUESE SOVEREIGN DEBT SPREAD

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The essential problem is that our econometric models as complex as they have become, are still too simple to capture the full array of governing variables that drive global economic reality. A model, of necessity, is an abstraction from the full detail of the real world. (...)But these models do not fully capture the innate human responses that result in swings between euphoria and fear that repeat themselves generation after generation with little evidence of a learning curve.

Greenspan (2008)

RESUMO

Esta dissertação consiste numa análise mensal da evolução das *yields* de obrigações emitidas, a 10 anos, pela Republica Portuguesa, comparativamente aos títulos, com a mesma maturidade, suportados pelo Governo Alemão. Através deste estudo pretendemos identificar os principais determinantes, e analisar a evolução, dos juros da divida Portuguesa durante o período Janeiro de 2007 a Dezembro de 2014.

Factores de risco específico e agregado são ambos importantes para um estudo explicativo da evolução das *yields* associadas à divida soberana do estado Português. No entanto, a importância relativa de cada um deles é variável, ao longo do tempo, em linha com mudanças estruturais ocorridas na envolvente. No período que antecedeu a Crise Financeira Global, os juros da dívida Portuguesa, à semelhança de outras economias europeias, eram primeiramente explicados por um modelo de convergência económica. Mais tarde, com o início da Crise da Dívida Soberana, os investidores aumentaram a importância concedida a indicadores macroeconómicos dos países emitentes. Todavia, dentro de um contexto de instabilidade económico-financeira uma avaliação imparcial fica comprometida. A visível mudança ocorrida no processo de percepção de risco, e consequente atribuição de valor de mercado à divida soberana nacional, é explicada por um aumento no grau de incerteza e de aversão ao risco. Concluímos portanto, que anteriormente ao inicio da crise financeira global, o valor das *yields* estava a baixo do seu valor real (sobrevalorização de preços), e com a crise da divida soberana o seu valor permaneceu "*biased",* mas, desta vez, na direcção oposta (subvalorização de preços).

Classificação: G15, E62

Palavras Chave: Spread Português, Divida Soberana, Crise do Euro

ABSTRACT

The Portuguese Sovereign debt spread, from January of 2007 to December of 2014, is analyzed in this dissertation. Its main determinants are identified comparing monthly data and using Germany as a benchmark (benchmarked with German government bonds). The main objective of the present work is to examine the Portuguese Government bond yield spread *sensitivity* to changes both in the common and idiosyncratic risk factors. We investigated whether or not the relative importance of common and idiosyncratic risk factors has changed over time, aligned with structural changes in the economy.

The main conclusions are that both idiosyncratic and common risk factors explain the Portuguese sovereign debt spread developments. Although their relative importance has changed over time in line with disruptive structural market incidents. Prior to the Global Financial Crisis (GFC) the Portuguese government bond *yield* spreads were mostly driven by a trade convergence model. After the eruption of the Euro area sovereign debt crisis, investors increased their attention on macroeconomic fundamentals. However, in a scenario of financial distress, objective assessment of macroeconomic indicators is compromised, leading to investors' overreaction. This shift in the way investors *perceive* and *price* risk is mostly explained by the higher levels of uncertainty and increased risk aversion, typical in moments of market turmoil. Hence, we conclude that before the GFC, Portuguese government bond *yields* were below their true value *(*bond prices *overvalued),* and with the Euro area debt crisis it continued biased, but this time in the opposite direction *(*bond prices *undervalued).*

JEL Classification: G15, E62

Keywords: Portuguese Bond Market, Sovereign Debt, Euro Debt Crisis

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Who will never care about bonds, yields or financial markets, but does cares about me *for all that matters.* To Micas for growing up with me, for everything.

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LIST OF ABREVIATIONS

ADF	Augmented Dickey Fuller
BLUE	Best Linear Unbiased Estimator
Bps	Basis points
CDS	Credit Default Swap
LB	Lehman Brothers
EC	European Commission
EU	European Union
ECB	European Central Bank
EMU	European Monetary Union
FED	Federal Reserve System
GDP	Gross Domestic Product
GFC	Global Financial Crisis
HICP	Harmonized Index of Consumer Price
US	United States
USD	United States Dollar
MRLM	Multiple Linear Regression Model
SMP	Security Market Program
OMT	Outright Monetary Transactions
OLS	Ordinary Least Squares
OTC	Over The Counter
PCA	Principal Component Analysis
PC	Principal Component
RSS	Residual Sum of Squares
SCDS	Sovereign Credit Default Swap
VIF	Variance Inflation Factor

1.INTRODUCTION

Currently, the Portuguese sovereign debt market is passing through one of its most important phases ever as compared to the German bonds. After an increase of 1160 basis points (bps), from October of 2009 to January of 2012, the Portuguese government bond yield spread is now hitting historical lower levels and in a tightening process. It is within this context that an understanding of which set of risk factors has been behind the evolution of the Portuguese spread has become quite an actual and challenging issue.

This thesis dissertation aims to go further than identifying the main determinants of Portuguese sovereign debt spread. The ultimate goal is to examine Portuguese bond yields sensitivity to changes both in common and idiosyncratic risk factors. In other words, we aim to assess whether or not the relative importance of common and specific risk factors has changed over time, aligned with structural changes in economy.

The European Union was created with a well-defined purpose of building a place where most people, goods, services and capitals could move freely. The establishment of a single currency, the Euro, in 1999, was clearly a big step towards reaching the desired "single market". After creating the European Monetary Union (EMU), and as the outstanding government bonds suffered from a currency redenomination and new issues started to be mainly done in Euro, the EMU managed to eliminate fluctuations and the exchange rate currency risk (Mcdonald & Dearden, 2005). Within a monetary integration context, investors were less discriminating amongst issuers' countries and Portuguese government bond yield spreads were kept at a low and steady value until the eruption of the American subprime crisis in August of 2007 (Barrios *et al*., 2009). It´s a global financial world, where it's no longer possible to restrict the effects of a big event to the physical place where it has occurred. The collapse of such a huge financial institution, as the Lehman Brothers (LB), is more than evidence that there is no such a thing as "*too big to fail*". It also proved the close degree of interdependence between the US and European financial market: instability in a specific market is easily transferred to another.

Acharya *et al.* (2014) proposed an explanation for the beginning of the euro area sovereign debt crisis based on a transference of global financial risk to sovereign bonds through banking bailout schemes. Indeed, frightened of what had happened inside the US banking system, European Government authorities, including Portugal, announced a set of package stimuli with the aim of providing financial stability and increasing confidence in the national banking sector (Pereira & Wemans 2012). Nevertheless, these measures did not result in the desired consequences, leading to the deterioration of the Portuguese public finance accounts.

The research analysis focuses on the time period from January of 2007 to December of 2014. Using monthly data, we divided our analysis into three time samples. The data breakdown was defined accordingly to two disruptive market events: 1. First Papandreou speech as Greek prime minister; and 2. Mario Draghi's "*Whatever it takes*" well-known speech. Therefore, the data division appears as the following: first, the time period before global financial crisis was transformed into the euro area sovereign debt crisis (January 2007 - October 2009); second, the most intense period of euro area sovereign debt crisis (November 2009 - July 2012); and third, the recovering and spreads adjustment period (August 2012 - December 2014). Initially through the use of an OLS method and later including a PC (Principal Component) analysis, we developed our research analysis by estimating a multiple linear regression model; which was *"designed"* in a way that could account for the large majority of the different types of risk factors that may have been important in explaining the Portuguese sovereign debt spread developments.

Even though some previous studies have already been conducted under the topic "*Determinants of the Sovereign Debt Spreads*", other authors produced an aggregate analysis for several countries, with some perceived similar features. However, and as suggested by Gerlach, Schulz and Wolff (2010), currently the needed homogeneity condition does not hold. Therefore, an aggregate analysis may lead us to unreliable conclusions. Hence, and as a distinctive feature, this dissertation is focused on an analysis solely on the Portuguese framework.

Can the eruption of the US financial crisis be seen as a turning point for the Portuguese sovereign debt markets? Why has the Portuguese sovereign debt spread started such a drastic upward movement since the middle of 2009? Are the risk factors behind the yields increase the same that explain the downward trend observed from January of 2012? To which extent are macroeconomic fundamentals really important in explaining Government bond yield spreads developments? These are some of the questions that we aim to address through the development of a research analysis.

We find that market disruptive events such as the US subprime crisis and the LB bailout, along with scenarios pointing for economic recession and deterioration of finance public accounts, led investors to change their perceptions regarding developed economies probability of defaulting (Arghyrou & Tsoukalas, 2011), which ended up motivating a visible change in the investors' market pricing risk behavior. In the summer of 2007, prior to the first signs of the Global Financial Crisis, the spreads were mostly driven by a trade convergence model (Afonso, 2012). After October of 2009, along with a rise in the levels of uncertainty as well as in the degree of market risk aversion, the international risk factor increased its importance in explaining spreads´ developments (Arghyrou & Kontonikas, 2012). A market pricing behavior, mostly driven by the international risk factor, amplified the attention given to economic and fiscal fundamentals (Santis, 2012). However, under a scenario of uncertainty, an objective assessment of fundamentals is compromised, which consequently leads government bond yields to be biased and to not hold their true value.

The remainder of this dissertation will respect the following structure: Section two will present the basic concepts. Section three will review the literature. Section four will organize the data and present each one of the employed variables. Section five will describe the research methodology. Section six will perform the research analysis. Section seven will apply a set of robustness test in order to reach coherent conclusions. Section eight concludes the study, summarizes the main findings and presents suggestions for future work.

2. BASIC CONCEPTS

2.1 Yield Spread

Government bond yields can be seen as a reflection of the issuer's country perceived level of risk; and sovereign debt spread is then the yield differential between bonds, with the same maturity, issued by countries with a differing level of risk. Hence, bond yield spread is commonly understood as the additional compensation an investor demands over the riskless interest rate.

Particularly during times of financial distress, *"flights for safety*" and "*flights to liquidity"* are expected to increase significantly (Garcia & Gimeno, 2014). The effect of such asset allocation decisions are observed within the sovereign debt market: the bond yield spreads of countries with weaker economic fundamentals, like Portugal, tend to widen against the ones with a lower perceived level of risk, like Germany (Garcia & Gimeno, 2014). Typically, sovereign bond yields are seen as a reflection of the macroeconomic fundamentals and finance public accounts current context, as well as predicting indicators for the country future performance: an increase in government yields is linked to a rise in the long-term interest rates, which impacts consumption levels, as well influences investors market pricing behaviour (Barnett, 2012).

2.2 Determinants of bond yield spreads

In a context of a single monetary policy, and due to the relative integration of national bond markets, euro area government bond yield spreads are expected to reflect issuers' countries' differences in credit risk and liquidity conditions (Barbos & Costa, 2010). However, liquidity and credit risk are not exogenous factors. Thus, at any given moment, changes in investors' perceptions of global risk also plays a role in the understanding of the extra level of compensation that investors demand for bearing specific risk, credit and liquidity risk premiums. Hence, there are some others authors' arguing that, besides credit and liquidity risk, international risk is also strongly priced in a bond government bond yield (Arghyrou & Kontonikas, 2011).

2.2.1 Country Specific Risk

The **idiosyncratic or specific risk factor**, also known as specific and diversifiable risk, is the risk in which only specific agents or industries are vulnerable. Therefore, the specific risk factor captures:

1. Credit risk
2. Liquidity risk

2.2.1.1 Sovereign Credit Risk

Sovereign credit risk incorporates the country's probability of default (issuer incapability of meeting its current and future debt obligations). Whenever an investor is pricing a government bond, credit risk is taken into account and will be priced in yields (Codogno *et al*, 2003), Faini (2006), Bernoth (2004) and Schuknecht (2009).

According to Favero and Missale (2012), default risk always takes the role of the most important factor in explaining the development of the government bond yields. Default risk is included on yield value through credit risk premium, understood as the additional amount that investors demand for bearing the risk of the issuers entering in default or restructuring their debt. This implies that the value of the credit risk premium mirrors investors' perception about a given country's macroeconomic fundamentals and public finance accounts. Countries with an higher perceived probability of solvency are expected to offer an extra reward as a compensation to investors that stand to a higher default risk. (Favero & Missale, 2012)

The importance of the sovereign credit risk is commonly measured through: *(i)* macroeconomic fundamentals and finance public accounts, and *(ii)* Credit Default Swaps (CDS) spreads.

2.2.1.2 Sovereign Liquidity Risk

In a context of government bond markets, liquidity conditions, *e.g.*. the ability of a bondholder to quickly, and without significant price discounts to convert a bond into cash, are important in explaining yield developments particularly during periods of market turbulence (Garcia & Gimeno, 2014).

Liquidity conditions depend primarily on four components (Lipp, 2015)

1. Immediacy, expresses how quickly a bond can be converted into cash;
2. Depth, reflects the volume of bonds traded during a given period of time;
3. Width, compares the number of bonds traded in secondary market against to the total outstanding amounts;
4. Residency, relates to the speed of trading (number of transactions in a given period of time);

Countries with a small and shallow sovereign debt market need to offer a higher yield. Liquidity risk premium is the compensation demanded by investors to bear the risk of future potential deterioration in liquidity conditions. Investors require an extra reward for the eventual lack of liquidity that may be prevailing in the market at the time they sell the bond. The "*flights to liquidity*" episodes are not only a recent year phenomenon. In all previous historical periods of financial market turmoil, characterized by an increase of uncertainty and volatility, investors have tended to value liquidity rather than credit quality (Beber, 2009). Therefore, this interdependence between domestic liquidity conditions and changes in the global risk perception have played an important role in explaining spreads' developments.

2.2.2 International Risk Factor

Another important element in driving yield spreads is the international or aggregate risk factor. According to Barbosa (2010), the international risk premium captures the level of global uncertainty and risk aversion prevailing in international financial markets. The international risk factor is linked to the investors' willingness to bear risk and arises from the global market structure or dynamics, producing shock and uncertainty in all the agents in the market. The international risk factor affects and disturbs the spreads of all issuers (Geyer *et al.,* 2004). However, due to the different countries' sensitivity to changes in the perceived levels of global risk aversion and uncertainty, the effect of the international risk factor is not the same in yields across countries. As suggested by Favero (2007) the effect of international risk on yield spreads is heterogeneous, which explains why spreads' differentials have changed after changes in the global risk perception. Cordogno *et al.* (2003) analyzed the role of global risk aversion in driving yield spreads and concluded that the impact of international risk factors plays a greater role in countries with a higher government debt.

3. LITERATURE REVIEW

Previous studies discussing euro area sovereign debt spreads suggest that, given the current scenario of relative euro area bond market integration and without the existence of currency exchange rate risk, government bond yields are primarily driven by three main set of risk factors: *(i)* Credit risk, *(ii)* Liquidity risk and, *(iii)* International Risk factor.

Applying the broad definition of bond spread to the sovereign debt spread and considering aggregate risk as a common factor affecting all agents in the market, other authors have particularly focused in the breakdown between credit and liquidity risk premiums. Indeed, government bond yields are the first indication of what investors think of both each country's specific credit risk and liquidity conditions. Therefore, the following logical reasoning comes to mind: in the end, what do fixed income investors care more about when investing in sovereign debt spread? According to Beber *et al.* (2009) investors actually care about both factors, with fluctuating relative importance influenced by the structural changes in the economy over time.

In this phase the purpose is to define, chronologically, using other authors' previous empirical analysis, which set of risk factors investors tend to value most whenever setting the extra level of reward demanded for bearing risk.

3.1 Before European Monetary Union

In the time preceding the European Monetary Union (EMU), the European bond market had a significant level of heterogeneity: sovereign debt was mostly issued on domestic currency and each country had its specific fiscal, technical, legal, regulatory and supervisory framework. Hence, at that time, and in spite of the internal rules of each country, government bond spreads were mostly explained by the exchange rate risk premium (Thomsen, 2006).

3.2 Before Lehman Brothers bankruptcy

Before the Lehman Brothers declared bankruptcy, the sovereign debt of developed countries was typically seen as a risk-free investment and the issuer country's risk of default was not properly priced. Indeed, government bond yield spreads were mostly explained by aggregate risk factors, related to the perceived level of risk premium in international financial markets (Codogno and others, 2003; Geyer and others 2004; Sgherri and Zoli, 2009; Caceres and other, 2010; Favero and others, 2010).

Aggregate risk factor, also known as systematic risk, affects all market agents. It is not diversifiable and arises from the external market environment. There are three appropriate variables, which have been used to consider aggregate risk factors when pricing a government bond*: (i)* Changes in monetary policy, *(ii)* Global Uncertainty, *(iii)* Risk Aversion. International risk premium combines these last two variables and mirrors the degree of investors' risk aversion and global uncertainty prevailing in international financial markets. (Zoli & Kang, 2013)

3.3 After Lehman Brothers bankruptcy

Investors tend to re-assess and change the factors they value most whenever important structural changes happen in the global and internal framework (Barbosa & Costa, 2010). Most of the times these structural changes are caused by some trigger event episode. In fact, since the Lehman bankruptcy, financial markets have become more discriminating amongst government issuers (Sgherri & Zoli, 2009; Caceres and others, 2010). A market stress event, such as the unexpected bailout of an important American investment bank, undoubtedly impacted investors' perception of risk, which influenced pricing behavior and portfolio allocation decisions.

This financial uncertainty led to a substantial increase in the perceived level of risk aversion causing investors to start a set *"flight to liquidity"* and a "*flight for safety"* movements (Garcia & Gimeo, 2014). In other words, moments of distress tend to be followed by an increase in the demanded liquidity and credit risk premiums. However, one of the biggest challenges during the empirical analysis is to undertake a separate analysis between credit and liquidity risk due to the high correlation between these two risk factors (Ericsson & Renault, 2006).

Previous empirical analyses have focused on deconstructing the importance of credit risk and liquidity when explaining government bond yields developments. Although the large majority of studies indicate that after September of 2008 (Lehman Brother Bailout), the credit risk premium has been the most important factor in driving periphery sovereign debt spreads[1] (Mody (2009), Sgherri and Zoli (2009), Barrios *et al*. (2009) and Schuknecht *et al*. (2010), many authors have also stated that in times of financial market distress, investors will tend to value liquidity over credit quality. (Brandt & Kavajecz, 2006).

As discussed before, liquidity conditions relate to how easily investors are able to convert an asset into cash. Particularly during periods of high market volatility and uncertainty, it's always difficult to predict which direction the market will go. Hence, investors are forced to be more cautious about the liquidity conditions of the bonds they hold in their portfolios. According to Schwarz (2014), market liquidity conditions explain more than two thirds of the widening of sovereign debt spreads over the first half of financial crisis. In fact, the weak correlation between core and periphery market liquidity conditions have led to inverse movements in euro area sovereign debt markets (Garcia & Gimeno, 2014).

3.4 Euro area sovereign debt crisis

During the spring and summer of 2009, European government authorities, particularly the ones in charge of countries with weaker fiscal fundaments, came up with strict fiscal stabilization programs and structural reforms. "*Ireland is a fantastic example*", pointed out Vinny Catalano, president and global investment strategist at Blue Marble Research Advisory in the US. In fact, these reforms led to some visible outcomes and spreads between peripheral countries and Germany, starting a tightening process[2]. However it did not last long, and after October 16th of 2009, George Papandreou, Greek prime minister, announced that the national deficit would represent 12.7 % of GDP, which was immediately followed by a historical upward trend on peripheral spreads (Santis, 2012). Greece notoriously misreported budgetary data and disobeyed the European fiscal-discipline rules.

[1] Specifically when public finance indicators are assessed (Barbosa & costa, 2010)
[2] See graphical evolution as exposed on figure 1

The beginning of the Greek crisis exposed not only the weaknesses of governance in Greece but, also the 'euro area' as an whole. Schuknecht (2011) noted that during the first ten years, the euro area suffered from a lack of fiscal discipline, the sustainability of public finances was overlooked, good times were wasted, and in the end, the credibility of fiscal rules was compromised.

Credit rating agencies successively downgraded the Greek debt and consequently, as Gande and Parsley's (2005) general findings have suggested, a downgrade in a country's rating will always have a significant impact on sovereign credit spreads of other countries with similar features. In July of 2009, *Moody's* downgraded the Portuguese rating by four levels, citing the contagious consequences of Greece as the main reason: A default in Greece debt would increase the risks faced by Portuguese lenders (Santis, 2012). Greek debt crisis was spilling over and Eurozone sovereign debt crisis was about to begin.

The ratings address the expected loss posed to investors by the legal final maturity and thereby it's highly correlated with the issuer's perceived credit quality. In late 2009, with the eruption of Eurozone sovereign debt crisis, periphery suffered drastic cuts in its sovereign credit rating. In fact, at that time, the market value of peripheral sovereign debt drastically decreased (bond yields went significantly up), which is explained by changes in the perceived default probability and consequently, by an increase in the required risk premium for bearing risk (Garcia & Gimeno, 2014). So, did the rating agencies have an important role in explaining spreads? According to Afonso, Arghyrou and Kontonikas (2012) findings, sovereign credit ratings are statistically significant, yet their role in pricing bonds over the crisis was not as important as macro and fiscal fundamentals.

In fact, due to the spillover effect, peripheral countries may have been primarily judged by Greece's debt crisis rather than by their own fundamentals (Santis, 2012), still, these countries actually shared a set of common structural problems: *(i)* high debt to GDP ratio levels, *(ii)* economic growth stagnation, *(iii)* high unemployment rate. A chronological contextualization is crucial to better understand investors´ portfolio allocation decisions: European sovereign debt crisis erupted during a time when market participants hadn't yet completely recovered from the US financial crisis.

Accordingly, investors were going through a phase of low risk appetite and therefore were more willing to invest on "*safe heaven assets*". At that time, while peripheral countries were struggling with serious structural problems, Germany arose as a country able to meet the broad definition of a "*safe heaven":* the country had low inflation levels, a budget surplus as well as a current account surplus. (Schuknecht, 2009). So, with the aim of reducing their exposition to riskier securities, investors suddenly increased the demand for core countries' sovereign debt, like German government bonds. Contrastingly, investors required significantly higher risk premiums for investing in countries with weaker macro and fiscal fundamentals (Afonso, Arghyrou & Kontonikas, 2012).

As reports suggest, "*flight to safety"* episodes are quite important to explain why, with the eruption of the EMU sovereign debt crises, the peripheral sovereign yields rose sharply because of Germany. However, the increase in idiosyncratic premiums, demanded by investors for bearing more credit and liquidity risk, resulted out of an interdependence and interaction between both common and idiosyncratic risk factors (Santis, 2012).

4. DATA DESCRIPTION

The analysed data period goes from January of 2007 to December of 2014. In order to understand whether the relative importance of each one of the risk factors changes over time, in line with structural changes in the economy, when estimating the equation, the data was divided into three time sample periods. The data breakdown was determined accordingly with two well-known "episodes" occurred in the lately euro area history:

1. October 16th of 2009: Papandreou's 1st speech as Greek premier minister, in which several, worse than expected, fiscal problems were disclosed.
2. July 26th of 2012: Mario Draghi attempts to supply confidence to the markets by ensuring that the ECB will do "*whatever it takes"* to keep euro area together.

Therefore, the data division appears as the following: first, the time period before the global financial crisis was transformed into the euro area sovereign debt crisis (January 2007 - October 2009); second, the most intense period of euro area sovereign debt crisis (November 2009 - July 2012); and third, the recovering and spreads adjustment period (August 2012 - December 2014).

Figure 1: Portuguese sovereign debt spread evolution

(January 2007 - December 2014)

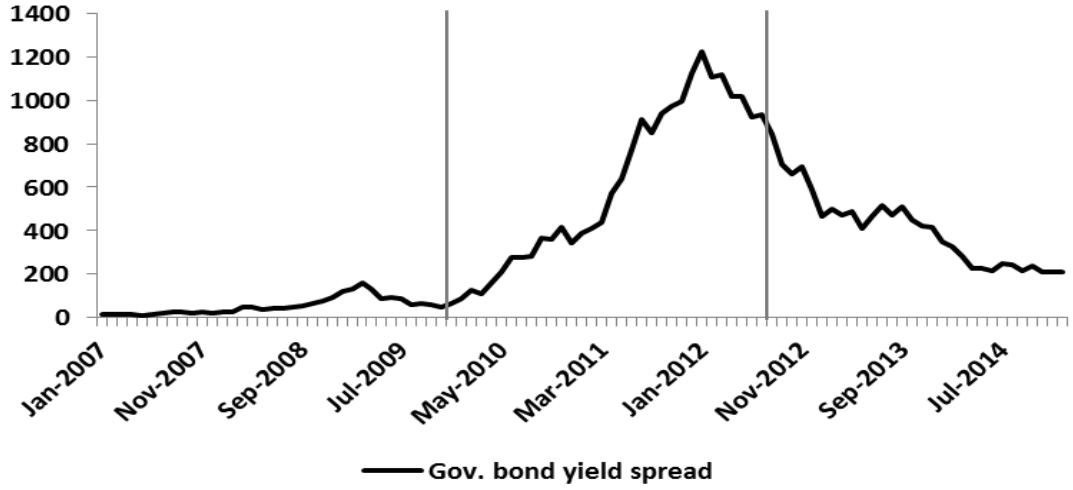

Figure 1: Yield spread between the 10 year Portuguese government bond and the German bond with the same maturity. The first vertical line marks the end of the first analyzed period and the beginning of the Sovereign debt crisis. The second vertical line points out the end of the second phase and it also stands for the Draghi's "*whatever it takes*" speech. Source: Bloomberg data; author analysis

In section 4, when estimating the regression model, a panel of explanatory variables is employed in order to estimate how each variation impacts the dependent variable.

4.1 Dependent Variable

The Portuguese sovereign debt spread is defined as the dependent variable. The spread is calculated as the difference between the Portuguese 10 year sovereign bond yield and and the German bond yield with the same maturity. Germany was chosen to be used as the reference country due to the "zero default risk investment" and benchmark status that their bonds have reached during the euro area sovereign debt crisis (Lipp, 2015).[3] Yet due to their "*safe heaven*" reputation (Barbosa & Costa, 2010), German Bund futures contracts have been widely traded as an hedging instrument.

[3] The choice may be debatable, as it depends on the applied criteria. For instance if liquidity is the main criteria, the Italian Government bonds would be the elected ones.

4.2 Explanatory Variables

As noted when reviewing literature, there are three particularly relevant risk factors in driving Government bond yields *(i)* Sovereign credit risk, *(ii)* Liquidity risk and *(iii)* International risk factor.

4.2.1 Spreads persistence

The lag variable (SPREAD$_{t-1}$) was included in order to take into account the Portuguese government bond yield spread persistence. The exclusion of the lag spread variable would lead to an omitted variable bias (Hallerberg & Wolff, 2008).

4.2.2 Sovereign credit risk

Affecting the sovereign bond yield spreads are the implied investor perceptions about a given country's credit quality. Hence, the importance of the sovereign credit quality, expressed as an amount of credit risk premium, is commonly measured through two types of alternative measures:

1. Macroeconomic and fiscal fundamentals
2. Credit Default Swaps

4.2.2.1 Macroeconomic fundamentals and public finance accounts. Investors may assess credit quality, and determine the demanded credit risk premium, by taking into consideration the issuer country's specific conditions. Macroeconomic fundamentals and public finance accounts can be used to predict indicators for the country-specific context. As a to capture the impact of macroeconomic fundamentals in driving the Portuguese sovereign debt spread, compared to Germany, the following is used: *(i)* the GDP real growth rate; *(ii)* general government debt (expressed as a % of GDP); *(iii)* monthly growth rate of industrial production; *(iv)* average expected general government debt (expressed as a % of GDP), *(v)* average expected budget balance (expressed as a % of GDP).

In order to better capture invertors' feelings and expectations about the issuer country´s default probability both historical and forecast data is used. While first historical data was analyzed, in the robustness test forecasts are employed in order to capture the impact of macroeconomic data projections in investors' investment decisions.

For the data that is not available on a monthly basis, Gerlach *et al.* (2012) approach is followed: the low frequency data is kept constant until new data is disclosed. Typically financial markets react to unexpected announcements; hence whenever historical macroeconomic variables are used, and in order to capture the impact of the *"announcement moment"*, the regression model is estimated by comparing, for example, the end of one month (February) spreads against the previous (January) time period inflation.

Figure 2: Macroeconomic fundamentals date of disclosure

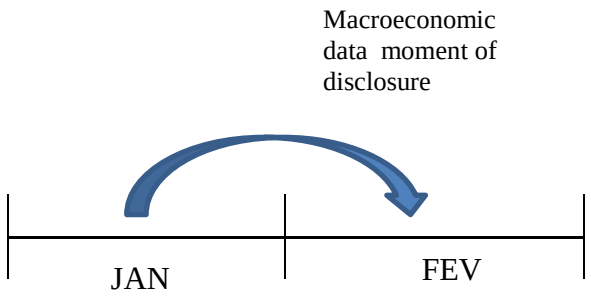

Figure 2:Macroeconomic information from period t (e.g: January) only becomes public data during the period t +1 (e.g: February). Employing this approach allows investors' reaction to the data disclosure to be considered. Source: author analysis

Expected Impact: Macroeconomic variables are included because economic performances theoretically impact on the country level of risk. The process typically happens as the following: during periods of economic slowdown the issuer country's credit quality tends to deteriorate, which consequently leads government bond yield spreads to widen. (Bernoth *et al.*, 2004). As investors demand a higher credit risk premium to invest in countries with weaker economic and fiscal fundamentals, those countries are expected to offer higher yields to compensate its bond holders for bearing more default risk.

4.2.2.2 Credit Default Swaps. Another approach used to capture an investor's expectations of a given country's probability of default is based on a market analysis where the probability of default is priced: the credit default swap (CDS) market. The sovereign Credit Default Swap (SCDS) is a financial instrument that plays the role of an insurance contract; it allows investors to buy protection against the event that the issuer

country enters in default or restructures its sovereign debt. Even though the SCDS market is not able to properly forecast the *real risk*, it gives us hints to measure the *perceived* level of risk. The 5 year contract was chosen to be included in the regression model as it is the most traded maturity for the SCDS. When interpreting the SCDS price movements, it´s important to take into account that the CDS's developments are not only explained by changes on the *perceived* likelihood of default: it also may be driven by fluctuations in liquidity conditions, as well by alterations in the degree of risk aversion prevailing in financial markets (Barbosa, 2010).

Expected Impact: The SCDS is expected to increase in times of market turbulence, as well as during periods of economic slowdown. As the SCDS have been widely used as an hedging instrument, against the risk of solvency, the SCDS prices and the government bond yield spreads are expected to move together.

A regression model that aims to capture the importance of the credit risk factor, in driving sovereign debt spreads, is more complete and accurate if in addition to macroeconomic variables, CDS price movements are also considered.

4.2.3 Liquidity Risk

One of the particular characteristic of the bond market is that most of the securities are traded over the counter - OTC. In line with knowledge the fact arises that, whenever analyzing previous literature, a commonly and widely accepted measure to empirically capture the relevance of liquidity risk premium in driving bond yield spreads cannot be found.

According to Schwartz (2014), immediacy is the most relevant component in influencing government bonds liquidity conditions, the bond yield bid-offer spread will be used as a proxy to measure the importance of liquidity in driving yields. The Bid-Offer spread is calculated as the difference between the bid and the offer side of the Portuguese 10 year government bond yield. Barrios *et al.*, (2009), Favero *et al.*, (2010), Gerlach *et al.* (2010), Bernoth and Erdogan (2012) also used the Bid/Offer spread as a proxy to empirically measure the relevance of liquidity conditions in driving bond yield spreads.

Expect Impact: Market liquidity conditions tend to become more influent, within the bond pricing process, during the times of market turbulence. So, in periods of financial distress, bonds are expected to be traded with a significant price discount, widening on their bid-offer spread while catering to investors demand for a higher liquidity risk premium. On the other hand, a lower liquidity risk premium is expected to be associated to bonds that can be traded quickly, at a fair price and without any significant price discount.

4.2.4 International Risk Factor

The international risk factor aims to capture the global uncertainty and the current level of risk aversion prevailing in the market. The importance of the international risk factor is typically measured through two types of alternative components:

1. BBB/AAA US Corporate Bonds spread
2. VIX, the implied market volatility Index

4.2.4.1 BBB/AAA US corporate bonds spread

The difference between the BBB and AAA rated 10 year US corporate bonds is used to capture the importance of international risk factor in bond yield spreads developments. This indicator measures the extra level of reward that investors demand to invest in BBB rated 10 year US corporate bonds, instead of in the ones with triple a A credit rating. As first suggested by Codogno (2003), and later on also by Gerlach (2010), the difference between the 10 year BBB and AAA US corporate bonds can be used to capture and measure the level of uncertainty and the degree of market risk aversion. Even though both the VIX and US corporate bond yield spreads have been described as a reliable proxy to measure the global degree of risk aversion, according to Santis (2012) US corporate bonds spread perform better. Hence, we chose the VIX to be used mostly during robustness tests.

***Expected Impact*:** It can be assumed that the investor will have a lower risk appetite in times of distress and therefore, we expect the BBB/AAA US corporate bonds spread to widen during periods of market turbulence.

4.2.4.1VIX, the implied market volatility index

The VIX index, Chicago board options implied stock market volatility index, is one of the proxies to capture the role of the international risk factor in explaining government bond yield spread developments. The VIX**,** also known as the "*investors fear of gauge*" (Afonso, 2010) mirrors investors' expectations for the market´s future implied volatility and is based on the number of put options contracts traded. Mody (2009), Beber *et al* (2009) and Gerlach *et al* (2010) have also defined, and incorporated, VIX as good proxy for the international risk factor.

Expected Impact: In line with BBB/AAA spread expectations, it is presumed that the VIX index will increase significantly during periods of higher market instability.

4.2.5 Other macroeconomic variables

In order to complete the set of risk factors employed in the MLRM other two macroeconomic measures will be included as explanatory variables. The choice relied on two variables that also can be understood as predictor indicators for the future economic performance: the economic sentiment indicator and inflation level.

4.2.5.1 Economic sentiment indicator

The economic sentiment indicator should combine judgments and attitudes of the principal actors in the economic process: the producers, consumers and investors. European Commission releases a survey based indicator monthly, known as the economic sentiment indicator (ESI), which aims to capture economic agent's expectations for a given country´s economic performance. ESI is constructed as an average, with non-equal weights, of five other confidence indicators: Industrial confidence indicator, Services confidence indicator, Consumer confidence indicator, Construction confidence indicator and Retail trade confidence indicator. This indicator is relevant to include in the model as it captures both the supply and demand side of economy, and also due to the fact that ESI data is available before the official release of macroeconomic data. (e.g. the industrial growth rate or the real GDP growth rate).

Expected Impact: It can be expected that an improvement in the investors' economic confidence would lead to a decrease on government bond yield spread; an increase in the confidence levels should lower the level of risk assigned to the issuer country.

4.2.5.2 Inflation

Levels of inflation and bond yields are positively correlated. Investors may take inflation into consideration, when pricing a bond yield, as it can be interpreted as a good predictor for the Central Banks future monetary policy decisions. Alternatively, a rise of inflation reduces the consumer's purchasing power of the bond´s future cash flows, and consequently leads investors to demand a higher yield, as a way of compensating for the risk of inflation. Inflation also reflects economic performance: in periods of lower consumption levels, which can be a sign of economic slowdown, inflation tends to decrease. As the aim is to assess the overall market expectations for the European Union as an whole, the average HICP (Harmonized Index Consumer Price) of 27 EU countries[4] will be employed.

Expected Impact: It can be expected that a rise in inflation will be followed by an increase in the government bond yields. Nevertheless, one is aware that that there is a more likely occurrence of inflation having a significant impact on the short end of the curve rather than on longer maturities.

[4] Austria; Belgium; Bulgaria; Croatia; Cyprus; Czech Republic; Denmark; Estonia; Finland; France; Germany; Greece; Hungary; Italy; Latvia; Lithuania; Luxembourg; Malta; Netherlands; Poland; Portugal; Romania; Slovakia; Slovenia; Spain; Sweden; United Kingdom

4.3 Data Final Remarks and Stylized facts

The below table summarizes the explanatory variables to be employed in the MLRM and their related risk factor.

Table 1: Explanatory variables and the related risk factor

Risk Factor	Variable	Variable
International Risk Factor	BBB/AAA	VIX
Liquidity Risk	BID/OFFER	-
Credit Risk		
Perceived Likelihood of default	CDS	-
"Real" Deafult Risk	DEBT	GDP
Other Macroeconomic Variables	ESI	INF

Table 1: The table relates each one of the explanatory variables to the type of risk factor that their inclusion in the MLRM aims to measure. Source: author analysis

Whenever dealing with time series data it can be expected that there will be non-stationary issues. Therefore, we will start our research analysis by assessing the presence of a unit root on the time series data, through the use of the Augmented Dickey-Fuller (ADF) test (Dickey and Fuller, 1979). The results obtained from modeling non stationary data may result in spurious conclusions, possibly suggesting a relationship between two variables where there is none. Thus, to create more consistent and reliable judgments non-stationary data will be transformed. In order to assess the possible existence of a deterministic and stochastic trend, we will start the analysis by employing a trend and intercept.

Table 2: ADF Unit Root Test

Variable	SPREAD	BBB/AAA	VIX	BID/OFFER	CDS	DEBT	GDP	IND	EXP. DEBT	EXP. DEFICIT	ESI	INF
Level	-1,48	-2,54	3,62	-1,74	-0,56	-1,09	-1,91	-2,77	-2,16	-2,84	-1,52	2,36
First Difference	-3,22	-9,55	-7,79	-7,00	-4,93	-9,67	-10,96	-13,48	-2,40	-9,49	-5,05	4,14

Table 2: The table reports the ADF Unit Root t-statistics for each one of the explanatory variables. Source: author analysis

So, we can apply the below linear transformation to convert non-stationary variables:

$$\Delta X_t = X_t + X_{t-1}$$

As a criteria decision for the ADF unit root tests results, we used a 5% confidence level to determine whether the data needed to be transformed into stationary or not; as well as to assess at which level each one of the variables may become stationary[5]. Analyzing the *t-statistics* from the ADF unit root tests, we can conclude that there is no statistical evidence to reject the presence of a unit root during the period January of 2007 to December of 2014. The exception is VIX. However, exp. DEBT does not become stationary in the first order. Hence, the second difference should be applied with the aim of reaching order two stationary for the exp. DEBT [6].We also performed ADF unit root tests for each one of the three time sample periods to compute the necessary data transformation before estimating the regression model[7].

As a summing point, the below table gathers all the previous described variables and their related data source.

Table 3: Data description and sources

Variable	Description	Source
SPREAD	10 year Portuguese bond yield (differential against Germany)	Bloomberg
BBB/AAA	Difference between BBB and AAA rated 10year US corporate bonds	FRED database
VIX	Market implied volatility index	Bloomberg
BID/OFFER	Difference between Bid/Offer 10 year government bond yield	Bloomberg
CDS	5 year credit default swap spread (US denominated)	Bloomberg
DEBT	Quarterly debt of GDP ratio (differential against Germany)	OECD database
GDP	Quarterly real GDP growth rate (differential against Germany)	OECD database
IND	Monthly industrial growth rate (differential against Germany)	OECD database
Exp. DEBT	Expected debt to GDP ratio (differential against Germany)	European Commission
Exp. DEFICIT	Expected deficit to GDP ratio (differential against Germany)	European Comission
ESI	Economic sentiment indicator	European Comission
INF	Monthly HICP (Average of 27 EU countries)	OECD database

Table 3: The table summarizes all the variables that we will use during the research analysis as well as their related data source. Source: author analysis

[5] If the p-value is above 0.05 the null hypothesis is not rejected, which means that, there is unit root and therefore, the variable is non-stationary.
[6] Exp. DEBT becomes stationary, in second order, with a 1% confidence level (p-value = 0,0001)
[7] The ADF Unit root test results, for each of the three sample periods, are shown on annex 12, 13 and 14

5. RESEARCH METHODOLOGY

The research analysis intends to study the relationship between the Portuguese sovereign debt spread and a set of relevant risk factors: credit risk, liquidity risk and international risk. In order to identify the main determinants, and to explain the evolution, of the Portuguese sovereign debt spread, we will start our empirical research analysis by estimating the Multiple Linear Regression Model (MLRM) through the use of the Ordinary Least Squares (OLS) method.

The below equation aims to explain the evolution of the 10 year Portuguese government bond yield, as compared to German bund with the same maturity, form January of 2007 to December of 2014. The model is defined on a monthly basis, and the non-stationary data issues were handled before its inclusion in the model.

$$SPREADt = \beta 0 + \beta 1 SPREADt - 1 + \beta 2\,(BBBt/AAAt) + \beta 3 BID/OFFERt + \beta 4 CDSt + \beta 5 DEBTt + \beta 6 GBPt + \beta 7\, ESIt + \beta 8 INFt \quad \textbf{(1)}$$

Where,

$SPREAD_{it,}$ - represents the dependent variable; and it is the difference between the Portuguese and the German 10 year government bond yields.

$SPREAD_{t-1}$ - is the lag variable; and it is included to capture the persistence of yields spreads.

($BID_t/OFFER_t$) - is the bid/offer spread of the Portuguese 10 year government bonds.

CDS_t - is the 5 year Portuguese sovereign debt CDS contracts (USD denominated)

GBP_t - represents the gross domestic product quarter to quarter real growth rate; and it is defined as a differential against Germany

$DEBT_t$ - stands for the differential between Portuguese and German general government debt, and it is defined as a % of GDP

INF_t - expresses the average monthly inflation for 27 Euro area countries

ESI_t - measures market agents confidence over the Portuguese economy future developments

(BBB_t/AAA_t) - represents the differential between the BBB and AAA rated US corporate bond yields

β_0 is the intercept and β_i (i=1,2,3,4,5,6,7,8) represents the coefficient for each of the independent variables. The above base equation was "*designed"* in a way that could account for the large majority of the different types of risk factors that, according to previous literature, may be important in explaining government bond yield spreads developments.

Before estimate the MLRM, and being aware that the presence of a close relationship between explanatory variables is a limitation of the model, we analyzed the interdependence between each variable and the others throughout a correlation matrix.

Table 4: Correlation Matrix

	SPREADt	SPREADt-1	BID/OFFER	CDS	GDP	DEBT	ESI	BBB/AAA	INF
SPREADt	**1**								
SPREADt-1	0,99	**1**							
BID/OFFER	0,91	0,88	**1**						
CDS	0,98	0,96	**0,93**	**1**					
GDP	-0,55	-0,53	-0,49	-0,54	**1**				
DEBT	0,71	0,67	0,55	0,73	-0,51	**1**			
ESI	-0,64	-0,65	-0,53	-0,59	0,12	-0,46	**1**		
BBB/AAA	0,1	0,09	0,17	0,13	0,2	0,08	0,57	**1**	
INF	0,23	0,2	0,36	0,28	-0,34	-0,05	0,04	0,16	**1**

Table 4:The above table reports the correlation level, from -1 to 1, between each variable and the others
Source: author analysis

The high correlation between our independent variables, shown in table 4, increases the difficulty in capturing the individual effect of each one of them in driving the Portuguese sovereign debt spread. In fact, the matrix correlation is the first sign that we may have to deal with multicollinearity issues and consequently must exclude one or more explanatory variables from the regression model. The strong correlation among some of the variables was already expected and is in line with what was discussed in section 2 and 3, when reviewing other reports.

CDS and BID/OFFER show a 0,93 coefficient of correlation[8]. The strong positive association between liquidity conditions and the country perceived likelihood of default has been a widely debated issue over the past years. This relationship is in line with previous studies conclusions: market liquidity conditions are driven by changes in the credit default swap market. Bongaerts *et al.* (2009) findings also suggested that the CDS market includes a reward demanded for the underlying asset expected liquidity conditions. There is a large credit risk component related to the underlying asset´s liquidity. According to Pelizzon and Subrahmanyam (2014) the relationship is stronger and tighter when the CDS spread is above 500 basis points.

Aware of the high correlation between explanatory variables, and in order to avoid spurious regression results, we will employ the following approach first for the entire time period, and then for each one of the others time period samples.

1. Estimate Equation 1
2. Multicollinearity test; Remove, in case it's needed, the VIF criteria suggested variable[9]
3. Re-estimate the equation
4. Multicollinearity test (Back to step 2 whenever collinearity problems still present; follow to point 5 if there are no longer collinearity issues to handle)
5. Robustness test for the international risk factor[10]
6. Perform specification tests for each period adjusted final equation

Before starting the research analysis, through the estimation of the MLRM, the below table summarizes the impact that we expect each one of the explanatory variables to have on the Portuguese sovereign debt spread.

Table 5: Explanatory variables expected coefficient signs

Variable	BBB/AAA	VIX	BID/OFFER	CDS	DEBT	GDP	Exp. DEBT	Exp. DEFICIT	IND	ESI	INF
Expected signal	+	+	+	+	+	-	+	+	-	-	+

Table 5: The table reports the impact that we expect each one of the explanatory variables to have on the Portuguese sovereign debt spread. Source: author analysis

[8] The coefficient of correlation goes from -1 to 1
[9] Marquardt (1970) VIF ≥ 10 selection criteria
[10] Estimate the model with VIX (instead of BBB/AAA) to capture the international risk

6. DISCUSSION OF RESULTS

6.1 Whole Period (January 2007 - December 2014)

After estimating the multiple linear regression model through the use of the eviews software, we reached the statistical significance levels for each one of the previously described explanatory variables. Nevertheless, when analyzing the results, we must take into consideration that, in spite of the perceived complexity of financial instruments, financial markets are made by people. We can determine that it´s *how* investors interpret the domestic and the external framework that better explains the financial market movements. This conclusion is also present within the government bond market context.

Therefore, in order to understand the Portuguese sovereign debt spreads' evolution, we must go through an analysis of the Portuguese main economic and political episodes. In the meanwhile we cannot forget to focus on the "*big picture*", so we must analyze the Portuguese framework within the international context. The table 34 summarizes the most relevant domestic and international episodes that may have a role in in explaining the government bond *yield* spreads developments from January of 2007 to December of 2014.

When first estimate the MLRM, as defined in equation 1, the findings (annex 15) indicate liquidity conditions, BID/OFFER, *perceived* credit quality, CDS, macroeconomic fundamentals, DEBT and GDP, and the economic sentiment, ESI, as statistically relevant to explain the Portuguese sovereign debt spread. The positive coefficient for the liquidity risk factor proves that a widening of the 10 years Portuguese Bid/Offer spread tends to be followed by an increase of the Portuguese sovereign debt spread. For the sovereign credit risk component, our findings also indicate that sovereign credit risk was a valuable factor on the Portuguese sovereign debt pricing process during the whole analyzed period. Investors valued both the *real risk* of default, measured through macroeconomic indicators, as well as the *perceived likelihood* of default, measured through CDS price movements. However, the correlation matrix (table 4) suggested an high degree of interdependence between explanatory variables, which may lead us to unreliable conclusions. Hence, we must perform the collinearity diagnostic test in order to be sure that we can distinguish the true effect of each one of the explanatory variables on the Portuguese sovereign debt spread.

A higher than 10 VIF value[11] for CDS and SPREADt-1 (annex 19) suggests that those two variables are highly correlated with, at least one, of the other explanatory ones. The most commonly used solution to handle collinearity issues relies on excluding the explanatory variable from the ones with strong correlation, with the smallest *t-test* value. Accordingly to the VIF criteria, SPREAD*t-1* should be the chosen variable to be removed from the MLRM. However, as the lag variable is included to capture the persistence of the Portuguese bond yield spread (theoretical reasons) we will instead exclude CDS and (re)estimate the equation accordingly. Nevertheless, still important to note that excluding CDS from the explanatory variables does not mean it is not an important risk factor to explain spreads developments. In fact, as illustrated in figure 3 below, the Portuguese 5 year CDS and the 10 year government bond yield spread move together over the whole analyzed period.

Figure 3: CDS and Portuguese sovereign debt spread
(January 2007 - December 2014)

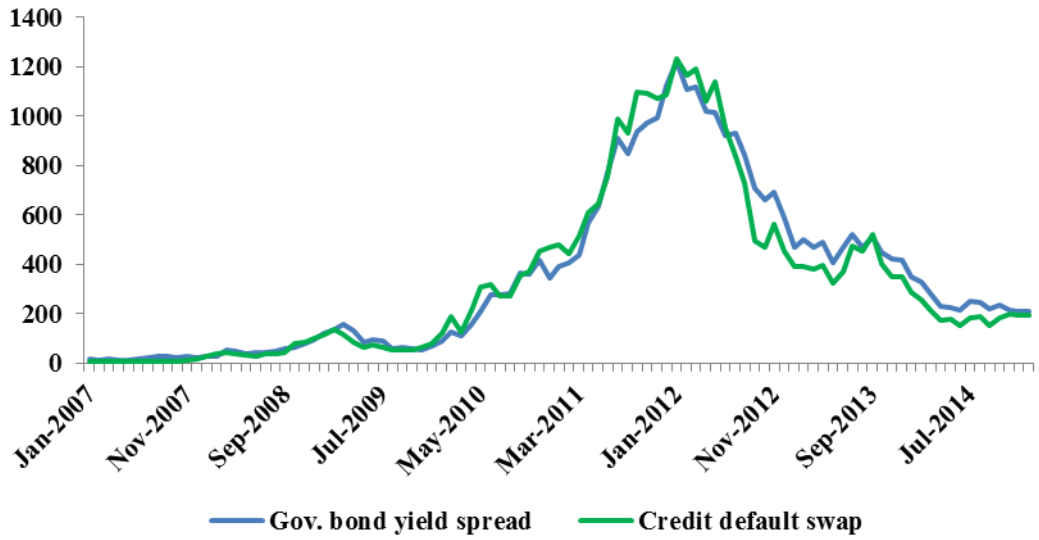

Figure 3: Yield spread between the 10 year Portuguese government bond and the German bonds with the same maturity; Portuguese 5 year credit default swap evolution from January of 2007 to December of 2014. Source: Bloomberg data; author analysis

[11] Accordingly to Marqardt (1970) a VIF value higher than 10 means that the variable Xj is strongly related with the others explanatory variables.

The sovereign CDS market developments are a reflection of changes in investors' market pricing behavior. It is interesting to discuss what drives the way investors' assess and price risk. As suggested by Santis *et al*. (2012) there are two important categories of risk factors in driving sovereign CDS: *(i)* a change in the market assessment of the underlying risk - debt issuers are riskier than initially thought; or *(ii)* a change in the market risk pricing behavior - the compensation demanded by investors to carry a given unchanged amount of risk is higher due to the increase in the degree of risk aversion.

Accordingly, we must re-estimate the MLRM, without CDS among the explanatory variables, but as a way of compensating the regression model, we include another variable that aims to capture the impact of macroeconomic fundamentals in driving government bond yield spreads; the *INDt.*

INDt - represents the monthly industrial production growth rate; and is defined as a differential against Germany (in line with the approach employed for all the other macroeconomic variables)

Hence, the adjusted MLRM becomes the following:

$$SPREADt = \beta 0 + \beta 1 SPREADt - 1 + \beta 2\,(BBBt/AAAt) + \beta 3(BIDt/OFFERt) + \beta 4 INDt + \beta 5 DEBt + \beta 6 GBP + \beta 7 ESIt + \beta 8 INFt \quad \textbf{(2)}$$

As we can see (annex 15) with the exclusion of CDS, the variables DEBT and GDP have lost their statistically significance and the new variable, INDt, appears as statistically significant. However, the inclusion of the monthly industrial production growth rate was not enough to compensate the absence of the CDS amongst the explanatory variables. The exclusion of the CDS implied a drastic reduction in the overall significance of the model: the adjusted R-squared decreased from 80% to 44%. As a robustness test we can switch the variable used to capture the impact of the international risk factor. After replacing BBB/AAA US corporate bonds spread per VIX , we re-estimate the equation:

$$SPREADt = \beta 0 + \beta 1 SPREADt - 1 + \beta 2\, VIXt + \beta 3(BIDt/OFFERt) + \beta 4 INDt + \beta 5 DEBTt + \beta 6 GBP + \beta 7 ESIt + \beta 8 INFt \quad (\mathbf{3})$$

We can observe, as shown on annex 15, that VIX performs better than the BBB/AA as its inclusion was able to slightly increase the overall significance of the model. International risk factor robustness test also allow us to explore the sensitivity among explanatory variables: replacing BBB/AAA per VIX led inflation to become statistically significant[12]. Re-computing the collinearity tests on the adjusted equation, as shown in annex 19, we can see that there are no longer any collinearity issues to handle.
In order to assess the overall robustness of the model besides the collinearity diagnostic test and we also performed tests on: 1. the errors normality assumption by computing the Jarque-Bera test; 2. the second order errors' autocorrelation through the Breusch-Godfrey test, and 3. the homoscedasticity assumption by applying the White test. The results shown in annex 30, 31 and 32 indicate that there is no statistical evidence to reject the no normality, homoscedasticity and no autocorrelation assumptions. Thus we can admit that OLS estimators are BLUE (Best Linear Unbiased Estimators).

Going through the breakdown of the whole analyzed period into three time periods we aim to capture the market pricing behavior sensitivity to changes in the risk factors. In order words, with the data decomposition, we can aim to assess whether or not the factors that investors value most, whenever investing in Portuguese sovereign debt, have changed over time, in line with structural changes in the economy.

6.1.1 First Period (January 2007 - October 2009)

Regarding the first time period sample, we can apply the same reasoning used before on the entire time period analysis and we start by estimating equation 1.The first period regression results (annex 16) proved the spreads persistence, with the SPREAD*t-1* appearing as statistically significant. In a time period that is mostly characterized by the damage done by the global financial crisis, as well as the eruption of the US subprime crisis in the summer of 2007, it is feasible that there is an increase in the international risk factor relevance in explaining the Portuguese sovereign debt spread.

Accounting for the country specific risk factor, we establish both the liquidity conditions and credit risk appearing to be the most valued risk factors. Upon a first look, we find that the variables included to measure credit risk (both "*perceived"* likelihood and "*real"* risk of default) are important driving elements of the Portuguese sovereign debt spread.

[12] With a 10% confidence level

The macroeconomic variables, DEBT and GDP, which account for a country´s specific economic conditions and may give investors hints about the issuer country´s real credit quality, are both statistically important for the first period. However, it's interesting to explore if their relevance is still significant when the model is adjusted to handle the collinearity problems. We can apply the VIF test to the first period, and following its suggestion, re-estimate the model without including the economic sentiment index among the explanatory variables. The exclusion of ESI produced changes in the statistical significance level of the remaining explanatory variables. Once again, the country´s macroeconomic fundamentals were not able to preserve their statistical importance during the equation´s re-adjustment process. The degree of risk aversion prevailing in international markets, measured through the BBB/AAA Spread, has also lost some of its statistical relevance with the model (re)adjustment. The results keep pointing out the spreads persistence and also indicate the perceived level of default risk and the liquidity conditions to be the most important factors in explaining yields developments between January of 2007 and October of 2009.

Figure 4: Government bond yield spread , CDS and Bid/Offer spread
(January 2007 - November 2009)

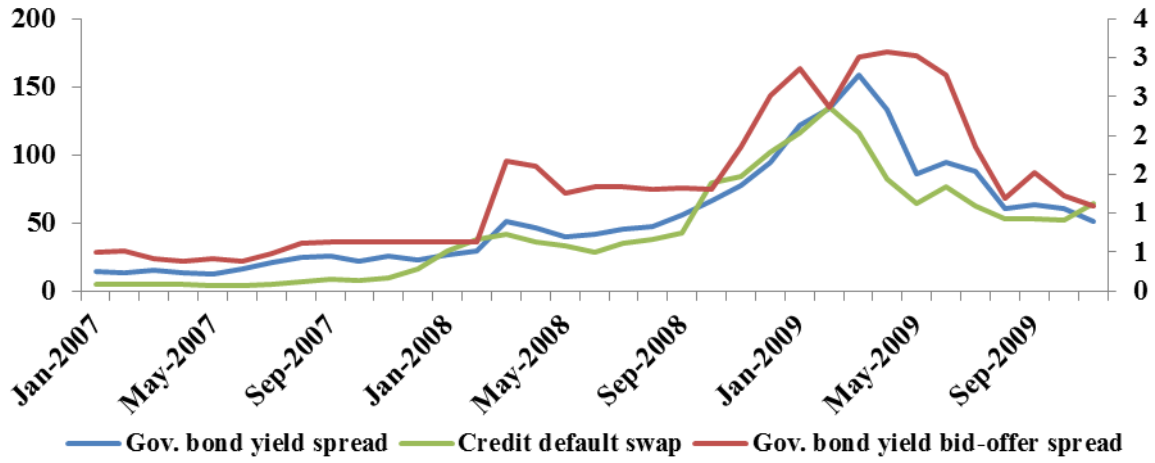

Figure 4: Yield spread between 10 year Portuguese government bond and the German bond of the same maturity; Portuguese 5 year credit default swap and the 10 year Portuguese government bond yield bid-offer spread. Source: Bloomberg data: author analysis

In line with the regression results, figure 4 illustrates the importance of liquidity conditions *(*BID/OFFER) and the *perceived* likelihood of default (CDS) as driving elements of the Portuguese sovereign debt spread by showing how the three factors have been moving together during the entirety of the first time period.

Re-assessing the degree of correlation among the remaining explanatory variables, the collinearity test (as shown on annex 20) does not indicate the exclusion of any other variable from the model, which leads us to the first period final equation:

$$SPREADt = \beta 0 + \beta 1SPREADt - 1 + \beta 2\,(BBBt/AAAt) + \beta 3(BIDt/OFFERt) + \beta 4CDSt + \beta 5DEBTgt + \beta 6GBP + \beta 7INFt \quad (\mathbf{4})$$

Even though our findings from January of 2007 to October of 2009 indicate the market *perceived* likelihood of default, measured through the CDS, and liquidity conditions, measure through the BID/OFFER, as the most relevant factors, we can also identify two international incidents that have impacted on the degree of risk aversion, measured through the international risk factors BBB/AAA or VIX, and that consequently influenced the Portuguese sovereign debt spreads´ developments:

1. August of 2007 - The *official beginning* of US subprime crisis
2. September of 2008 – The Lehman Brothers bankruptcy

Figure 5: Government bond yield and BBB/AAA US corporate bonds spread: (January 2007 - November 2009)

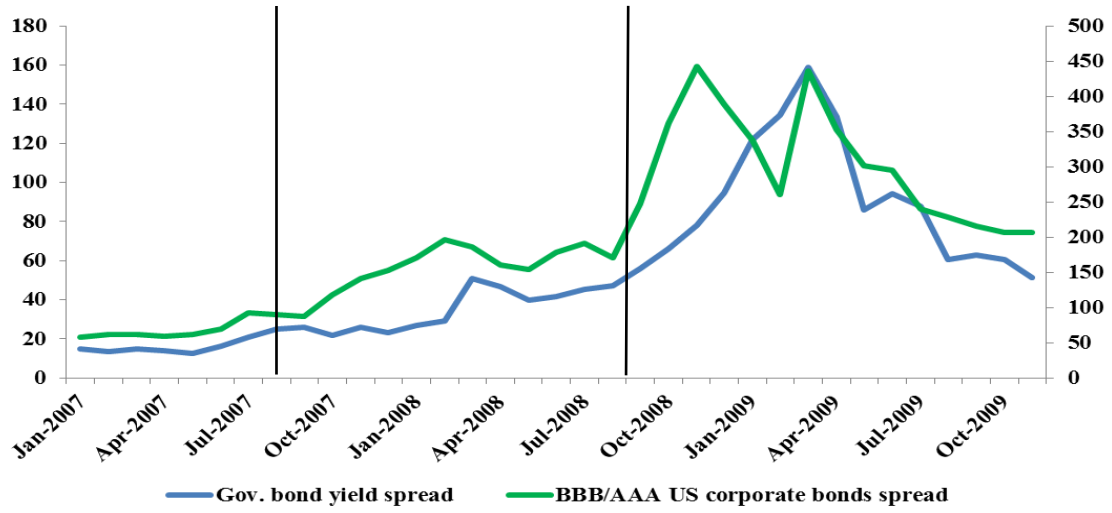

Figure 5: The 10 year Portuguese government bond yield spread ; BBB/AAA US corporate bond spread. The first vertical line marks the *"beginning"* of the US subprime crisis; the second line stands for the Lehman Brother bailout. Source: Bloomberg and FRED database; author analysis

The BBB/AAA US corporate bond spread is broadly used to capture investors' degree of risk aversion. Looking at its graphical evolution we observe how the BBB/AAA increased, after immediately being followed by the Portuguese bond yield spread, around each one of the two events. The first event, which primarily affected the American economy, was able to spread across international borders and lead to an increase in the Portuguese sovereign spread. However, the greater impact came after the second event took place in September of 2008: the Lehman Brothers bankruptcy. The bailout of such an important investment bank can be comprehended as a worldwide triggering event for the global financial markets. Although first "reduced" to be known as the US subprime crisis, the LB bailout caused the world to take notice and thus begin a dangerous global financial crisis.

Initially it was hard to predict just how deeply and widely other countries' economies would be affected. So, how and why were these "*events*" able to affect the Portuguese sovereign debt market? These two disruptive triggers´ increased the Portuguese sovereign yield spreads, firstly leading to *(i)* an immediate increasing in the investors level of risk aversion and consequently to *(ii)* change the way investors perceive and price the country´s risk.

Before the summer of 2007 with bond yield spread around 20bps investors seemed barely indifferent between investing in Portuguese and German sovereign debt. The closer values for the Portuguese and German yields at that time prove that fixed income investors weren´t yet demanding a significant extra reward for investing in Portuguese sovereign debt. In fact, since the beginning of the EMU that the Portuguese 10 year government bond yields, compared to the German ones, were kept at stable and low values. This is explained due to the "*safe heaven*" status that investors used to assign to all the developed economies. Nevertheless, due to the US subprime crisis´ spillover effect to European countries, a turning point in the market pricing risk behavior can be identified: investors started to care more about each country´s fundamentals, and consequently started to further dissect issuers' countries.

6.1.2 Second Period (November 2009 - July 2012)

Applying over the second time period the same reasoning used for the whole sample, as well as for the first one, we start by estimate equation 1. The estimation results (annex 17) show the specific risk factors (both credit risk and liquidity risk) as the most important elements in explaining bond yield spreads during the euro area sovereign debt crisis. Since the summer of 2007, mostly due to the side effects of the global financial crisis, investors were already increasing the "*flights for quality*" and the "*flights to liquidity"*. However after the disclosure of Greece´s *worse than expected* severe fiscal problems, in October of 2009, investors´ risk perception suffered another crash, followed by a sharp increase in the Portuguese sovereign debt spread.

The first estimation results indicate macroeconomic fundamentals, GDP and DEBT, as important elements to drive spreads during this time period. In fact, at that time the Portuguese economic activity was slowing down and the levels of debt, as a % of GDP, were reaching new high historical levels. In line with this, and due to the deterioration of the macroeconomic and fiscal conditions, investors penalized the Portuguese spreads and started demanding higher returns for bearing the risk of investing in the Portuguese government bonds. However, were the investors' reactions proportional to the levels of deterioration in the macroeconomic conditions?

As a robustness test for the macroeconomic fundamentals, and in line with the VIF test suggestion, we can exclude the CDS from the explanatory variables and (re)estimate the equation. The new regression results (annex 17) are in line with what had happened for the whole time period: Due the exclusion of the CDS macroeconomic fundamentals (DEBT and GDP) have lost their statistical relevance and the variable that aims to capture the importance of liquidity conditions (BID/OFFER) is the only one that remain as statistically significant. (Re)computing the collinearity diagnostic test, it seems the outputs on annex 21 indicate the exclusion of the new variable IND. Therefore, we can exclude both CDS and IND can and re-estimate the following equation:

$$SPREADt = \beta 0 + \beta 1 SPREADt - 1 + \beta 2\,(BBBt/AAAt) + \beta 3(BIDt/OFFERt) + \beta 4 DEBTt + \beta 5 GBPt + \beta 6\, ESIt + \beta 7 INFt \quad (\mathbf{5})$$

Accordingly liquidity was the most important factor in driving Portuguese government bond yields during the euro area debt crisis. Hence, the results indicate that the "*flights to liquidity"* flows were a relevant element behind the drastic changes in government bond prices during the global financial crisis and also in the euro area sovereign debt crisis. This finding is in line with what was also suggested by Garcia and Gimeno (2014), how during periods of market stress investors value liquid bonds rather than less liquid bonds, even disregarding their credit quality.

6.1.3 Third Period (August 2012 - December 2014)

After reaching its highest level in January of 2012 (1223bps) Portuguese government bond yield spreads have started on a downwards trend. Therefore, the last analyzed period is mostly known as the adjustment phase in the Portuguese sovereign debt spread. In line with the approach followed previously, we start by estimating equation 1. Nevertheless, we have to go through a (re)adjustment process in order to account for the collinearity problems.

Initially we can find the international risk factor, the *perceived* country likelihood of default and the lag spread as the most important variables to explain the release on Portuguese spreads. It is interesting to note why any of the macro economic variables, DEBT and GDP, come out as statistically significant. Also, the coefficient for both variables doesn´t appear with the expected direction, which may relate to the fact that the spreads started on a decreasing trend before the macroeconomic conditions started to improve. Liquidity conditions lost some of their explanatory power after August of 2012, as this third period is the only one where the liquidity variable does not appear as statistically relevant when the base regression model was estimated. However, "liquidity effect" must be incorporated in at least one of others explanatory variables. This thought arises from the fact that BID/OFFER is, according to VIF criteria, the first chosen indicator to be removed from the model. So, as an attempt to assess in which of the other variables the BID/OFFER is included, we (re)estimate the equation 1 but this time using BID/OFFER as the dependent variable. Nevertheless the results (annex 23) are inconclusive and none of the explanatory variables appear as statistically significant in explaining the BID/OFFER spread.

Even though we are not able to identify, or determine, the most important factors behind the BID/OFFER developments, in order to avoid multicollinearity problems we remove the liquidity variable from the model and re-estimate the equation. We can see that the results have not changed significantly, as we still find the international risk factor, the *perceived* country probability of default and the lag spread as the three most statistically significant variables. However, the collinearity problems are not completely solved yet, and the multicollinearity diagnostic test indicates that we also need to remove the BBB/AAA spread from the explanatory variables. So, we re-estimate the model without this variable, but instead including VIX, to capture the importance of the international risk factor in explaining Portuguese yield spreads developments. In conclusion, after removing BID/OFFER, DEBT and replacing BBB/AAA with VIX, we are able to reach the following third period final equation:

$$SPREADt = \beta 0 + \beta 1SPREADt - 1 + \beta 2VIXt + \beta 3(BIDt/OFFERt) + \beta 4GBPt + \beta 5ESIt + \beta 6INFt \quad (\mathbf{6})$$

According to the third period final results, as shown in annex 18, we can determine that the *perceived* country likelihood of default, CDS, is the only statistically significant driving factor for the Portuguese sovereign debt spread´s tightening process.

6.2 Final remarks

We have started time sample´s research analysis by estimating equation 1, which was "*designed*" to incorporate all the different types of risk factors that may have been behind the sovereign debt spread developments. The main limitation of our MLRM relies on the high levels of correlation among explanatory variables. However, as the final purpose is to be able to identify, and to distinguish, the true impact of each one of the explanatory variables on the Portuguese sovereign debt spread, it was necessary to adjust equation 1, in each one of the stages, before we reached the final equation. [13]

[13] The equation adjustment process followed the six steps approach, as described on section 5.

The results prove that the international risk factor played an important role in driving the Portuguese government bond yield spread. The relevance of the international risk factor becomes more evident when exploring the relationship between the prevailing levels of risk aversion and the changes in the way investors *perceive* and *price* risk. In fact, that helps to explain why and how the international risk became particularly important during the peaks of financial distress.

We can also see that, whenever pricing a government bond, the *perceived* likelihood that the issuer country will enter in default, measured through the CDS price, and the expected future liquidity conditions, captured through the Bid/Offer spread variable, are the most valued factors. But the close degree of interdependence between these two variables makes the results interpretation harder.

The time period from January of 2007 to October of 2009, is the only time in which CDS and BID/OFFER do not appear as highly correlated, and therefore the collinearity diagnostic does not require the exclusion of any of them from the regression model. The lower number of SCDS contracts traded before the Global Financial Crises, and the following lack of liquidity on the developed countries sovereign CDS market, plays a role in explaining this. In the time preceding the global financial crisis, the SCDS market was mostly focused on emerging countries; market agents used to associate emerging economies with higher levels of volatility and uncertainty to lower levels of credit quality. Nevertheless, the euro area sovereign debt crisis deteriorated investors' perceptions, and expectations, also over developed countries credit quality.

In any case, neither the DEBT nor GDP appeared as statistically significant in the adjusted final equation. In fact, when we first estimated equation 1, for the whole period and also for the second time sample, both results showed them to be relevant in driving the Portuguese sovereign debt spread. However, in both cases, the macroeconomic fundamentals lost their statistical value whenever CDS was removed from the regression model.

Table 6: Main interactions between explanatory variables

	SPREAD t-1	BBB/AAA	VIX	BID/OFFER	CDS	DEBT	GDP	IND	ESI	INF
Jan 2007 - Dec 2014										
Base Eq.	-	-	-	X	X	X	X	-	X	-
Removed Variable	-	-	-	-	X	-	-	-	-	-
Added Variable	-	-	-	-	-	-	-	X	-	-
Final adj. Eq.				X				X	X	X
Jan 2007 - Oct 2009										
Base Eq.	X	X	-	X	X	-	-	-	-	-
Removed Variable	-	-	-	-	-	-	-	-	X	-
Added Variable	-	-	-	-	-	-	-	-	-	-
Final adj. Eq.				X	X					
Nov 2009 - Jul 2012										
Base Eq.	-	-	-	X	X	X	X	-	-	-
Removed Variable	-	-	-	-	X	-	-	X	-	-
Added Variable	-	-	-	-	-	-	-	X	-	-
Final adj. Eq.				X						
Aug 2012 - Dec 2014										
Base Eq.	X	X	-	-	X	-	-	-	-	-
Removed Variable	-	X	-	X	-	X	-	-	-	-
Added Variable	-	-	X	-	-	-	-	-	-	-
Final adj. Eq.					X					

Table 6: The black cross indicates the variables that are statistically significant in the beginning as well as in the end of each time period. The red cross marks the variable excluded from the MLRM. The green cross represents the variable included among the explanatory variables. Source: author analysis

7. ROBUSTNESS TESTS

In order to reach reliable results we must perform a set of robustness tests:

1. Define CDS as the dependent variable and estimate the regression model
2. Include macroeconomic forecasted data
3. Calculate the Principal Component of the two series, CDS and BID/OFFER spread, and include it as an explanatory variables
4. Establish a panel of 5 dummy variables in order to account for the impact of structural breaks and non-standard monetary policy announcements.

7.1 CDS as dependent variable

Over the previous section, our empirical findings indicated that the country´s *perceived* likelihood of default, CDS, systematically appeared as the largest component of the Portuguese government bond yield spread. The model loses overall significance, expressed through the adjusted R-squared, whenever we removed it from the explanatory variables. On the other hand, the variables included with the aim of capturing the importance of the country´s macroeconomic fundamentals, DEBT and GDP, when compared with the CDS´s explanatory power, were not that influential in driving spreads developments. Which leads us to the following question: How does the CDS market actually work? How do investors price the risk of unexpected loses? What is the relationship between the sovereign CDS and the government debt market? Does one "*drive*" the other?

In order to assess the explanatory power of the remaining independent variables, on the sovereign CDS spread, the variables SPREAD and CDS switch places and we re-estimate the MLRM with CDS as the dependent variable; expressed as the following:

$$CDSt = \beta 0 + \beta 1 SPREADt + \beta 2\,(BBBt/AAAt) + \beta 3(BIDt/OFFERt) + \beta 4 DEBTt + \beta 5 GBPt + \beta 6 ESIt + \beta 7 INFt \quad (7)$$

As expected, the results (annex 24) prove a high correlation level between sovereign bond yield spread and sovereign CDS. When we first estimated the equation for the full time sample, with CDS as the dependent variable, the found that the sovereign debt spread (SPREAD), the liquidity conditions (BID/OFFER) and also the macroeconomic fundamentals (DEBT and GDP) were statistically significant in driving the Portuguese

sovereign CDS market. Nevertheless, when SPREAD is removed only the liquidity indicator is able to keep its statistical value and the model drastically loses overall significance[14]. The findings are not surprising. As according to Schawrz (2014) the movements in sovereign CDS market are fully reflected in the sovereign debt spread developments, which implies that the sovereign CDS is capable in not only capturing the credit risk, but of all the other components of the government bond yield.[15] Hence, as argued by Longstaff, Pan, Pedersen and Singleton (2011) transaction costs, tax effects and counterparty risk are the main differencing points between sovereign CDS contracts and bond prices, and the reasoning behind whenever this theoretical relationship does not hold.

The importance of macroeconomic fundamentals and other important risk factors, is included both in the sovereign CDS market and sovereign bonds´ prices. Nevertheless, when compared to government bonds the SCDS, particularly during periods of higher market turmoil, tends to absorb the new available information faster. As suggested by Santis (2012) the shifts of the sovereign CDS pricing behavior can be interpreted as an investor overreaction whenever in the presence of unexpected systematic events. Hence, the drastic increasing trend on the SCDS market occurred during the euro area sovereign debt crisis, indicate that the spread increased more than would be expected, and justified, by the macroeconomic context.

We can also estimate the equation, using CDS as the dependent variable, for each one of the three sub sample time periods, shown in annex 25. These results are in line with the whole period´s main findings.

7.2 Forecast data

Government bond yield spreads may be more affected by the release of forecasts than by past performance results. Therefore, in order to test if the inclusion of forecasted macroeconomic information would lead to different results, we can follow the Gerlach, *et al.* (2012) approach and employ forecasted macro-economic information.

[14] Adjusted R-squared decreases from 71% to 0, 19%.
[15] In theory, accordingly to Duffie (1999), hold a Portuguese bond + long Portuguese CDS position + short German CDS position = Buy a German bond. This means the CDS automatically incorporates all the determinants of the bond yields.

As suggested by Gerlach, *et al.* (2012), and later on also applied by Santis (2012), when estimating the model we keep the lower frequency data constant until a new observation occurs. The European Commission releases forecasts regarding the economic and fiscal situation for all European countries every year, in Spring and in Autumn. Based on Santis (2012) approach, we will use the European Commission forecasted data from Spring and Autumn, to collect the necessary data for the two forecasted variables included in the model: DEBT(EXP) and DEF(EXP)[16].

$DEF\ (EXP)_t$ - is the forecast General Government Deficit, expressed as a % of GDP.

DEBT (EXP)t - is the forecast General Government Debt, expressed as a % of GDP.

7.3 Principal Component Analysis

Principal component analysis (PCA) is an useful statistical technique that, as the name implies by itself, finds the principal component (PC) of two, or more, data series. Applying this methodology allows us to reduce the number of variables, to obtain important evidences from unclear data as well as to disclose some hidden dynamics that may have been neglected as their importance was captured for the strong explanatory power of others dependent variables.

Figure 6: Government bond yield spread; CDS and Bid/Offer spread: (January 2007 - December 2014)

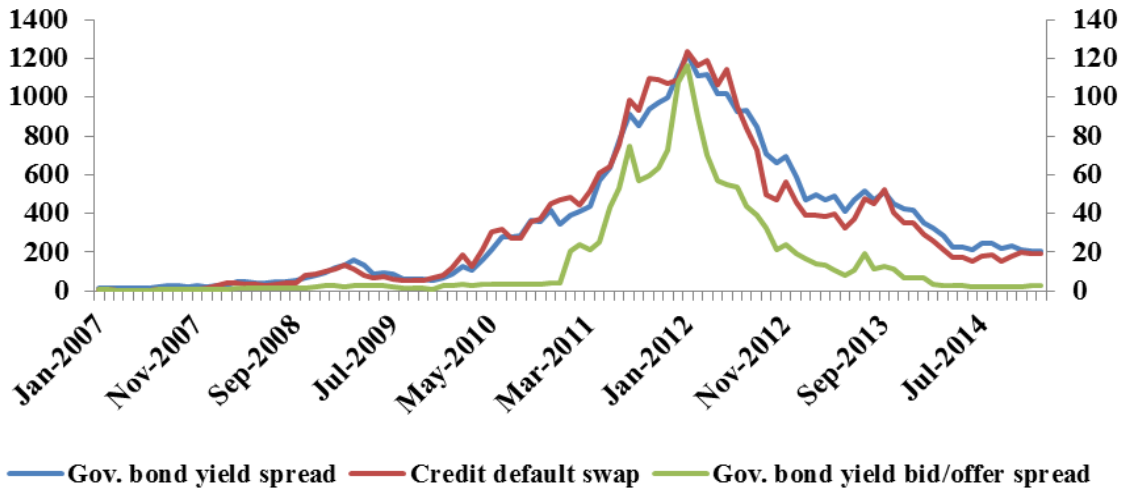

Figure 6: Yield spread between the 10 year Portuguese government bond and the German bond of the same maturity, Portuguese 5 year credit default swap and the 10 year Portuguese government bond yield bid/offer spread. Source: Bloomberg data; author analysis

[16] Both variables are defined, and included in the model, as a differential against Germany.

As illustrated in Figure 6, and also in line with our regression results, the CDS and bid-offer spread are highly correlated. In fact, in section 5, when estimating the equation 1, we always had one or the other appearing as the most important factor in driving government bond yield spreads. However, and due to the high correlation levels amongst these two variables, as well as between them and the Portuguese bond yield spread, the true statistical value of some of the other explanatory variables may be undervalued.

Hence, assembling the PCA[17] approach with the inclusion of macroeconomic forecasts in our regression model, the equation become the following:

$$SPREADt = \beta 0 + \beta 1SPREADt - 1 + \beta 2BBB - AAA + \beta 3DEBTt + \beta 4GDP + \beta 5DEBT\ (EXP)t + \beta 6DEF(EXP)t + \beta 7ESI + \beta 8INF27 + \beta 9PCt \quad (\mathbf{8})$$

Not surprisingly, PC is a statistically valuable driving factor for all of the time periods, and shows an dramatically high and positive coefficient[18]. When compared with our previous empirical research, what becomes "new" and interesting to explore relies on which other factors, besides "the already expected*"* PC, were able to appear as statistically important.

7.3.1 PCA Whole Period (January 2007 - December 2014)

In the whole period, we find the historical performance of the debt level, *DEBT,* and the market agents' expectation fort the Portuguese economy activity, ESI, as the most important factors in driving government bond yield spreads. These results highlighted the Dornbusch *et al.* (2000) theory, in which he argues that the government bond yield spreads´ developments are mainly explained by two sets of elements: 1. The issuer countries´ fundamentals dynamics; 2. The investors´ sentiment perceptions.

Our whole period findings are in line with this approach, as while debt accounts for the importance of economic fundamentals in explaining government bond yield spreads, the economic sentiment index is a confidence driven indicator, mirroring the investors' insights for the current and future economic activity performance.

[17] As their statistical effect is almost indistinguishable, we calculate the principal components (PC) of the two series; CDS and bid-offer spread, and employed it in our regression model.
[18] Range from 130,78 (2ºPeriod) to 375,60 (1ºPeriod)

7.3.2. PCA First Period (January 2007 - October 2009)

In a period marked by the global financial crisis, uncertainty and risk aversion have increased their importance in determining Portuguese government bond yield spreads developments. The international risk factor, BBB/AAA, appearing as statistically significant comes in line with initial expectations: periods of higher turmoil are automatically followed by an increase in the perceive degree of risk aversion. Once again, a sentiment driven indicator, which aims to capture market risk perception, appears as significant along with one macroeconomic variable, the expected DEFICIT to GDP ratio. Uncertainty and higher levels of risk aversion deteriorated investors' confidence levels, followed by a shift in the investors risk pricing behavior.

The DEFICT´s higher level of significance, when compared with other macroeconomic indicators, is not completely unexpected. In the end of 008, afraid of what had happened with the American banking system, the Portuguese government announced a set of measures, table 36, designed to provide financial stability and give liquidity to the national banking sector. Nevertheless, these measures had negative consequences as they also led to the deterioration of Portuguese public finances. After growing around 2% in 2007, the Portuguese economic activity decreased significantly during 2008[19]. The general gross government debt increased to 66,4 % of GDP, worse than the 63,5% registered in 2007. The current account balance deficit also went up and represented, in 2008, 11,9% of GDP.[20] Similarly, analyzing projected data we find another expected significant deterioration of the Portuguese public finances[21]. This comes as a consequence of both the recessionary context as well as the number of discretionary measures, including the fiscal impulse package announced, which was to be implemented in 2009.

[19] Real GDP stagnated in 2008. (Spring 2009, European Commission bulletin)
[20] Up from the 9,7% current account deficit to GDP ratio of 2007 (Spring 2009, European Commission bulletin)
[21] Spring 2009 European Commission projections pointed out to a government deficit to GDP ratio of 6, 5% to be reached in 2009 (against the 2, 6% recorded in 2008).

7.3.3 PCA Second Period (November 2009 - July 2012)

Along with the beginning of the euro area debt crises late in 2009, there was a drastic increase on the government bond yield spread. In this period, besides the PC factor, none of the other explanatory variables were statistically capable to explain such a drastic rise. In fact, these results are interesting because they end up suggesting a visible change in the investors' *sensitivity* to perceive and price fundamentals during the debt crisis[22]. This change in the way investors' perceive and price risk is observed in the extra reward investors' demand for bearing a given unchanged amount of risk (Santis, 2012).

In October of 2009, the Portuguese government bond yield spread was around 61bps. Nevertheless, afterwards, boosted by the beginning of the euro sovereign debt crisis, spreads started a drastic upward movement and have reached the 1223bpps (historically highest level) in January of 2012. As shown on the below table, even though the Portuguese economic conditions, particularly when compared to Germany, deteriorated during the two years of intense sovereign debt crisis, the financial markets response, which led to an increase of 1162bps in spreads, indicates an overreaction from investors.

Table 7: Portugal and Germany macroeconomic fundamentals: (4Q2009 - 4Q2011)

Germany

	4Q2009	4Q2011
DEBT	44,2	44,3
GDP	0,9	0,00
UNEM	7,7	6,0
DEFICIT	-3,3	-0,86

Portugal

	4Q2009	4Q2011
DEBT	78,7	117,4
GDP	0,00	-1,6
UNEM	8,8	9,4
DEFICIT	-9,8	-7,4

Table 7: The table reports the economic and fiscal indicators recorded for Portugal and Germany in 4Q2009 and 4Q2011. Source: OECD; author analysis

[22] See Beirne and Fratzscher (2013)

During periods of crisis investors tend to become more sensitive in pricing fundamentals. Before the global financial crisis the government bond yield spreads did not reflect macroeconomic fundamentals accurately. However, with the beginning of euro area debt crisis, investors started to look at the fundamentals yet still they overrated everything. Thus, we conclude that the yields did not hold their true value prior to the global financial crisis. Moreover, during the euro debt crisis their value was also *biased*, but in the opposite direction.

7.3.4 PCA Third Period (August 2012 - December 2014)

In this phase, we intend to assess whether the decrease of the Portuguese sovereign debt spread is explained by the same set of factors that led to its previous increasing trend.

In the last period we find uncertainty and macroeconomic fundamentals as the most valued factors in explaining the decrease in the Portuguese sovereign debt spread. In fact, the joined effect of these two types of risk factors already explained the spreads developments during the first period. The difference relies on the direction that those factors were heading in each time period. While in the first period the risk aversion was going through a hiking moment and macroeconomic fundamentals were deteriorating, from August of 2012 to the end 2014 the levels of risk aversion decreased and the Portuguese economic performance improved gradually[23].

The results suggest the statistical significance of one macroeconomic indicator both for the first and the third period. Nevertheless, it is interesting to discuss their different nature: while during the first period, investors seemed to care more about the public finances deterioration context[24], during the recovery moment market agents tended to place greater value on real economic performance improvements[25].

[23] Portuguese quarterly GDP real growth rate improved from -1,4 % (2Q2012) to 0,4% in(4Q2014). OECD data.
[24] Forecasted DEFICT is statistically significant, with 1% confidence level, in the period from January 2007 to October 2009
[25] GDP is statistically significant, with a 10% confidence level, in the period from August 2012 to December 2014

7.4 Dummy variables

7.4.1 Structural breaks

In order to account for the possibility of structural breaks in the relationship between Portuguese government bond yield spread and its driving factors, we define two hypothetic breaking points and include it, among the explanatory variables, in the regression model.

The first dummy variable *(D2008.09)* intends to assess the impact of the Lehman Brothers bailout in September of 2008. The date is known as a turning point for investors risk perception. According to Barbosa and Costa (2010), until the LB bailout, the common risk factor was the most valued in explaining spreads developments. However, after that the importance of specific risk factors increased and investors started to look more towards the fundamentals. The second dummy *(D2009.10)* aims to capture the impact of the beginning of the sovereign debt crisis. In October 16th of 2009, George Papandreou disclosed a deficit of 12,7% of GDP for 2009[26]. This date is acknowledged as the "official beginning" of the euro area debt crisis (Santis, 2012).

7.4.2 Non-standard monetary policy

In 1998, with the creation of the EMU, the ECB assumed the role of setting the monetary policy to be followed by all the country members. ECB's primary goal is to maintain the price stability of the euro system and of the single monetary policy for which it is responsible and as a result,, ensure that price stability acts as the monetary policy contribution to economic growth and job creation. The ECB's Governing Council, which includes both governors of the euro-area NCBs and members of the ECB's Executive Board, has monthly meetings and is officially in charge of defining the euro area monetary policy. In order to reach its main goal, the ECB´s may use a set of standard and non-standard instruments (European Central Bank, 2015)

Standard measures. The ECB's Governing Council uses its monthly meetings to decide on *(i)* the interest rate for the main refinancing operations , *(ii)* the interest rates for the standing facilities and, *(iii)* the interest rate for the marginal lending facility and the deposit facility. **Non-standard measures.** Particularly after 2009, along with the beginning of the sovereign debt crisis in euro area, and with the aim of containing the

[26] Against an initial expected 6% of deficit to GDP ratio.

drastic increase[27] in the peripheral countries government bond yields, the ECB has defined several non-standard monetary policy measures, i.e. asset purchasing programs, to complement its traditional measures (European Central Bank, 2015).

The most controversial action was related to the development of the two programmes to buy, in a secondary market, government bonds: *(i)* Securities market program and later on, *(ii)* Outright Monetary Transactions. According to Valliante (2011), the debate over the use of a Quantitative Easing program, to boost liquidity, typically raises two objections: the risk of moral hazard by member states and the risk of deviation from the price stability mission set out in the ECB statute and the European Treaty (TFEU, Art. 121.1) In spite of all the expansionary monetary policies that the ECB applied to contain the euro debt crisis, Zingales (2011*)* argued that unless the ECB uses all of its available resources to make markets believe that countries are doing everything possible to avoid default, the situation will not stabilise.

In order to capture the impact of ECB non-standard monetary policy measures announcements on the Portuguese sovereign debt spread, we will employ a panel of three dummies variables in the equation. Following the Lo Luca and Straub (2014) approach, we defined three announcements that were perceived as unexpected and relevant enough to impulse market movements. As criteria to select the announcements, we pick the ones that appeared on the Financial Times front page right on the day following its announcement. The inclusion of such "events" in the front page of an well-known international newspaper means that the announcement had a large enough exposure to influence investors pricing behavior on sovereign debt. Accordingly, we can define three events with the aim to capture the impact of monetary policy in influencing yield spreads. The first dummy variable *(D2010.05)* aims to assess the market reaction to the Securities Markets Program (SMP) announcement on May 10th 2010. The second dummy variable *(D2011.08)* intends to capture the impact of the SMP reactivation announcement on August 8th of 2011. The third dummy variable *(D2012.07)* is included to evaluate the success of the Mario Draghi´s "*Whatever it takes"* speech in giving confidence to investors.

[27] Particularly felt and visible in euro area peripheral countries government bond yield (Afonso, 2012)

Dummy results

After we repeat our estimations accounting for the presence of structural changes in the spreads determinants the table 32 reports the OLS estimation results.

Colum (1) records the results from the non-standard monetary policy announcements as well as the Mario Draghi confidence speech. The findings suggest a significantly higher market reaction to the announcement of the SMP reactivation, on 8th August of 2011, rather than to its first announcement, on 10th May of 2010. The main conclusion is that while the first time SMP announcement, during the most intense moment for the euro area debt crisis, was not capable of containing the upward movement of the Portuguese government bond yields, after the second SMP announcement all of the explanatory variables were priced in the Portuguese sovereign debt spread. After the Draghi's "*whatever it takes"* speech, the results indicate the international risk factor, the macroeconomic fundamentals (both historical series and forecast data), the inflation level and the investors economic sentiment as the most important factors to explain the Portuguese sovereign debt spread developments. Colum (2) analysis the capability of the two chosen trigger incidents to change the main determinants of the Portuguese government bond yield spread. The international risk factor appears as a statistically significant driving factor after the Lehman Brother bankruptcy in September of 2008. This finding accounts for a market pricing behavior more driven by the prevailing market uncertainty as well as for the degree of risk aversion since the beginning of the global financial crisis. The expected debt started to be negatively reflected on the Portuguese sovereign debt spread since the LB bailout. The PC variable shows a positive and statistically significant coefficient after October 2009, pointing once again for a mispricing in the Portuguese sovereign debt spread (both in the period before and after the beginning of the euro area sovereign debt crisis).

8.1 CONCLUSION

In this dissertation we analyzed the main determinants of the 10 year Portuguese sovereign debt spread from January of 2007 to December of 2014. The German government bond yields, with the same maturity, were defined as benchmark. After estimating the MLRM for the entire period, the data was divided into three time samples: the time period before global financial crisis was transformed into the euro area sovereign debt crisis (January 2007 - October 2009); the most intense period of euro area sovereign debt crisis (November 2009 - July 2012); and the recovering and spreads adjustment period (August 2012 - December 2014). The objective behind this data treatment was to account for the structural changes in the main determinants of the Portuguese sovereign debt spread.

In order to capture the relative influence of the aggregate and specific risk factors we examine the role of an extended set of variables: *(i)* the global uncertainty and degree of investors risk aversion; (*ii)* the *perceived* likelihood of default; (*iii)* the macroeconomic fundamentals and public finance accounts (historical and forecasts series); *(iv)* the liquidity conditions; *(v)* the confidence levels of economic agents; and *(vi)* the twenty seven European Union countries average level of inflation. We estimated, through the use of the Ordinary Least Squares (OLS) method, a Multiple Linear Regression Model (MLRM). The main limitation of this approach results from the high degree of correlation among explanatory variables. Therefore, in order to reach reliable results, distinguishing the true impact of each explanatory variable, we employed a six-step methodology (**1**. Estimate the *base* equation 1; **2.** Apply the collinearity diagnostic test; **3.** Re-estimate the adjusted equation; **4.** Re-perform the collinearity diagnostic test; **5.** Apply the robustness test for the international risk factor; **6.** Perform stability tests for the each period final adjusted equation). This approach allowed us to explore the main interactions among explanatory variables:

- The macroeconomic fundamentals lose explanatory power whenever the CDS variable is excluded from the MLRM.
- CDS and BID/OFFER spread are highly correlated. The first interval, January 2007 - November 2007, is the only in which these two risk factors are not excessively correlated, and the collinearity diagnostic test does not suggest the exclusion of any of them from the MLRM. Prior to the Global Financial Crisis, the sovereign

CDS market was mostly focused on emerging economies because investors used to perceive developed countries as zero default risk. This explains the lower volume of SCDS contracts traded over the developed economies, and the consequent lack of liquidity.

- The Portuguese sovereign debt spread and CDS market move together during the entire analyzed period. This leads to the question: Does the CDS market *drive* the Sovereign debt market or is it the other way around? Besides credit risk, the CDS market is able to capture all the risk components included in the sovereign bond yield. Moreover, during moments of higher market turbulence, the sovereign CDS market tends to absorb new available information faster.
- The third period, from August of 2012 to December of 2014, is characterized by the decrease and adjustment on the Portuguese sovereign debt spread. This is the only time in which the BID/OFFER spread is not one of the most valuable factors in explaining spreads developments. The "*fights to liquidity"* episodes are particularly visible in periods of market turbulence, where investors struggle for high-liquidity bonds, even disregarding their credit risk level.

In spite of the several interactions between explanatory variables, we could not reach a common final equation for each of the analyzed time periods after concluding the model readjustment, which compromises our initial goal: assess whether or not the relative importance of the common and specific risk factor has changed over time, aligned with structural changes in the economy.

Therefore, we repeated our analysis assembling forecast macroeconomic data with a PCA (Principal Component Analysis) methodology. This approach allowed us to disclose some hidden dynamics that had been neglected due to the strong explanatory power of the variables CDS and Bid/Offer spread. The collinearity issues disappeared, the model stabilized and the results comparison become more reliable.

The results show that the Portuguese government bond yield spreads, in the long run, are mainly explained by two broad categories of risk factors: 1. the country´s specific fundamentals dynamics; 2. the investors' sentiment and perceptions over the issuer country future economic performance. Moreover, the findings also suggest a visible shift in the investors pricing behavior when structural changes occur within the economic and social context.

The low and stable values for the Portuguese sovereign debt spread (10-20bps) support the idea that before the beginning of the GFC (Global Financial Crisis), the Portuguese government bond yields were mostly driven by a *trade convergence model*. This change in the main determinants of the Portuguese sovereign debt spread can be analyzed in three intervals:

- In the period January 2007 - October 2009, marked by the begging of the US subprime crisis as well as for the Lehman Brothers bailout, the prevailing degree of risk aversion and the expected developments in fiscal fundamentals were the most valuable drivers of the Portuguese sovereign debt spread.
- During the second time period, November 2009 - July 2012, the Portuguese spreads increased by 1160 bps. In this phase, besides the PC (Principal Component) indicator, none of the other explanatory variables was statistically capable of explaining such a drastic rise. This dramatic upward movement in the Portuguese sovereign debt spread is not fully explained by the deterioration on macroeconomic conditions and therefore, it is mostly justified due to the investors' overreaction whenever in the presence of unexpected systematic events.
- In August 2012 - December 2014, we find that the relevant risk factors in the adjustment phase, are the same as in the first period (the international risk factor and the macroeconomic & fiscal fundamentals). The main difference is the direction that these risk factors were heading in each period.

Hence, we conclude that before the Global Financial Crisis, Portuguese government bond yields were below their true value *(*bond prices *overvalued)*, and with the Euro area debt crisis it continued biased, but this time in the opposite direction *(*bond prices *undervalued).*

8.2 SUGGESTIONS FOR FUTURE WORK

This work allowed us to get a better understanding of the Portuguese sovereign debt market, however it is important to recognize the limitations of the models employed. Therefore, as a final note we suggest some other approaches that can be interesting to explore in future studies:

1. Evaluate the impact of Credit Rating agencies in driving the Portuguese government bond *yields.* In efficient markets the price of an asset should automatically incorporate all the available relevant information; consequently the credit ratings and outlook updates should only be a formal reflection of all the publicly disclosed data. In the case this assumption holds, the importance of credit rating agencies should be limited. Nevertheless, previous studies have suggested that downgrades, or negative outlooks, in sovereign credit ratings partly explain the dramatic upwards trend in the EMU peripheral countries government bond yields since October of 2009.

2. Measuring the spillover effect across EMU countries (transmission effects within peripheral countries as well as between core countries and the periphery). We live in a global financial world where is no longer possible to contain the impact of an event to the physical place where it has occurred. Hence, the inclusion of a component that allow us to measure at which extend the disclosure of *worse than expected* macroeconomic information, for a given issuer government, is capable of affecting the sovereign debt developments of other country (with some perceived similar features) will also be an interesting side to explore.

3. The sovereign credit default swap market and the government bond yields move together during the entire analyzed period. Thus, performing a deeper analysis over the most relevant set of risk factors behind the sovereign CDS market pricing process can also lead us to a better understanding of the main determinants of the Portuguese government bond yields.

4. Investors tend to react expressively to *non-expected* announcements as well as to important market incidents. Therefore, the development of a study event methodology could allow us to capture investors main reactions to both international and domestic events, as well as to disclose some interesting dynamics behind the sovereign debt pricing process.

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APPENDIX I

Table 8: Descriptive Statistics

JAN 2007 – DEC 2014

	Mean	Median	Maximum	Minimum	Observations
SPREAD	351,79	245,73	1 223,05	12,44	95
BBB/AAA	175,31	176,00	442,00	58,00	95
VIX	21,93	19,08	62,27	11,11	95
BID/OFFER	15,93	3,14	116,26	0,38	95
CDS	339,92	211,84	1 232,50	4,13	95
DEBT	12,22	12,20	21,30	3,90	95
GDP	-0,39	-0,50	2,20	-2,70	95
Exp. DEBT	20,61	12,40	50,95	1,10	95
Exp. DEFICIT	-3,81	-3,20	-1,70	-13,00	95
ESI	92,52	93,80	108,50	74,80	95
INF	2,13	2,20	4,40	0,20	95
IND	-3,92	-4,05	14,72	-16,70	95
PC	0,00	-0,63	4,66	-1,13	95

Table 8: The table reports the main descriptive statistics (Mean; Median; Maximum; Minimum and Nº of Observations) for each one of the explanatory variables from January of 2007 to December of 2014.

Table 9: Descriptive Statistics

JAN 2007- OCT 2009

	Mean	Median	Maximum	Minimum	Observations
SPREAD	55,64	46,87	158,94	12,44	33
BBB/AAA	199,03	178,00	442,00	58,00	33
VIX	28,01	25,03	62,27	11,11	33
BID/OFFER	1,38	1,31	3,08	0,38	33
CDS	44,83	37,95	135,44	4,13	33
DEBT	6,87	5,80	11,00	3,90	33
GDP	0,22	0,00	2,20	-0,80	33
Exp. DEBT	1,88	2,00	2,40	1,10	33
Exp. DEFICIT	-2,39	-2,53	-1,70	-2,90	33
ESI	4,57	3,78	14,72	-4,05	33
INF	96,45	103,00	108,50	74,80	33
IND	2,45	2,20	4,40	0,20	33
PC	-1,02	-1,03	-0,80	-1,13	33

Table 9: The table reports the main descriptive statistics (Mean; Median; Maximum; Minimum and Nº of Observations) for each one of the explanatory variables from January of 2007 to October of 2009.

Table 10: Descriptive Statistics

NOV 2009 - JUL 2012

	Mean	Median	Maximum	Minimum	Observations
SPREAD	590,32	438,25	1 223,05	51,39	33
BBB/AAA	195,73	197,00	235,00	159,00	33
VIX	22,34	20,47	36,55	16,17	33
BID/OFFER	34,98	24,08	116,26	1,10	33
CDS	633,44	517,53	1 232,50	64,33	33
DEBT	16,54	16,10	21,30	9,80	33
GDP	-1,00	-0,90	0,30	-2,70	33
Exp. DEBT	17,39	12,40	34,05	7,87	33
Exp. DEFICIT	-5,20	-3,60	-3,03	-13,00	33
ESI	90,45	93,00	98,70	78,00	33
INF	2,47	2,70	3,30	0,50	33
IND	-4,60	-4,60	9,60	-15,50	33
PC	1,14	0,52	4,66	-0,98	33

Table 10: The table reports the main descriptive statistics (Mean; Median; Maximum; Minimum and Nº of Observations) for each one of the explanatory variables from November of 2009 to July of 2012.

Table 11: Descriptive Statistics

AUG 2012 - DEC 2014

	Mean	Median	Maximum	Minimum	Observations
SPREAD	417,37	422,38	845,88	212,87	29
BBB/AAA	126,48	123,00	205,00	90,00	29
VIX	14,54	14,13	18,06	11,53	29
BID/OFFER	10,80	7,75	39,35	1,96	29
CDS	340,76	351,72	729,57	150,84	29
DEBT	13,39	13,10	17,50	11,00	29
GDP	-0,40	-0,40	0,70	-1,50	29
Exp. DEBT	45,58	43,80	50,95	34,05	29
Exp. DEFICIT	-3,84	-3,87	-3,10	-4,65	29
ESI	91,08	90,70	103,10	76,90	29
INF	1,38	1,30	2,70	0,30	29
IND	-12,80	-12,80	-8,50	-16,70	29
PC	-0,14	-0,23	1,46	-0,77	29

Table 11: The table reports the main descriptive statistics (Mean; Median; Maximum; Minimum and Nº of Observations) for each one of the explanatory variables from August of 2012 to December of 2014.

Table 12:ADF Unit Root Test

JAN 2007 - OCT 2009

Variable	Level	First Difference
SPREAD	0,92	**0,01***
BBB/AAA	0,70	**0,00***
VIX	0,47	**0,01***
BID/OFFER	0,90	**0,00***
CDS	0,63	**0,04****
DEBT	0,14	**0,00***
GDP	0,24	**0,00***
IND	0,35	**0,00***
Exp. DEBT	0,72	**0,00***
Exp. DEFICIT	0,72	**0,00***
ESI	0,06	**0,00***
INF[28]	0,75	0,18

Table 12: The table reports the results from the OLS regression. The adjusted R-Square and the estimated coefficients are presented; * Significant with 1% of confidence level; ** Significant with 5% of confidence level; ***Significant with a 10% confidence level

Table 13: ADF Unit Root Test

NOV 2009 - JUL 2012

Variable	Level	First Difference
SPREAD	0,96	**0,00***
BBB/AAA	0,12	**0,03****
VIX	0,41	**0,00***
BID/OFFER	0,58	**0,03****
CDS	0,98	**0,00***
DEBT	0,98	**0,00***
GDP	0,83	**0,00***
IND	0,33	**0,00***
Exp. DEBT[29]	0,22	0,79
Exp. DEFICIT	0,47	**0,02****
ESI	0,25	**0,00***
INF	0,68	**0,00***

Table 13: The table reports the results from the OLS regression. The adjusted R-Square and the estimated coefficients are presented; * Significant with 1% of confidence level; ** Significant with 5% of confidence level; ***Significant with a 10% confidence level

[28]INF only becomes stationary in second order
[29] Exp. DEBT only becomes stationary in second order

Table 14: ADF Unit Root Test

AUG 2012 - DEC 2014

Variable	Level	First Difference
SPREAD	0,09	**0,00***
BBB/AAA	0,84	**0,03****
VIX	0,00	**0,00***
BID/OFFER	0,00	**0,00***
CDS	0,07	**0,00***
DEBT	0,59	**0,02****
GDP	0,34	**0,00***
IND	0,00	**0,00***
Exp. DEBT	0,32	**0,00***
Exp. DEFICIT	0,68	**0,00***
ESI	0,53	**0,01***
INF	0,24	**0,01***

Table 14: The table reports the results from the OLS regression. The adjusted R-Square and the estimated coefficients are presented; * Significant with 1% of confidence level; ** Significant with 5% of confidence level; ***Significant with a 10% confidence level.

Table 15: OLS Regression

JAN 2007 - DEC 2014

Variable	Coefficient	Coefficient	Coefficient
C	1,97	1,83	-14,18
SPREAD t-1	-0,03	0	-0,01
BBB/AAA	0,09	0,15	-
VIX	-	-	0,73
BID/OFFER	**2,36***	**4,51***	**4,54***
CDS	**0,55***	-	-
DEBT	**-6,45***	-2,83	-3,4
GDP	**-9,48****	-1,16	-0,41
IND	-	**-3,52****	**-3,69****
ESI	**-2,45****	**-4,28***	**-3,29*****
INF	9,9	23,72	**30,12*****
Adjusted R-squared	**0,8**	**0,44**	**0,45**

Table 15: The table reports the results from the OLS regression. The adjusted R-Square and the estimated coefficients are presented; * Significant with 1% of confidence level; ** Significant with 5% of confidence level; ***Significant with a 10% confidence level.

Table 16: OLS Regression

JAN 2007 - OCT 2009

Variable	Coefficient	Coefficient
C	-0,13	-0,14
SPREAD t-1	**0,32****	**0,27*****
BBB/AAA	**-0,07*****	-0,06
BID/OFFER	**22,81***	**20,16***
CDS	**0,67***	**0,62***
DEBT	1,80	1,16
GDP	-1,90	-2,42
ESI	0,76	-
INF	-0,83	-0,64
Adjusted R-squared	**0,54**	**0,54**

Table 16: The table reports the results from the OLS regression. The adjusted R-Square and the estimated coefficients are presented; * Significant with 1% of confidence level; ** Significant with 5% of confidence level; ***Significant with a 10% confidence level.

Table 17:OLS Regression

NOV 2009 - JUL 2010

Variable	Coefficient	Coefficient
C	12,22	21,29
Spread t-1	-0,06	-0,08
BBB/AAA	0,36	1,25
BID/OFFER	**2,55***	**3,83***
CDS	**0,47***	-
DEBT	**-7,92*****	-6,43
GDP	**-19,51****	-9,19
ESI	-2,30	-2,75
INF	15,74	40,87
Adjusted R-squared	**0,78**	**0,43**

Table 17: The table reports the results from the OLS regression. The adjusted R-Square and the estimated coefficients are presented; * Significant with 1% of confidence level; ** Significant with 5% of confidence level; ***Significant with a 10% confidence level.

Table 18: OLS Regression

AUG 2012 - Dec 2014

Variable	Coefficient	Coefficient	Coefficient
C	-7,22	-7,21	2,23
SPREAD t-1	**-0,14****	**-0,11*****	-0,04
BBB/AAA	**1,60***	**1,66***	-
VIX	-	-	-0,79
BID/OFFER	1,38	-	-
CDS	**0,55***	**0,60***	**0,67***
DEBT	-0,30	-0,14	-0,52
GDP	8,94	7,80	4,44
ESI	-0,15	-0,02	-0,52
INF	7,13	11,29	18,21
Adjusted R-squared	**0,89**	**0,89**	**0,76**

Table 18: The table reports the results from the OLS regression. The adjusted R-Square and the estimated coefficients are presented; * Significant with 1% of confidence level; ** Significant with 5% of confidence level; ***Significant with a 10% confidence level.

Table 19: VIF Test

JAN 2007 – DEC 2014

a) OLS

	SPREAD t-1	BBB/AAA	BID/OFFER	CDS	GDP	DEBT	ESI	INF
Tolerance	0,04	0,39	0,10	0,02	0,50	0,26	0,23	0,55
VIF	24,00	2,59	10,03	**41,11**	2,02	3,89	4,43	1,81

Table 19:The tables report the results for the collinearity diagnostic test

	SPREAD t-1	BBB/AAA	BID/OFFER	DEBT	GDP	IND	ESI	INF
Tolerance	0,06	0,37	0,13	0,46	0,49	0,26	0,24	0,59
VIF	18,01	2,69	7,63	2,2	2,03	3,86	4,24	1,68

Table 19: The table reports the results for the collinearity diagnostic test

b) PCA

	SPREAD t-1	PC	BBB/AAA	DEBT	GDP	EXP(DEBT)	EXP(DEF)	ESI	INF
Tolerance	0,05	0,08	0,33	0,39	0,47	0,23	0,85	0,24	0,52
VIF	21,97	12,85	2,99	2,56	2,12	4,44	1,18	4,20	1,92

Table 19: The table reports the results for the collinearity diagnostic test

Table 20: VIF Test

JAN 2007 - OCT 2009

	SPREAD t-1	BBB/AAA	BID/OFFER	CDS	DEBT	GDP	ESI	INF
Tolerance	0,09	0,11	0,21	0,13	0,16	0,57	0,06	0,39
VIF	10,56	9,1	4,69	7,78	6,27	1,75	**17,05**	2,59

Table 20: The table reports the results for the collinearity diagnostic test

	SPREAD t-1	BBB-AAA	BID/OFFER	CDS	DEBT	GDP	INF
Tolerance	0,13	0,11	0,22	0,16	0,19	0,6	0,44
VIF	7,98	8,99	4,52	6,37	5,16	1,67	2,3

Table 20:The table reports the results for the collinearity diagnostic test

Table 21: VIF Test

NOV 2009 – JUL 2012

	SPREAD t-1	BBB/AAA	BID/OFFER	CDS	GDP	DEBT	ESI	INF
Tolerance	0,02	0,24	0,13	0,02	0,52	0,24	0,14	0,16
VIF	47,37	4,13	7,99	**46,74**	1,92	4,13	7,26	6,23

Table 21: The table reports the results for the collinearity diagnostic test

	SPREAD t-1	BBB/AAA	BID/OFFER	GDP	DEBT	ESI	INF
Tolerance	0,05	0,25	0,16	0,55	0,25	0,14	0,17
VIF	20,03	4,07	6,18	1,82	4,02	7,09	5,82

Table 21: The table reports the results for the collinearity diagnostic test

Table 22: VIF Test

AUG 2012 – DEC 2014

	SPREAD t-1	BBB-AAA	BID/OFFER	CDS	DEBT	GDP	ESI	INF
Tolerance	0,06	0,12	0,03	0,04	0,34	0,31	0,15	0,20
VIF	16,67	8,11	**30,66**	22,33	2,97	3,21	6,87	4,92

Table 22: The table reports the results for the collinearity diagnostic test

	SPREAD t-1	VIX	CDS	GDP	ESI	INF
Tolerance	0,12	0,84	0,13	0,51	0,17	0,22
VIF	8,52	1,19	7,58	1,96	5,76	4,51

Table 22: The table reports the results for the collinearity diagnostic test

Table 23: OLS Regression (Bid/Offer spread as the dependent variable)

JUL 2012 - DEC 2014

Variable	Coefficient
C	-0,42
SPREAD	0,01
CDS	0,02
BBB/AAA	0,04
DEBT	0,15
GDP	-0,86
ESI	0,14
INF	1,89
Adjusted R-squared	**0,3**

Table 23: The table reports the results from the OLS regression. The adjusted R-Square and the estimated coefficients are presented; * Significant with 1% of confidence level; ** Significant with 5% of confidence level; ***Significant with a 10% confidence level.

Table 24: OLS Regression (CDS as dependent variable)

JAN 2007 – DEC 2014

Variable	Coefficient	Coefficient	Coefficient
C	-1,27	1,73	-1,00
SPREAD t	**1,19***	-	**1,06***
BID/OFFER	**-1,43****	**3,78***	-
BBB/AAA	-0,06	0,11	-0,06
DEBT	**9,88***	6,33	**9,17***
GDP	**15,17***	11,31	**14,38****
ESI	1,71	-3,04	1,63
INF	-4,20	22,91	-4,72
Adjusted R-squared	**0,71**	**0,19**	**0,70**

Table 24: The table reports the results from the OLS regression. The adjusted R-Square and the estimated coefficients are presented; * Significant with 1% of confidence level; ** Significant with 5% of confidence level; ***Significant with a 10% confidence level.

Table 25: OLS Regression (CDS as dependent variable)

Three time sample periods

	1ºPERIOD	***2º PERIOD***	***3º PERIOD***
Variable	**Coefficient**	**Coefficient**	**Coefficient**
C	0,71	-7,37	4,58
SPREAD t	**0,62***	**1,34***	**1,36***
BID/OFFER	**-13,95****	**-2,36****	1,68
BBB/AAA	0,03	0,32	**-1,90***
DEBT	-2,97	12,36	0,49
GDP	2,11	**34,86****	-7,72
ESI	-0,95	2,76	0,23
INF	-1,22	-6,45	-20,07
Adjusted R-squared	**0,47**	**0,65**	**0,83**

Table 25: The table reports the results from the OLS regression. The adjusted R-Square and the estimated coefficients are presented; * Significant with 1% of confidence level; ** Significant with 5% of confidence level; ***Significant with a 10% confidence level.

Table 26: OLS Regression (Principal Component Analysis)

JAN 2007 – DEC 2014

Variable	Coefficient	Coefficient
C	2,01	3,09
Spread t-1	-0,03	-0,03
PC	**149,27***	**151,46***
BBB/AAA	0,10	0,11
DEBT	**-5,28*****	**-5,39*****
GDP	-7,15	-7,36
Exp. DEBT	-	-1,71
Exp. DEFICIT	-	0,85
INF	11,91	10,91
ESI	**-2,67****	**-2,63****
Adjusted R-squared	0,71	0,70
S.E. of regression	28,59	29,11

Table 26: The table reports the results from the OLS regression. The adjusted R-Square and the estimated coefficients are presented; * Significant with 1% of confidence level; ** Significant with 5% of confidence level; ***Significant with a 10% confidence level.

Table 27: OLS Regression (Principal Component Analysis)

JAN 2007 – OCT 2009

Variable	Coefficient	Coefficient	Coefficient
C	-0,20	0,56	0,54
Spread t-1	**0,29*****	0,21	0,22
BBB/AAA	-0,05	**-0,08*****	**-0,08****
DEBT	1,88	2,19	2,29
GDP	-1,22	-0,23	-0,14
Exp. DEBT	-	6,67	7,22
EXP. DEFICIT	-	-24,60*	**2,29***
INF	1,29	1,31	1,28
ESI	0,24	-0,11	-
PC	**375,60***	**310,56***	**315,98***
Adjusted R-squared	**0,46**	**0,69**	**0,58**

Table 27: The table reports the results from the OLS regression. The adjusted R-Square and the estimated coefficients are presented; * Significant with 1% of confidence level; ** Significant with 5% of confidence level; ***Significant with a 10% confidence level.

Table 28: OLS Regression (Principal Component Analysis)

NOV 2009 – JUL 2012

Variable	Coefficient	Coefficient
C	16,48	18,60
Spread t-1	-0,09	-0,09
BBB/AAA	0,65	0,71
DEBT	-7,19	-7,08
GDP	-15,64	-15,90
Exp. Debt	-	-2,79
Exp. Deficit	-	1,69
ESI	-2,07	-1,55
INF	17,87	15,45
PC	**130,78***	**133,95***
Adjusted R-squared	**0,71**	**0,70**

Table 28: The table reports the results from the OLS regression. The adjusted R-Square and the estimated coefficients are presented; * Significant with 1% of confidence level; ** Significant with 5% of confidence level; ***Significant with a 10% confidence level.

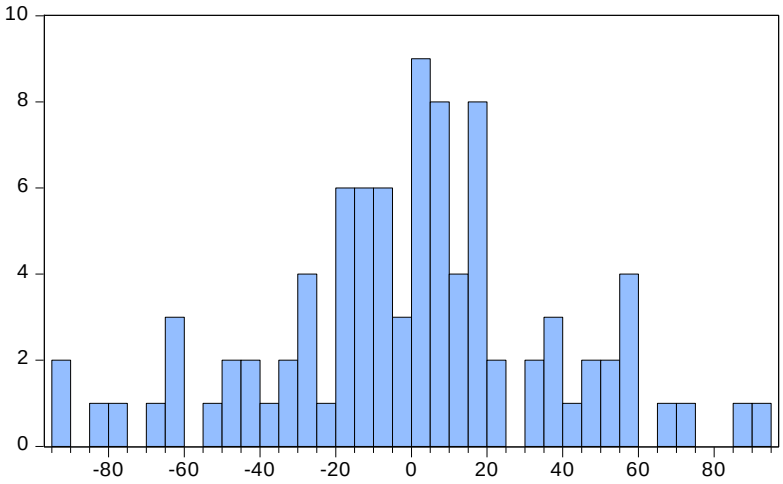
Table 29: OLS Regression (Principal Component Analysis)

AUG 2012 – DEC 2014

Variable	Coefficient	Coefficient
C	-10,15	-10,40
Spread t-1	**-0,21****	**-0,20****
BBB/AAA	**1,31***	**1,33***
DEBT	2,10	2,29
GDP	**15,55*****	**16,55*****
Exp. DEBT	-	-0,01
Exp. DEFICIT	-	21,39
ESI	-2,38	-2,79
INF	-3,65	-17,64
PC	**181,55***	**183,70***
Adjusted R-squared	**0,83**	**0,82**

Table 29: The table reports the results from the OLS regression. The adjusted R-Square and the estimated coefficients are presented; * Significant with 1% of confidence level; ** Significant with 5% of confidence level; ***Significant with a 10% confidence level

Table 30: Errors Normality Test (Jarque Bera test)



Series: Residuals	
Sample 2007M03 2014M09	
Observations 91	
Mean	3.71e-15
Median	2.846863
Maximum	93.96359
Minimum	-92.88238
Std. Dev.	37.89236
Skewness	-0.119499
Kurtosis	3.257323
Jarque-Bera	0.467647
Probability	0.791502

Table 30: The graph reports the Jarque-Bera Erros Normality test.

Table 31: Errors Autocorrelation Test (Breusch Godfrey Test)

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	2.546074	Prob. F(2,80)	**0.0847**
Obs*R-squared	5.445691	Prob. Chi-Square(2)	**0.0657**

Table 31: The table reports the Breusch-Godfrey Errors Autocorrelation test.

Table 32: Heteroscedasticity test (White test)

Heteroskedasticity Test: White

F-statistic	1.329038	Prob. F(44,46)	0.1710
Obs*R-squared	50.93403	Prob. Chi-Square(44)	**0.2195**
Scaled explained SS	46.67847	Prob. Chi-Square(44)	**0.3629**

Table 32: The table reports the White Heteroscedasticity test.

Table 33: Dummy Variables

(a) Non-standard Monetary Policy

Variable	Coefficient
C	208,00
SPREAD t-1	**-1,38****
BBB/AAA	-0,20
BBB/AAA*D2010.05	7,04
BBB/AAA*D2011.08	**-23,31****
BBB/AAA*D2012.07	**14,95*****
DEBT	-27,10
DEBT*D2010.05	86,78
DEBT*D2011.08	**-805,78***
DEBT*D2012.07	**744,57***
GDP	-4,79
GDP*D2010.05	-42,18
GDP*D2011.08	**1 195,94***
GDP*D2012.07	**-1 156,99***
Exp. DEBT	-76,15
Exp. DEBT*D2010.05	88,32
Exp. DEBT*D2011.08	**648,58***
Exp. DEBT*D2012.07	**-620,31***
DEFICIT	-119,81
Exp. DEFICIT*D2010.05	136,12
Exp. DEFICIT*D2011.08	**-10 589,86***
Exp. DEFICIT*D2012.07	**10 366,06***
ESI	-4,49
ESI*D2010.05	12,62
ESI*D2011.08	**-270,62***
ESI*D2012.07	**283,02***
INF	-3,11
INF*D2010.05	-427,98
INF*D2011.08	**-3 648,80***
INF*D2012.07	**4 185,27***
PC	-476,55
PC*D2010.05	1 398,34
PC1*D2011.08	**-1 416,07***
PC1*D2012.07	-38,03
Adjusted R-squared	**0,58**

Table 33: The table reports the results from the OLS regression. The adjusted R-Square and the estimated coefficients are presented; * Significant with 1% of confidence level;** Significant with 5% of confidence level; ***Significant with a 10% confidence level.

(b) Structural Breaks

Variable	Coefficient
C	320,86
SPREAD t-1	**-0,55*****
BBB/AAA	**-10,01***
BBB/AAA*D2008.09	**10,40***
BBB/AAA*D2009.10	-0,10
DEBT	44,00
DEBT*D2008.09	-103,74
DEBT*D2009.10	67,18
GDP	81,44
GDP*D2008.09	-76,28
GDP*D2009.10	10,31
Exp. DEBT	**683,88***
Exp. DEBT*D2008.09	**-1 441,96***
Exp. DEBT*D2009.10	771,74
Exp. DEFICIT	**-462,60****
Exp. DEFICIT*D2008.09	317,60
Exp. DEFICIT*D2009.10	148,54
ESI	31,94
ESI*D2008.09	**-42,97*****
ESI*D2009.10	9,86
INF	**-708,61***
INF*D2008.09	**970,74***
INF*D2009.10	**-339,16***
PC	36 580,13
PC*D2008.09	-36 683,94
PC*D2009.10	**226,00***
Adjusted R-squared	0,80

Table 33: The table reports the results from the OLS regression. The adjusted R-Square and the estimated coefficients are presented; * Significant with 1% of confidence level;** Significant with 5% of confidence level;***Significant with a 10% confidence level.

Table 34: Chronology of the main disruptive international and domestic events

Date	Event
08/2007	US suprime crisis
03/2008	Bear Sterns was rescue
08/2008	Lemanh Brothers Bailout
11/2008	BPN Nationalization
02/2009	Irish government announced a stringent of fiscal stabilization measures
03/2009	One-day general strike in protest against to government austerity measures
09/2009	Governing Socialist Party wins re-election but loses its overall majority
10/2009	1st Papandreou speech as Greek prime minister: Disclosure of severe fiscal problems
11/2009	Greek Government revealed a revised budget deficit of 12,7% for 2009 (the double of the previous estimated)
11/2009	Portuguese government releases the new deficit forecasts: increased from 5,9% to 8%
Dec/2009	S&P cuts portuguese rating to A-
01/2010	Government announces and even higher than expected 2009 deficit, 9,4%
03/2010	Government announces a new package of austerity measures, including cuts in public spending and tax increasing
03/2010	Fitch cut the rating of Portugal by one notch to AA-
03/2010	S & P cuts the rating of Portugal on two levels to A-,
07/2010	Moody's cuts Portugal rating from Aa2 to A1.
09/2010	Premier minister Jose Socrates announces more austerity measures
12/2010	Moody's says that a rescue would not necessarily be bad to Portugal
03/2011	Portuguese Finance Minister, Teixeira dos Santos announces more austerity measures
03/2011	Government resigns after parliament rejects new austerity package.
03/2011	Fitch cuts Portugal rating from A + to A-
04/2011	Fitch cuts Portugal rating from A- to BBB-
04/2011	Moody's cuts Portugal rating to A3 from Baa1.
04/2011	Portugal becomes the third European Union country after Greece and Ireland to apply for EU financial assistance to help it cope with its budget deficit.
05/2011	Troika memorandum is approved and measures are presented to the media
05/2011	The European Union and International Monetary Fund agree a 78bn-euro bailout for Portugal
06/2011	Parliamentary elections. Social Democratic Party wins and Ruling Socialist Party is ousted
07/2011	Credit ratings agency Moody's downgrades Portugal's public debt to junk status
09/2011	The government announces the country's biggest spending cuts in 50 years.
10/2011	The government submits another package of spending cuts and tax increases to parliament
11/2011	Credit ratings agency Fitch downgrades Portugal's public debt to junk status
01/2012	Credit ratings agency Standard and Poor's downgrades Portugal's rating to junk status

01/2012	Portuguese Prime minister, Passos Coelho, guarantees that "Portugal will not ask for more time or more money"
02/2012	Mario Draghi said, in an interview to WSJ, that Portugal will not need a new bailout.
06/2012	Troika concluded the fourth review of the program and says that Portugal is "on track"
07/2012	Draghi "*whatever it takes*" speech gives confidence to the markets
09/2012	The EU, IMF and European Central Bank give Portugal another year to reduce its deficit below the EU target of 3% of GDP, after noting progress in rebalancing the economy
09/2012	One of the largest protest demonstrations ever against the Portuguese government
01/2013	FMI warning: Portugal may need additional austerity measures
03/2013	Ministers of the European Union Finance decide to extend payment deadlines for loans of Portugal and Ireland
04/2013	Tribunal Constitutional (TC) declares as unconstitutional a set of austerity measures
06/2013	IMF criticizes the Government for not presenting measures to cut nearly 25% of expenditure up to 2013 as part of state reform.
03/2013	Troika gives another year to Portugal to reduce the deficit to below 3%
05/2014	Portugal exits international bailout without seeking back-up credit from its lenders
06/2014	Portugal will not need the final part of the loan
08/2014	The government bails out the Banco Espirito Santo - Portugal's largest private bank to the tune of 3.9bn euros in order to avert a possible wider economic collapse

Table 34: The table summarizes the main Portuguese and International economic, political and social episodes that have occurred from January of 2007 to December of 2014.

Table 35: European Central Bank Non-standard monetary policy measures

Date	Event description
05/2009	ECB announced the first Covered Bond Purchase Program (CBPP1) and also the first time twelve month SLTROs (four programs were conducted between June 2009 and December 2011)
05/2010	The Securities Markets Program (SMP) was launched in response to the sovereign debt crisis: ECB announced direct purchases of government bonds in secondary markets under the SMP (initially purchases were limited to Greek, Portuguese and Irish Government bonds)
08/2011	The ECB extended the SMP also to Italian and Spanish Government bonds.
12/2011	The ECB announced two "very" long term refinancing operations (VLTROs) with three year maturity. In these two VLTROs, the ECB allotted around 1019 euro billions in total
09/2012	ECB announced the Outright Market Transactions (OMT) program

Table 35: The table summarizes the ECB main nonstandard monetary policy announcements

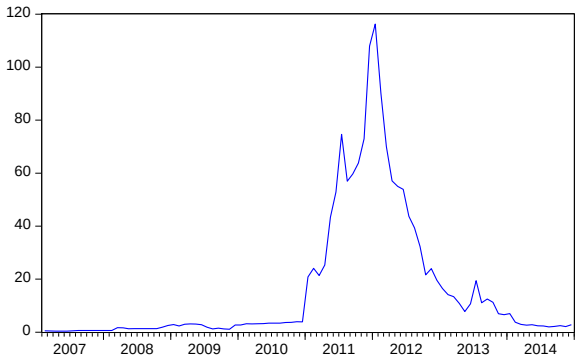
Table 36: Portuguese Government stimuli packages announcement dates

Date	Measure
10/2008	The increase of the guarantees on deposits from €25.000 to €100.000 and set a €20 billion facility to be used in guarantees to banks
11/2008	The increase of the guarantees on deposits from €25.000 to €100.000 and set a €20 billion facility to be used in guarantees to banks
12/2008	The announcement of a fiscal stimulus package, to boost investment and employment , which reached to 0.8% of GDP (around €1.3 billion)

Table 36: The table presents the stimuli packages announced by the Portuguese Government, late in 2008, as a way to boost liquidity and increase confidence in the Portuguese Banking Sector

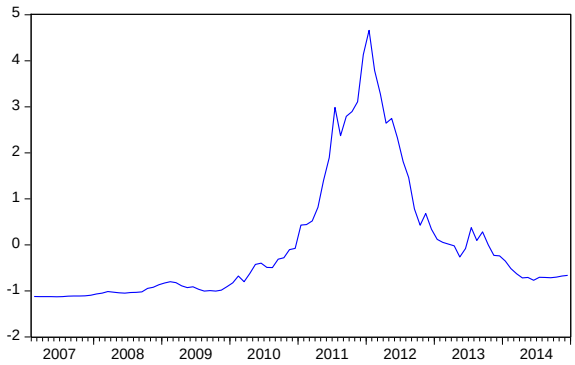
APPENDIX II

Figure 7: 10 year government bond yield Bid/Offer Spread



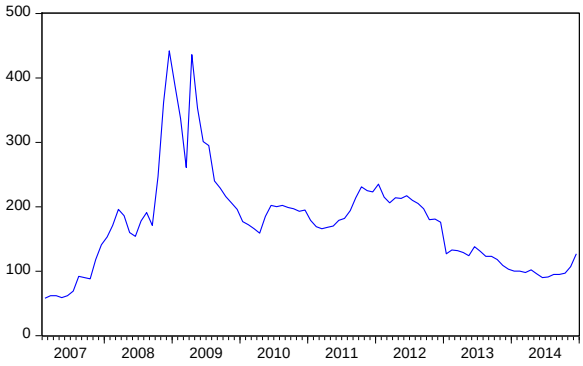
Source: Bloomberg; author analysis

Figure 8: Bid/Offer and CDS principal component



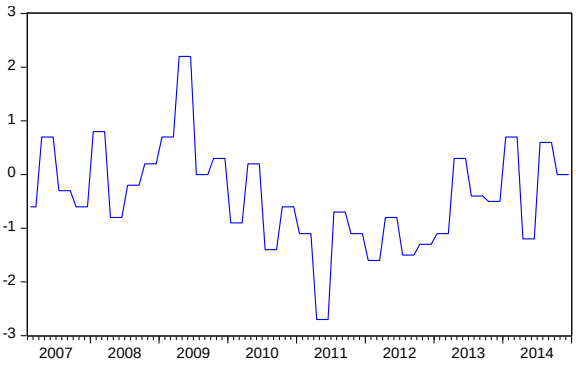
Source: Bloomberg; author analysis

Figure 9: BBB/AAA US Corporate Bonds



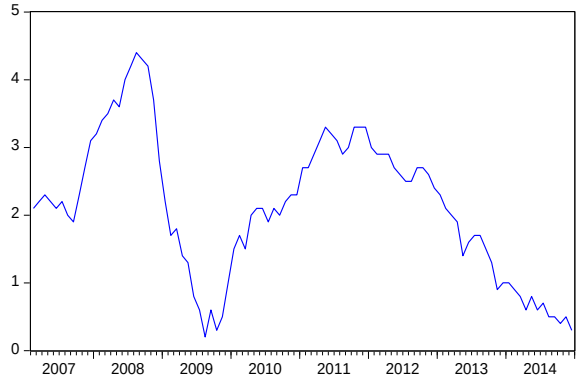
Source: FRED database; author analysis

Figure 10: Quarterly GDP real growth rate



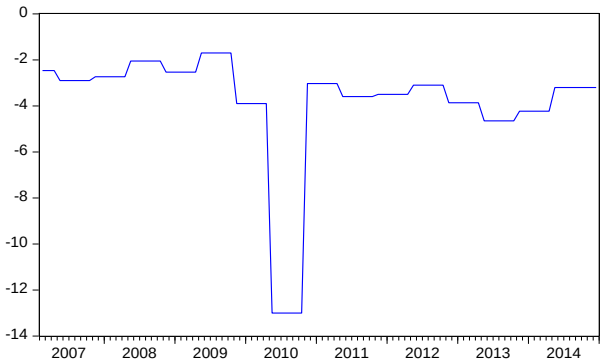
Source: OECD database; author analysis

Figure 11: Monthly EU HIPC



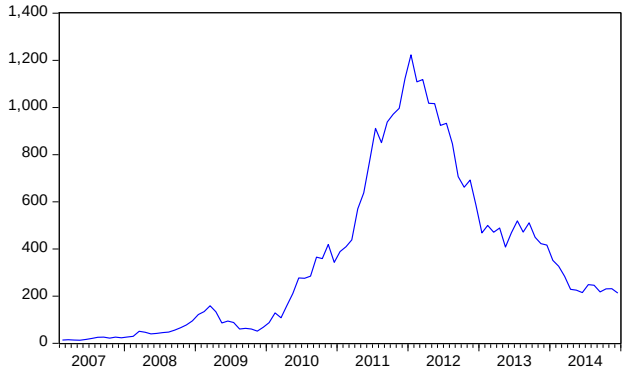
Source: OECD database; author analysis

Figure 12: Expected deficit to GDP ratio



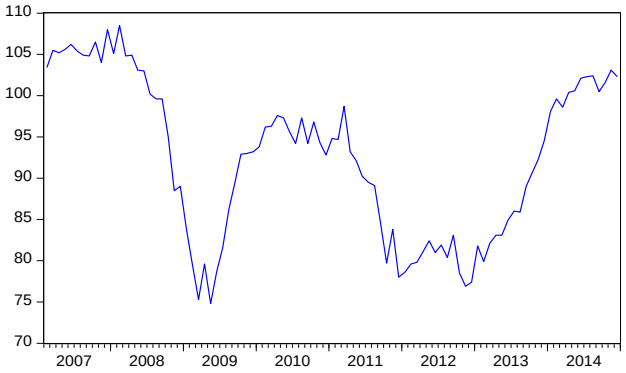
Source: European Commission; author analysis

Figure 13: 10 year government bond yield spread



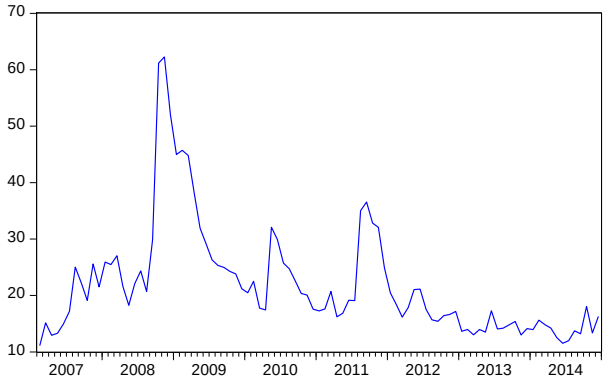
Source: Bloomberg; author analysis

Figure 14: Economic sentiment indicator



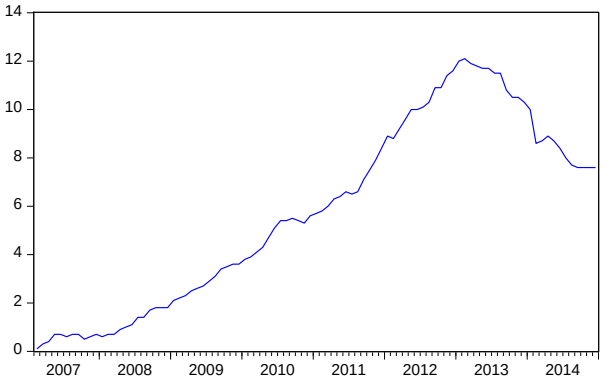
Source: European Commission; author analysis

Figure 15: VIX



Source: Bloomberg; author analysis

Figure 16: Monthly unemployment growth rate



Source: Eurostat database; author analysis