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Determinants of Government Bond Yield Spreads in Eurozone During Crises

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Abstract

This paper studies the determinants of sovereign bond yield spreads across ten Eurozone countries between the first quarters of 2000 and 2014 with a special focus on developments during the global financial crisis that started in 2007 and sovereign debt crisis that started in 2009. Despite the single currency, with the outbreak of global financial crisis the spreads between yields on government bonds of Eurozone countries and those of Germany increased significantly. Widening of spreads have continued for some countries during the sovereign debt crisis and reached historical levels. We apply a fixed effect model to identify the role of credit risk, liquidity risk and global investors' risk aversion on the spreads by proxying with fiscal variables, bid-ask spread and US corporate bond spread respectively.

We find that during the pre-crises period financial markets are unresponsive to deterioration in fiscal position of governments and global risk perception has the main role in determination of spread levels. With the start of financial turmoil after the second half of 2007 investors have started to pay more attention to fiscal fundamentals and demanded compensation for credit risk. And also with the beginning of the sovereign debt crisis, the liquidity conditions of government bonds have had an important role on the spreads. While before and during the global financial crisis general investors' risk aversion had kept its importance, according to our findings its role diminished significantly during the sovereign debt crisis especially for periphery countries with high debt burden.

Keywords

Eurozone

Sovereign bond spreads

Credit risk

Liquidity premium

Risk aversion

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1 Introduction

In the aftermath of the outbreak of the global financial crisis in the second half of 2007, long-term government bond yield spreads relative to Germany have increased significantly for most of the Eurozone countries. This upsurge was followed by another wave of increase after the last quarter of 2009 with the onset of the sovereign debt crisis in the Eurozone. What could be the reason of this divergence in the government bond yield spreads after a period of convergence since the beginning of single currency? Is this widening in spreads a result of alteration of general economic environment in the world or it is related to idiosyncratic factors of countries of interest?

Taking into account the variation of spreads over the course of these two crises, we observe different reactions from different country groups in different time periods. We observe that during the global financial crisis the spreads of most of the countries in Eurozone relative to Germany move in a similar manner. After 2009, when the debt problems of Greece came to light, countries with weak fiscal position have diverged from others and experienced historical levels of interest rate differentials. This situation is explained in the literature with the differences of risk factors for different countries and the change of global risk perception of investors.

Commonly held determinants of the government bond yield spreads in the literature are the credit risk of the issuer government, liquidity risk of the security and the variation of the general investors' risk aversion over time. The change in global risk aversion is shown by many studies as the main factor that determines the yield spreads especially after the collapse of Lehman Brothers where the global financial system was badly influenced. With the outbreak of the crisis and the escalating fiscal problems in Eurozone, mostly resulting from the banking rescue packages of national governments, attracted the attention to the fiscal situation of governments and caused repricing of credit risk by investors for these countries in trouble. With the increased credit risk and risk aversion, the investors' behaviors to avoid potential losses brought forward the liquidity of government bonds as an important component of the spreads.

In accordance with the literature, we are trying to find out the main determinants of government bond yield spreads of Eurozone countries vis-à-vis Germany during two important crises Europe faced after the second half of 2007. For our analysis we use the data from first ten members and most important economies of Eurozone which are:

Austria, Belgium, Finland, France, the Netherlands, Greece, Ireland, Italy, Portugal and Spain. We used a panel data fixed effect model where general government debt to GDP ratio and expected budget deficit to GDP ratio are used as fiscal variables to be able measure the debt sustainability and the credit risk of the government, the spread between the bid and ask prices of government bonds is used as a proxy for measuring the liquidity risk and lastly the spread between the US low grade corporate bond yields and the US treasury benchmark bonds is used as a proxy for measuring the influence of the global investors' risk aversion on the spreads. For technical reasons we performed our estimation in three different ways, first without controlling heteroscedasticty and autocorrelation, second with only controlling heteroscedasticity and lastly with controlling both to be able to have a better insight about the statistical significance of our results.

As a result of our empirical analysis we find that the main determinant of the government bond spreads before the crises is the general investors' risk aversion. We observe that during this period investors do not pay attention fiscal deteriorations and under pricing the credit risk. With the outbreak of the global financial crisis while the global risk aversion maintain its role on yield spreads, the importance of fiscal position of governments increase due to the repricing of default risk by investors. Furthermore from this point on, investors start to differentiate countries according to their fiscal performance. During the sovereign debt crisis while the fiscal variables remain one of the most important factors on spreads in periphery countries, we cannot see the same influence on the core countries. And also with the outbreak of sovereign debt crisis, liquidity of the government bonds became another important determinant of spreads.

The rest of the study is structured as follows. Section 2 introduces a broad literature survey on the main factors determining the sovereign bond yields spreads in Eurozone and explains the transition mechanisms from these factors to the spreads. In section 3, a descriptive analysis of the data used for the analysis and also alternative measures used in the related literature are presented. Section 4 explains the econometric model and estimation method used for the analysis and reports the results of our empirical study. Section 5 concludes.

2 Literature Review

Government bond yield spreads basically represents a premium which investors demand based on their perception of and willingness to take risk. Based upon the recent literature, determinants of government bonds can be classified as country-specific factors and international factors which are mainly credit risk of domestic government, liquidity risk of domestic security and investor's degree of risk aversion (Bernoth et al., 2012; Schuknecht et al., 2009; Haugh et al., 2009; Aßmann and Boysen-Hogrefe, 2009; Barbossa and Costa, 2010; Bernoth and Erdoğan, 2010; Barrios et al., 2009).

Investor's rate of return is the main driver of the investment decisions and it depends on several factors such as expected yield of the security and expected transaction costs. According to the standard portfolio theory the optimal amount of investment on a domestic security is determined by the level of the yields of domestic and foreign yields and also default risk of domestic government, liquidity risk of the domestic security and investor's risk aversion degree. If we consider the foreign security risk free, the interest rate difference between domestic and foreign security essentially indicates the risk premium asked by the investor for the default probability of the domestic government, a liquidity premium reflecting the expected transaction cost if he/she wants to sell the domestic security before maturity and a premium reflecting the variation in the risk pricing of investor (Bernoth et al., 2012; Schuknecht et al., 2009).

In the Eurozone due to the monetary union and relative integration of bond markets, another important determinant of government bond yield spreads, exchange rate risk resulting from real exchange rate differentials doesn't exist. This can be seen as an advantage for our analysis for Eurozone (Haugh et al., 2009; Aßmann and Boysen-Hogrefe, 2009; Barbossa and Costa, 2010).

2.1 Credit Risk

According to Barrios et al. (2009), credit risk contains three types of premia related to default risk, credit spread risk and downgrade risk. Default risk premium is the yield difference demanded by investors for the probability of non-payment of full amount initially agreed (Haugh et al., 2009). The level of default risk premium depends on the perception of investors on the country-specific factors of the issuer that signalizes the level of risk such as the fiscal position of the government (Barbossa and Costa, 2010).

The assessment of investor on the financial position of the domestic government is one of the very important determinants of default risk, since it gives an idea about the sustainability of the debt. According to the market discipline hypothesis, in case of a deterioration of fiscal position of a government such as an increase in debt levels or deficits, markets penalize governments by imposing a risk premium (Schuknecht et al., 2009).

In a monetary union such as Eurozone, since the member governments give up monetary policy tools in favor of a central authority and they issue their debts in a currency that they don't have control over, their capacity to cope with financial difficulties is restricted (Schuknecht et al., 2009). Therefore in a monetary union the default risk of member governments are higher if other governments and the central bank don't have any obligation to rescue governments in financial difficulties. On the positive side if investors expect a bailout by the other governments of the union and the central bank, this may reduce the perceived default risk by investors (Bernoth et al., 2012).

Credit risk premium is defined by Barrios et al. (2009) as the extra yield demanded by investors for the probability of fall in the market value of the domestic security compared to similar quality securities in the market. And the possibility of downgrade by the credit rating agencies is priced as the downgrade risk by investors (Barrios et al., 2009).

Recent studies on the role of credit risk on the government bond yield spreads generally show a positive relation between the fiscal variables and the interest rate differentials. But according to the estimation period and the countries included, there are differences between studies.

According to Codogno et al. (2003), domestic fiscal variables have a role in explaining the high interest rates only for Austria, Spain and Italy amongst ten Eurozone countries. Similar to these findings Heppke-Falk and Hüfner (2004) showed expected fiscal deficit is an important determinant of bond yields in Germany and France for the period of 1999-2004.

In their studies for the period of 2003 to 2009, Barrios et al. (2009) and Sgherri and Zoli (2009) find that investors ask for a high compensation for the deterioration in fiscal position of the governments after the 2008 global financial crisis. And also the premium demanded by the investors are differentiated after the 2008 crisis similar to the

1975 debt crisis in New York, where markets started to discriminate the bonds issued by highly indebted cities or states (Schuknecht et al., 2010). The reason of increased sensitivity of the markets after crisis is explained by the ECB (2008) and Attinasi et al. (2009) with the transfer of the private sector risk to the public sector through broad-based rescue packages in the banking sector.

Besides, Haugh et al. (2009), Barrios et al. (2009) and Sgherri and Zoli (2009) emphasize that the effect of deterioration in fiscal position on yield spreads became more significant with the increase of global risk aversion. In addition to these results, Gomez-Puig (2008), Schuknecht et al. (2009) and ECB (2009) showed a positive relation between the credit risk and government bond yield spreads.

2.2 Liquidity Premium

Bernoth et al. (2012) stresses that the bond yields spreads cannot be explained solely by fiscal performance. The lower level of German bond yields compared to those bonds issued by governments with a better fiscal position is an example that markets take into consideration different factors while pricing government bonds. The reason may be the possibility of trading of German bonds immediately and with lower costs.

Liquidity premium is a price demanded by investors to offset trading costs of a security (Bernoth and Erdoğan, 2010). In a liquid market there has to be market depth, sufficient volume of sell and buy orders which provides to trade anytime without losses and market breadth, limited effects of individual transactions on prices which allows investors to trade with lower trading costs (Barrios et al., 2009). Therefore in a large bond market where bonds can be traded quickly at low cost, the liquidity premium demanded by investors will be limited (Haugh et al., 2009).

According to Barbossa and Costa (2010), the liquidity premium of a security depends on security's expected level of liquidity which depends on the outstanding amount of security, remaining time to its maturity and if they are eligible for the futures market or not and on the probability of unanticipated changes in liquidity which depends on factors that may affect the future liquidity of the security and global security demand.

Liquidity of a security becomes more significant in times of economic uncertainty and greater volatility. In these times, investors prefer securities that allow them to shift their portfolio quickly at low costs. Therefore during a time of crisis the demand for

securities with higher liquidity will be higher and the premium demanded for securities with lower liquidity will be higher (Barbossa and Costa, 2010).

Lastly, liquidity and credit risks are interconnected. An increase in the supply of government bonds increases the liquidity by creating a larger market and puts a downward pressure on liquidity premium. However, the increased public debt puts upward pressure on credit risk by raising doubts about the sustainability of government debt (Barrios et al., 2009).

The results of empirical studies about the role of liquidity risk on the government bond yields are controversial. Bernoth et al. (2006; 2010) and Schuknecht et al. (2009, 2010) couldn't find a significant effect of liquidity on the pricing of the government bonds of Eurozone countries following the start of EMU. On the other hand Gomez-Puig (2006), Ejsing and Sihvonen (2009), Barrios et al. (2009) and Attinasi et al. (2009) found liquidity effects on the yield spreads of Eurozone countries.

But in many cases, results show that there exist a liquidity premium in the government bond interest rates but this premium is limited to certain countries or time periods. Codogno et al. (2003) and Sgherri and Zoli (2009) found very limited effect of liquidity in Eurozone countries but they emphasized the increasing role of liquidity through the increase in general risk aversion and interaction with the credit risk.

Whereas Favero et al. (2010) show that the liquidity has an influence only for some countries in the Eurozone, Beber et al. (2009) show that liquidity is an important factor during certain periods such as where there is heightened market stress. Manganelli and Wolswijk (2009) confirm this result and add that half of the interest rate differentials in Eurozone can be explained by liquidity when interest rates are high.

2.3 Investor's Risk Aversion

Investor's risk aversion signifies the willingness to take risk by investors. In times of financial uncertainty, even if the credit and liquidity risks of a security remain the same, investors' risk assessment may change due to the international factors. During these times investors becomes more risk averse and restructure their portfolio toward less risky securities. In the literature the concept of selling high risky securities and buying less risky ones (such as Germany in Eurozone) is called fly-to-security or fly-to-liquidity (Barrios et al., 2009; Bernoth and Erdoğan, 2010; Sgherri and Zoli, 2009; Manganelli and Wolswijk, 2009).

Empirical studies show that during the Russian default in 1998 and the Turkish currency crisis in 2001, bond yield spreads had widened between EMU member countries. In a similar way, after the Asian crisis in 1997 and again Russian crisis in 1998 an upsurge was observed in the differences between provincial and federal yields in Australia, Canada, Germany, Switzerland and the US (Schuknecht et al., 2009).

Codogno et al. (2003), Sgherri and Zoli (2009), Manganelli and Wolswijk (2009) and Favero et al. (2010) found empirical evidence showing that there is an important role of international factors indicating the general risk aversion of investors on the yield spreads in Eurozone. In addition, Barrios et al. (2009) show that there is an important interaction with domestic factors and international factors where with the higher risk aversion, credit and liquidity risks have amplified influence on the government bond yield spreads.

Relative importance of these three factors and their share in the government bond yield spreads has changed over time. From the beginning of the common currency to the first signals of the financial crisis, international risk premium had been the main determinant of the yield spreads in Eurozone (Barbossa and Costa, 2010; Bernoth and Erdoğan, 2010; Pozzi and Wolswijk, 2010).

Until to the end of 2006 markets paid less attention to country-specific risks and didn't discriminate Eurozone countries according to their fiscal positions. According to Bernoth and Erdoğan (2010) at the and of 2006, two years before the crisis, and according to Barbossa and Costa (2010) with the deepening of the financial crisis, investors started to discriminate Eurozone government bonds first according to their liquidity risk, and after the fiscal position of governments. After the start of financial turmoil in September 2008, fiscal discipline became the main driver of the yield spreads and markets started to penalize fiscal imbalances with a higher premium on government bond yields (Bernoth and Erdoğan, 2010; Barrios et al., 2009; Ejsing and Sihvonen, 2009; Mody, 2009; Aßmann and Boysen-Hogrefe, 2009). In addition, with the increasing global investors' risk aversion, the role of the fiscal position became more important (Haugh et al., 2009; Barrios et al., 2009; Bernoth et al., 2010; Sgherri et al., 2009) and according to Barbossa and Costa (2010) the differences between credit risks of Eurozone governments and increasing investors' risk aversion had been the most important factors determining the government bond yield spreads during the first half of 2010.

3 Data and Descriptive Analysis

3.1 Data

In the previous section, based on the existing literature, the fundamental determinants of government bond yield spreads were introduced as the credit risk of the issuer government, the liquidity risk of the security and the general risk aversion of investors. In this section the variables that will be used as the proxies in our analysis for capturing effects of these factors on the spreads will be discussed and defined.

The countries under analysis are Austria, Belgium, Finland, France, Greece, Ireland, Italy, the Netherlands, Portugal and Spain. These are the first ten member states of the single currency area except Germany and Luxemburg. Since the Luxemburg is insignificant in terms of its economic magnitude and Germany is taken as the benchmark country, these two countries are excluded from the analysis. Germany is chosen as the benchmark country due to its safe heaven status which was maintained during financial turmoil as a consequence of its relatively high fiscal quality and liquidity (Barbossa and Costa, 2010). The sample period runs from the first quarter of the 2000 to the end of first quarter of 2014. Due to the availability of macroeconomic fundamentals, the data frequency is determined on quarterly basis.[1]

The dependent variable, government bond yield spreads, are calculated as the difference between 10-year maturity benchmark bonds of each country subject to analysis and the benchmark bond of Germany with the same maturity.

In the literature there are two types of variables which are used to proxy credit risk of a country. These are sovereign Credit Default Swap (CDS) premiums and macroeconomic variables related to a government's fiscal performance. CDS is a financial instrument that allows investors to protect themselves against the possibility of a default (Barbossa and Costa, 2010). Therefore the CDS premium on a security reflects the perceived level of default risk by the investor.

Macroeconomic variables are widely used in literature for capturing the credit risk of a country on the spreads since these variables reflect sustainability of fiscal stance

[1] A detailed explanation of data is given in Annex II.
[2] The vertical bars denote the collapse of Lehman Brothers (2008q1), reveal of fiscal situation in Greece (2009q4), Deauville agreement (2010q4), and whatever it takes speech of ECB president and OMT

and the quality of a government as a borrower. Variables generally preferred as proxies of credit risk are debt relative to gross domestic product (GDP) and budget balance relative to GDP (Haugh et al., 2009; Aßmann and Boysen-Hogrefe, 2009; Bernoth and Erdoğan, 2010; Schuknecht et al., 2010; Bernoth et al., 2012). In addition to these two, the ratio of government debt service to current government revenues is used as another measure. This measure shows the ability of governments to raise revenues from a given volume of GDP (Haugh et al., 2009; Bernoth et al., 2006; 2012).

Preferred proxies for our analysis are debt to GDP ratio and budget balance to GDP ratio. If the fiscal position of a country deteriorates vis-à-vis benchmark country it is expected investors to ask a higher premium and the yield spreads to increase. For our analysis debt to GDP ratio is calculated as the differential between the general government debt of the relevant country as percentage of its GDP and the benchmark country, Germany. The data is taken in quarterly frequency from Eurostat.

For the budget balance to GDP ratio, by taking into consideration the forward looking behavior of market participants, instead of historic values we prefer to use forecasts. In addition to taking into account behavior of market participants, using forecast data avoids a potential endogeneity bias in the estimation resulting from the fact that historic values contain government interest payments (Heppke-Falk and Hüfner, 2004; Bernoth and Erdoğan, 2010; Bernoth et al., 2012). Barbossa and Costa (2010) justifies usage of projected values instead of historical values by considering the fact that during the crises investors reassess countries' credit risk more frequently. The data is taken from the forecasts of European Commission, which is published twice a year in spring and autumn. Thus, we allocate the deficit forecasts of the spring report to the second and third quarters of the current year and forecasts of the autumn report to the fourth quarter of the current year and the first quarter of next year (See e.g. Aßmann and Boysen-Hogrefe (2009); Bernoth and Erdoğan (2010); Barbossa and Costa (2010) and Bernoth et al. (2012)). Deficit to GDP ratios are also expressed in differences to the deficit to GDP figures of Germany. Besides, we include quadratic terms of fiscal variables to allow for non-linear relationships.

Empirical studies examining the role of liquidity on government bond yield spreads use various types of measures for capturing different dimensions of the issue. For this purpose indicators related to transaction costs, speed of transactions, trading volume or market depth is used to measure liquidity premium on spreads. Within this framework

bid-ask spreads are commonly used as a proxy for liquidity since it is reflecting transaction costs. Moreover, bid-ask spread is influenced by the market depth and in a deep market, liquidity premium in bond yield spread is expected to be smaller.

The country's outstanding amount of debt securities to total outstanding government bonds of the same currency and the same type (Haugh et al., 2009), the issue size of a specific bond (Schuknecht et al., 2010; Aßmann and Boysen-Hogrefe, 2009; Bernoth et al., 2012), trading volume and number of transactions (Barbossa and Costa, 2010) are used as proxies for liquidity as well. The logic behind the latter is explained by Gomez-Puig (2006) with the fact that the larger issues of bonds may have lower information costs and therefore the volume of the market for a given security increases its liquidity.

In literature bid-ask spread is generally accepted as a better measure compared to traded volumes. Data on volumes can be affected by multiple trading operations between bank's affiliates to meet balance sheet requirements and the variations in volumes may be misleading in terms of liquidity (Barrios et al., 2009; Bernoth and Erdoğan, 2010).

For the reasons aforementioned, we use bid-ask spread as the proxy variable for liquidity in our analysis. Bid-ask spreads are calculated as the average of the differentials of daily bid and ask prices of 10-year maturity government bonds for each quarter. As it was in other variables, it is measured relative to bid-ask spread of benchmark country, Germany. The data is taken from Bloomberg.

Because the investors' risk aversion cannot be observed directly, in the literature several variables are used to measure the influence of international risk factor on government bond yield spreads. These variables are generally, low-grade corporate bond spreads, short-term interest rates and in some cases several CDS and volatility indices (Barbossa and Costa, 2010).

Corporate bond yield spreads are the most widely used proxy for the general investors' risk aversion (Codogno et al., 2003; Favero et al., 2010; Bernoth et al., 2006; 2012; Schuknecht et al., 2010; Haugh et al., 2009; Aßmann and Boysen-Hogrefe, 2009). This variable measures the spread between low-grade corporate bonds and government bonds and the logic behind of its usage is related to flight to safety motive. Since the government bonds are considered safer and more liquid in comparison with corporate bonds, in times of global financial crises or grater uncertainty, investors' preferences

shift from corporate to government bonds. Thus, the spread between these two types of bonds widens reflecting the increase in general risk aversion of investors. For our case an increase in general risk aversion represents an extra premium for the less safe and illiquid government bond yields.

Another proxy used for the general risk aversion is short-term interest rates. If the long-term interest rates are generally low compared to short-term interest rates, investors have an incentive to look for new investment opportunities offering attractive spreads over short-term interest rates (Shucknecht et al., 2009; Bernoth et al., 2010). In other words when short-term interest rates are low, investors are keen on taking risk and their general risk aversion decreases (Manganelli and Wolswijk, 2009).

We are going to use US corporate bond yield spread as a proxy for our study, which is taken from BofA Merrill Lynch Database through FRED (Federal Reserve Bank of St. Louis). This data is calculated as the difference between the yield on Merrill Lynch US Corporate BBB Index and the yield on ten-year US treasury benchmark bonds.

3.2 Descriptive Analysis

Before carrying out econometric analysis for explaining the government bond yield spreads in Eurozone, it would be useful to look at the evolution of spreads and explanatory variables in the course of time. After the evolution of spreads, first we will look at the relationship between spreads and fiscal variables and then the evolution of bid-ask spreads for the countries subject to analysis as a measure of liquidity and US corporate bond spreads as a proxy for general risk aversion.

In the aftermath of introduction of Euro as the single currency, interest rate differentials between Eurozone government bonds declined significantly. As it can be seen clearly from the Figure 1, starting from the year 2001 the government bond spreads of Eurozone countries vis-à-vis Germany narrowed even further reaching the lowest point at 2004. After this date this low trend on spreads continued with a slight divergence until the start of financial turmoil at the second half of 2007.

After October 2007, especially with the collapse of the Lehman Brothers in September 2008, Eurozone government bond spreads relative to Germany started to increase substantially most likely due to the improving safe haven status of Germany resulting from global uncertainty. In addition to the global financial crisis, bank rescue operations and the fear of recession in the Eurozone deepened the concerns about default

risk of these governments and contributed the widening of spreads. Despite the reversal of this widening in spreads in the first half of 2009 due to the diminishing global uncertainty and easing of global financial market tensions, the emerging developments on Greece's fiscal position led to considerable increases in government bond spreads again in the Eurozone starting from the last quarter of 2009.

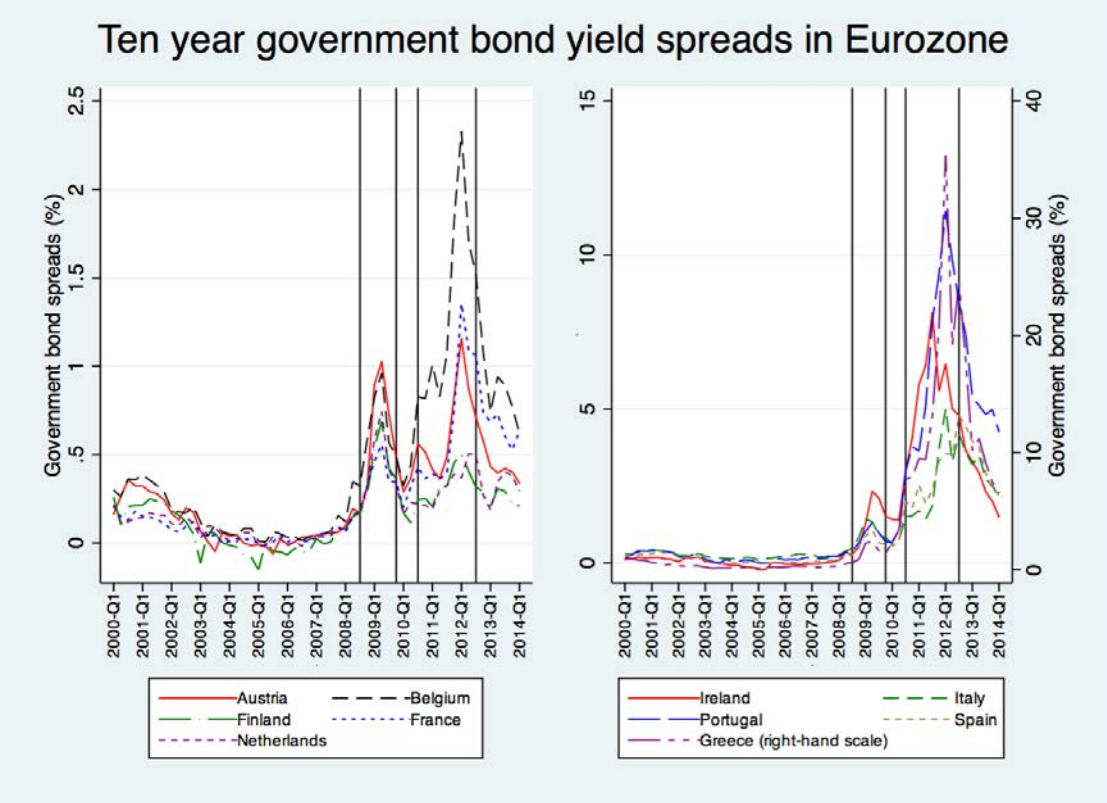

Figure 1: Ten year government bond yield spreads in Eurozone[2]
Source: Datastream

The influence of financial turmoil on Eurozone government bonds had been different for different countries. As one can see from the Figure 1, peripheral countries such as Greece, Ireland, Italy, Portugal and Spain who had weak fundamentals had witnessed the biggest widening in spreads. We see an increase in spreads in a lesser extent in core countries but we can see that countries with weaker fundamentals such as Belgium and France were differentiated by market imposing a higher risk premium. Countries such as Austria, Finland and the Netherlands who had solid fiscal stances also experienced a limited increase in bond yield spreads, which is presumably due to flight to security behavior of markets that increases demand for German government bonds due to global uncertainty.

[2] The vertical bars denote the collapse of Lehman Brothers (2008q1), reveal of fiscal situation in Greece (2009q4), Deauville agreement (2010q4), and whatever it takes speech of ECB president and OMT communications (2012q3) respectively.

On 19 October 2010 in Deauville, Chancellor of Germany Angela Merkel and President of France Nicolas Sarkozy agreed on the private sector involvement in the resolution of the Greek sovereign debt. This announcement triggered sharp rise in government bond spread yields in Eurozone. After this announcement, until to the end of second quarter of 2011 especially Greek, Irish and Portuguese ten-year maturity government bond yield spreads increased to historical levels. During the same period Spanish and Italian spreads also increased considerably. On the other hand in core countries the rise in yield spreads remained very limited except Belgium and France. Following July 2011, the debt structuring proposal for Greece, which proposed private bond holders' involvement, another wave of increase in government bond yield spreads in Eurozone had been seen which reached the top point at the first quarter of 2012. Spreads increased excessively especially for Portugal and Ireland.

Eurozone government bond yield spreads started to decrease with the involvement of ECB. On 26 July 2012, ECB president Mario Draghi announced that ECB was ready to "do whatever it takes to preserve the euro". Following this announcement, in 2 August 2012 ECB announced the Outright Monetary Transactions (OMT) programme, which was aiming to "safeguard an appropriate monetary policy transmission and the singleness of the monetary policy" (ECB, 2014). Due to the firm stance of ECB for decreasing borrowing costs for European governments and unconventional monetary policies, spreads in Eurozone started to decrease but couldn't returned to the levels before the sovereign debt crisis.

In Figure 2, the relationship between the spreads and debt to GDP ratios in Eurozone is presented. Sub-graphs are representing different periods and in each sub-graph, the government bond spreads and debt to GDP ratios in relation to Germany are shown on the vertical and horizontal axis respectively. While each particular point corresponds to an observation of one of the countries, the straight line represents a simple regression of debt to GDP ratio on the spreads.

As one can see clearly from the Figure 2a, during the whole period there is a positive relationship between the spreads and debt to GDP ratio. This positive relation signifies that higher levels of spreads are related to higher levels of debt to GDP ratios. However, the strength of this relation which is represented by the slope of the regression line, as one can see from the Figures 2a, 2b and 2c, is different in each period. In the pre-crisis period, even though the relation is positive it is very weak (Figure 2b). During this

period we don't see important divergence in the spreads and also the level of debt to GDP ratios vis-à-vis Germany remains moderate.

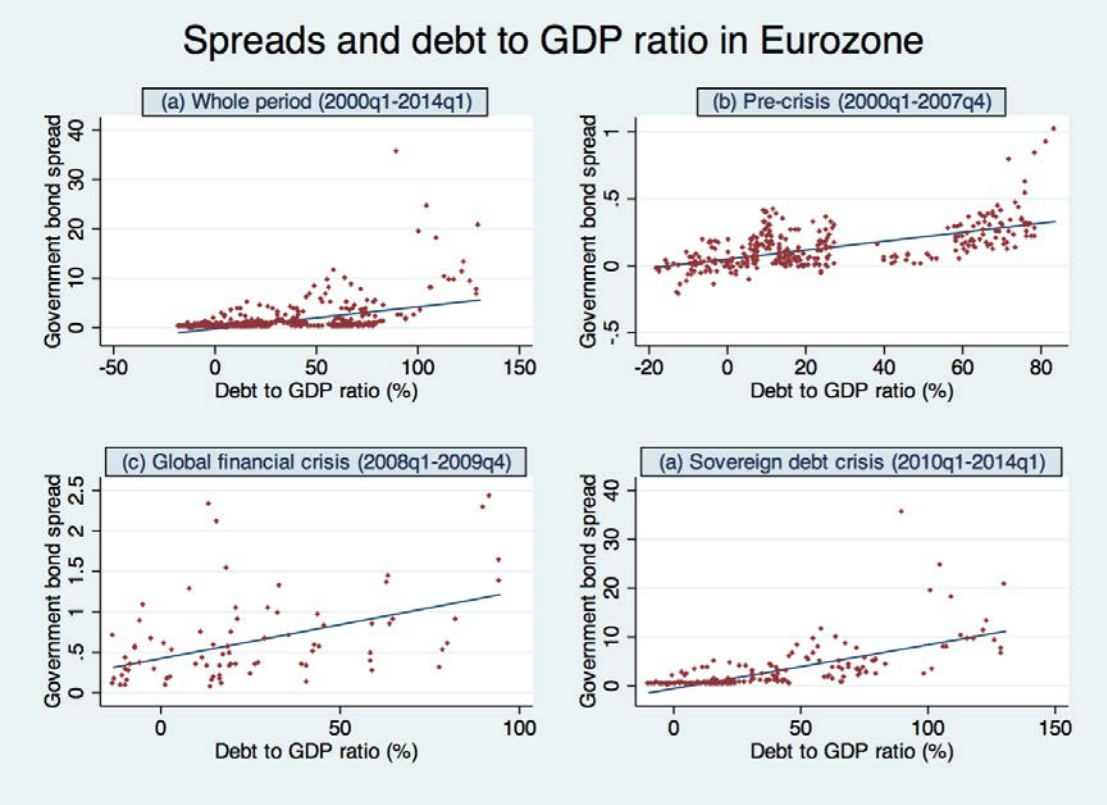

Figure 2: Spreads and debt to GDP ratio in Eurozone
Source: Eurostat, Datastream

After the last quarter of 2007 with the start of the global financial crisis the regression line becomes slightly steeper but the positive relationship remains still weak. It is possible to see from the Figure 2c that during this period debt to GDP ratios relative to Germany had increased compared to previous period. Figure 2d shows that the relationship between spreads and debt to GDP ratios becomes very significant following the outbreak of sovereign debt crisis in Eurozone. The level of spreads increases considerably during this period especially in peripheral countries such as Greece, Portugal and Ireland associated with very high levels of debt to GDP ratios relative to Germany. Since debt to GDP ratios taken as a proxy for the credit risk, at the first sight it is possible to say that the perception of default of markets for Eurozone governments had increased progressively in the aftermath of the global financial crisis. Sharp increases in public debt ratios after 2010 with the rescue operations for banking system led to historically high levels of spreads.

Similar to the analysis above, Figure 3 shows the relationship between the government bond yield spreads and expected government budget deficit to GDP ratio in

Eurozone. Observations are differentials in relation to Germany as it was before. While negative sign represents budget deficit, positive sign represents budget surplus.

Over the course of the whole period (Figure 3a) we see a strong negative relation between spreads and expected level of deficit to GDP ratio suggesting that at higher levels of expected negative budget balance are associated with rising bond yields. As it is in the debt to GDP ratio, the significance of the expected deficit to GDP ratio on the spreads changes over time.

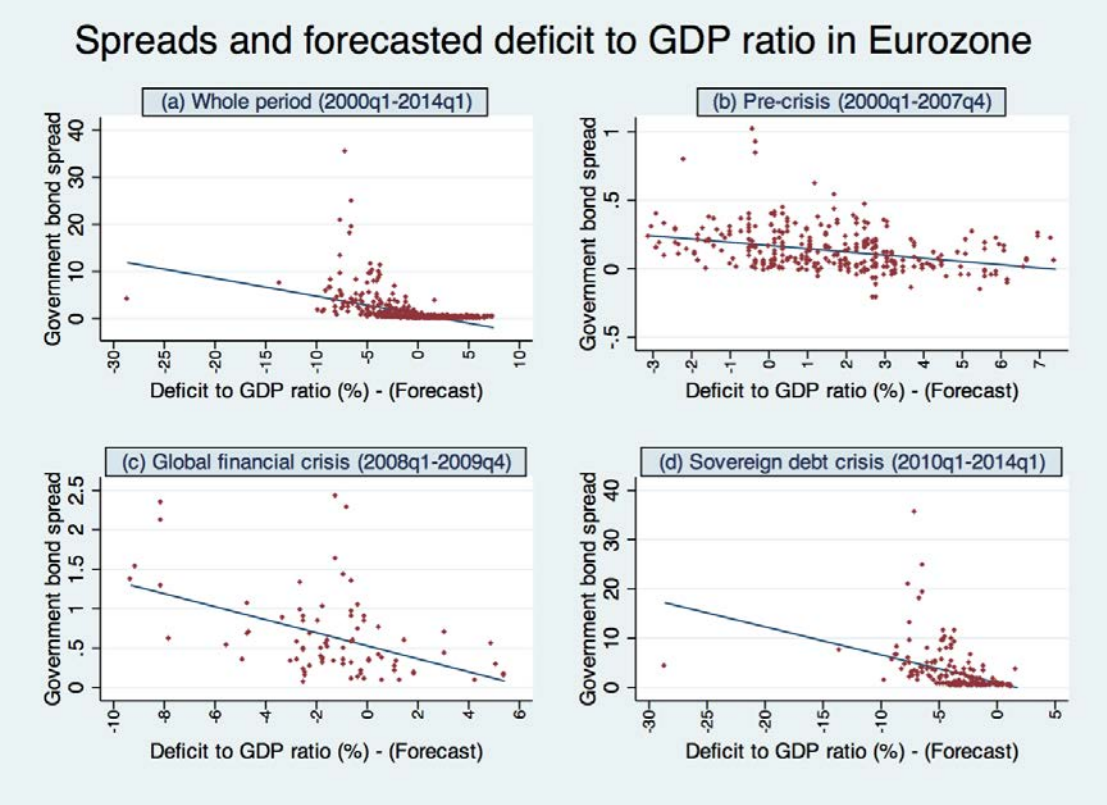

Figure 3: Spreads and forecasted deficit to GDP ratio in Eurozone
Source: European Commission, Datastream

During the pre-crisis period, while the value of expected budget balance to GDP ratio vis-à-vis Germany varies between -3 and 7, the spreads are clustering around zero. Therefore the regression line is almost horizontal in this period showing that the correlation is relatively weak (Figure 3b). One can see from Figure 3c that this correlation had become more significant with the increasing expected deficit to GDP ratios in the aftermath of the financial turmoil that started at the second half of 2007 and worsened with the collapse of the Lehman Brothers. Even though the regression line steepens during the global financial crisis, the effect of budget deficits on spreads remains limited.

Fiscal balance becomes very important in the Eurozone with the outbreak of the sovereign debt crisis starting from 2010. During this period in some countries budget deficits increased dramatically due to the problems in their banking sectors and also expectations of recession. As it can be seen from the Figure 3d the expected budget deficit to GDP vis-à-vis Germany increased to 30 per cent in Ireland. However, despite its high level of deficit, the government bond spread remained relatively low compared to Greece that had relatively better budget deficit in a part of this period.

Both of our variables representing the fiscal position show that the relationship between government bond yield spreads and fiscal imbalances becomes more significant during the sovereign debt crisis. Even though some outlier observations from Ireland and Greece affects the slope of the regression line, fiscal variables remains highly significant during this period due to increased default risk perception of investors.

In Figure 4 bid-ask spreads of government bond spreads in Eurozone is presented. While on the left side, there are core countries whose interest rate differentials related to Germany remained lower compared to the peripheral countries who take place on the right side of the Figure. When we look at closely to the bid-ask spreads we don't see much variation in core countries. Even though there are small variations in Austria after the collapse of Lehman Brothers and in Belgium in the aftermath of the Deauville agreement, these variations are negligible. On the other side, as it is the situation in core Eurozone countries there had been small fluctuations in the bid ask spreads of peripheral countries after the collapse of Lehman Brothers. But as one can clearly see from the right side of the Figure 4, there had been a sharp increase in peripheral Europe after the Deauville agreement which was related to involvement of private bondholders to the debt resolution. This agreement presumably increased the doubts about the liquidity of these bonds and caused flight-to-safety movements. When we compare the variation of bid-ask spreads in these countries after 2010 with the variation of government bond spreads after 2010 (Figure 1) we see a very similar pattern. By looking at the Figure 4, one can say that while the government bonds of core countries such as Austria, Belgium, Finland, France and the Netherlands and to a lesser extent some peripheral countries such as Spain and Italy had enjoyed the liquid market conditions during this period, some countries such as Portugal, Ireland and especially Greece paid much more compensation to investors for illiquidity of their bonds.

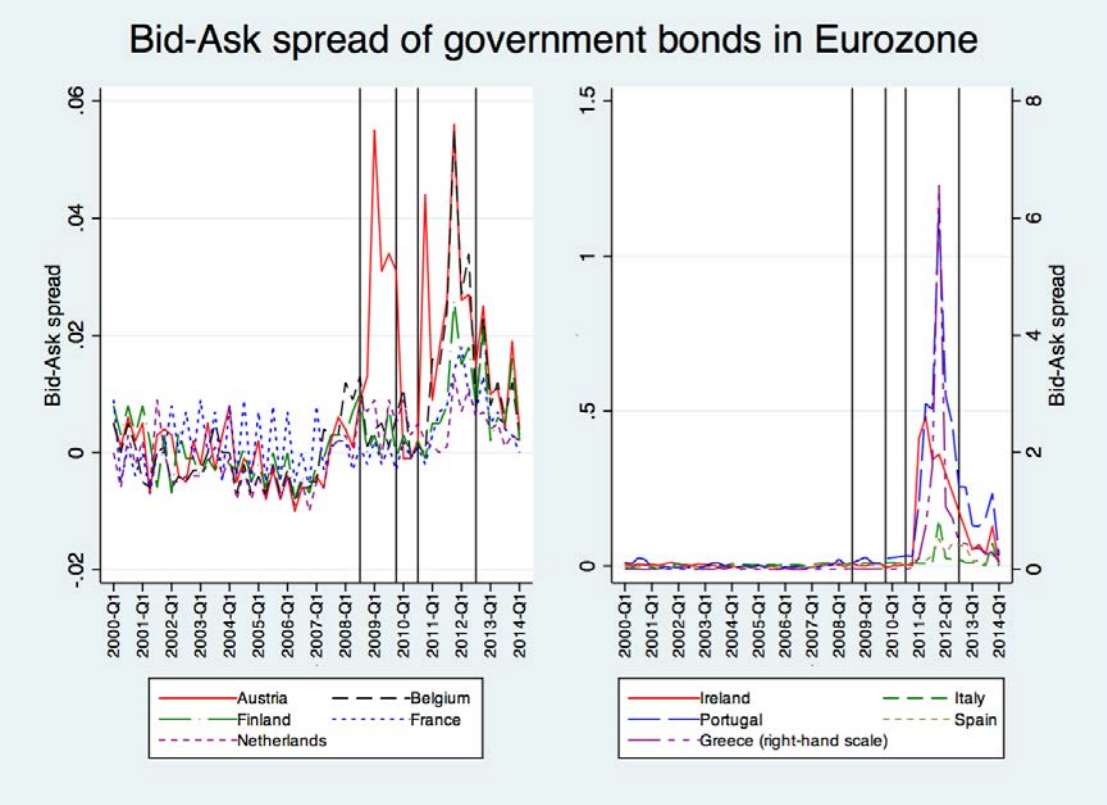

Figure 4: Bid-ask spreads of government bonds in Eurozone[3]
Source: Bloomberg

The evolution of the last explanatory variable of our analysis, US (BBB) corporate bond spread, during our sample period is given in Figure 5. The fluctuation of US corporate bond spread implies the changes in the global investors' risk aversion. From the Figure 5 one can say that after a relative rise in risk aversion in the early years of 2000s, it stabilized starting from 2004 by decreasing the initial levels. We see a sharp increase in risk aversion on the onset of the financial turmoil in mid-2007 and a sudden upsurge with the collapse of Lehman Brothers in the third quarter of 2008. After reaching the peak level in the first half of the 2009, global risk aversion decreased sharply to the levels of 2008 in a year and continued decreasing until the second quarter of 2011. Following a limited increase for three quarters, global risk aversion decreased again gradually and at the end of our sample period reached to a level close to pre-crises. As one can see, global risk aversion was affected notably by the collapse of Lehman Brother, which is represented with the first vertical bar in the Figure 5. Moreover it is possible to say that global risk aversion was not sensitive to euro-wide developments that are shown by the other three vertical bars in the Figure.

[3] The vertical bars denote the collapse of Lehman Brothers (2008q1), reveal of fiscal situation in Greece (2009q4), Deauville agreement (2010q4), and whatever it takes speech of ECB president and OMT communications (2012q3) respectively.

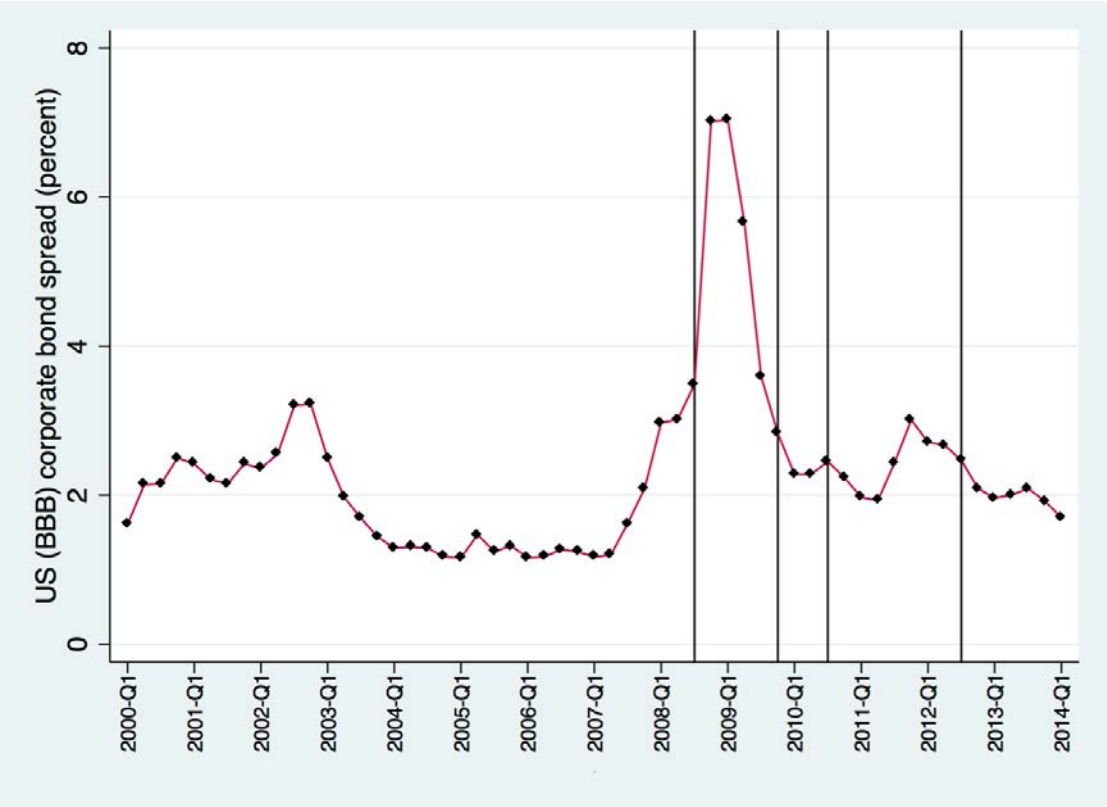

Figure 5: US (BBB) corporate bond spread[4]
Source: FRED (Federal Reserve Bank of St. Louis)

[4] The vertical bars denote the collapse of Lehman Brothers (2008q1), reveal of fiscal situation in Greece (2009q4), Deauville agreement (2010q4), and whatever it takes speech of ECB president and OMT communications (2012q3) respectively.

4 Model and Estimation

In line with the information given in the previous sections we will set an econometric model to be able to reveal the role of credit risk, liquidity premium and global investors' risk aversion on the government bond yield spreads of ten Eurozone countries vis-à-vis Germany. Since we work with quarterly data and the number of observations is limited we will do our analysis in two sub-periods. For the first period we specify and estimate a fixed effect model as follows:

$$spread_{it} = \alpha + \beta * debt_{it} + \gamma * deficit_{it} + \delta * ba_{it} + \mu * uscorp_{it} + \alpha_i + u_{it}$$

where $spread_{it}$ is the government bond yield interest rate of country i in period t, $debt_{it}$ is the ratio of general government debt to GDP of country i in period t, $deficit_{it}$ is the expected ratio of budget deficit to GDP of country i in period t, ba_{it} is the bid ask spread of government bond yields of country i in period t, $uscorp_{it}$ is the US low grade corporate bond spread in period t, α is the constant term and α_i is the fixed effect variable which captures unobserved time-invariant country specific effects for the country i.

The model specified for the second period is as follows:

$$spread_{it} = \alpha + \beta * debt_{it} + \gamma * deficit_{it} + \delta * ba_{it} + \mu * uscorp_{it} + \rho_1 * lehman + \rho_2 * greece + \rho_3 * dville + \rho_4 * ecb + \alpha_i + u_{it}$$

In addition to the variables that are used in the first period, in the second period dummy variables, $lehman$ to capture the effect of the collapse of Lehman Brothers at the last quarter of 2008, $greece$ to capture the effect of surfacing of fiscal situation in Greece at the first quarter of 2010, $dville$ to capture the effect of the Deauville agreement about the inclusion of private bond holders to the debt restructuring of Greece at the second quarter of 2011 and lastly ecb to capture the effect of whatever it takes speech of ECB president and also OMT communication at the third quarter of 2012, are included to the model.[5] Both models were also estimated with a non-linear specification by adding squares of *debt* and *deficit* variables to the model. Because of the fact that the explanatory power of the model didn't change significantly we exclude the non-linear specification and only use linear model for simplicity purposes.

[5] The quarters of the dummies lehman, greece and dville are modified according to the breaking points in the data by taking into account the possible effect lags.

Considering the descriptive analysis in the previous section and the information given in the literature review we can comment on the expected signs of explanatory variables. Fiscal variables such as debt and expected deficit to GDP ratios provide insight for investors about the sustainability of government debt. Therefore, an increase in the debt to GDP ratio leads to an increase in the debt service of the government and increases the probability of default. That's why we can expect a positive sign meaning that an increase in the government debt to GDP ratio causes a rise in the spreads through default risk. In a similar manner when the expected deficit to GDP ratio increases (budget balance increases in the negative way), government's debt to GDP ratio increases and through same mechanism the spreads increase. Thus, we can expect a negative sign for expected deficit to GDP ratio.

Bid-ask spread is the measure of liquidity and an increase in this variable signifies illiquidity of the security. Therefore when the security's liquidity deteriorates, the premium demanded by the investor will increase automatically. So, we expect a positive sign for the bid ask spread. Lastly, a rise in US corporate bond spread means that investors' willingness to take risk is lower and they invest on more secure bonds by selling the others. Since in the Eurozone the German bonds are considered as secure ones, in times of higher risk aversion investors will sell other bonds and buy German bonds to secure themselves which leads to an increase in in the spreads vis-à-vis Germany.

As mentioned above, for two different periods two different models will be used. For the first period, running from the first quarter of 2000 to the second quarter of 2007, the estimation will be carried out with all the countries in the dataset. As it was explained in the previous section, there is not an important divergence between the bond yield spreads of the countries during this period and the spreads are not volatile in general.

For the second period that runs from the third quarter of 2007 to the end of first quarter of 2014, analysis will be conducted first with all the countries in the dataset except Greece[6]. Then countries will be divided into two sub-groups according to the similarity of the behaviour of their bond yield spreads during this period as core (Austria, Belgium, Finland, France and the Netherlands) and periphery (Ireland, Italy, Portugal and

[6] Greece is excluded due to excessive deviations in its data which diverges the fitted values of model from the actual spreads.

Spain) and estimation will be carried out to reveal the reason of convergence of spreads between these country groups.

A technical note should be made here. Our analysis is based on a panel data that includes 10 countries and 57 quarters meaning that the number of countries is very short compared to the length of the time series, which is not the preferred data structure in panel data regression with fixed effects. Since we have heteroscedasticity and serial autocorrelation problems in our data, standard errors and p-values produced by Stata are not reliable and will be misleading for the interpretation of coefficients of the estimation. In normal circumstances Stata produces heteroscedasticty and autocorrelation consistent standard errors with the robust option but because of the fact that this would reduce the degrees of freedom substantially due to the aforementioned structure of our dataset, we cannot use this option for the estimation.

To overcome this problem we will estimate each equation in three different ways which will give us the same coefficients but different standard errors and p-values. First we will estimate our model with fixed effects but without robustifying, where there is no correction for heteroscedasticty and autocorrelation. Secondly the same model will be estimated with fixed effects with robust option where heteroscedasticity and autocorrelation is corrected but standard errors are not reliable due to the reason explained above. And lastly the model will be estimated with fixed effects with Stock and Watson -sw- option that corrects only for heteroscedasticty but not for autocorrelation and gives us Stock-Watson bias-corrected heteroscedastic-robust standard errors (Stock and Watson, 2002). It is expected to have larger standard errors due to the decrease in degrees of freedom at each step. The standard errors obtained from these three regressions will be evaluated together to decide on the significance of the coefficients of the estimation.

Table 1 summarizes the results of first estimation for the first period with all countries in the dataset and without dummy variables. The results suggest that fiscal variables are significant during the pre-crises period. The sign of debt to GDP ratio coefficient is positive as it is expected and p-values are significant in three different equations. While the significance level is 1 per cent in the first and third estimations, when we control for heteroscedasticty and autocorrelation the significance level falls to 10 per cent. If we look at the value of the coefficient we see that the influence of debt to GDP ratio on government bond yield spreads is relatively smaller compared to other

variables. Thus, it is possible to deduce that during this period financial markets do not seem to be concerned about the size of the government debt and do not demand an important amount of premium arising from debt burden.

Table 1: Estimation results for pre-crises period (2000q1-2007q2) - All countries

VARIABLES	(1) FE	(2) FE Robust	(3) FE SW
debt	0.00513***	0.00513*	0.00513***
	(0.00118)	(0.00250)	(0.00133)
deficit	-0.0282***	-0.0282***	-0.0282***
	(0.00486)	(0.00674)	(0.00472)
ba	2.200**	2.200***	2.200*
	(0.983)	(0.517)	(1.258)
uscorp	0.105***	0.105***	0.105***
	(0.0105)	(0.0185)	(0.0106)
Constant	-0.133***	-0.133**	
	(0.0290)	(0.0491)	
Observations	297	297	297
R-squared	0.468	0.468	0.468
Number of country	10	10	10
Country FE	YES	YES	YES

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

The other fiscal variable of the estimation, deficit, also seems significant in terms of its sign and p-values. As it is expected the coefficient of deficit has a negative sign. And also p-values are very close to zero meaning that the coefficient is highly significant in each of three estimations. The value of the coefficient is far higher then the debt coefficient in absolute terms but still relatively small. This can be interpreted as that investors attached more importance to budget deficit then debt ratio but still difficult to say that it is an important factor for determination of spreads.

Bid-ask spread as the liquidity measure seems an important factor as a determinant of bond yield spreads. The sign is positive as theory suggests. Although standard errors and p-values are various in each estimation, the coefficient is significant at least at 10 per cent level with the Stock-Watson bias-corrected heteroscedastic-robust standard errors.

The last variable US low-grade corporate bond spread as a measure for general risk aversion also seems very significant. The sign is positive as expected, meaning that

when investors are more risk averse the spread is higher. In all three estimations the coefficient is highly significant and the variation in the standard error is limited. Considering the actual values of the variables in our regression, it is possible to say that global risk aversion is the most important determinant of government bond yield spreads in the pre-crises period.

This can also be seen from the tables in Annex I where the composition of fitted values are presented according to the regression result shown in Table 1[7]. As one can see, in most of the countries US corporate bond spread has the highest share in fitted values compared to other variables. According to the graphs during the pre-crises period global investors' risk aversion is the main determinant of the spreads except for Belgium, Italy and Greece where debt to GDP ratio is the main determinant. With taking into consideration the fact that the scale is very small for spreads in this period, by looking at graphs it is possible to say that the influence of other variables on government bond yield spreads seems insignificant during this period.

Estimation results related to the crises period with all countries except Greece are summarized below in Table 2. In this second period the estimation is performed with dummy variables in addition to the first model to be able to see impact of important events that are chosen according to the analysis in the previous section.

One can see from Table 2 that the influence of fiscal variables is higher during the crises period. We observe a decrease in the significance of debt to GDP ratio when we control for heteroscedasticty and autocorrelation compared to other estimations. The sign is still positive as it was in the previous period but the magnitude of the coefficient is much more important in this period. Financial markets are paying more attention to government debt in this period compared to the previous one.

When we look at the expected deficit to GDP ratio variable we see a similar situation. The significance of the coefficient disappears when it is controlled for heteroscedasticity and autocorrelation. The sign is negative as it was in the pre-crises period and the value of the coefficient is almost two times higher. From the results related to fiscal variables, it is possible to say that financial markets are paying more attention to the fiscal position and the sustainability of government debt after the second half of 2007.

[7] Since some coefficients and the constant of the regression are negative the calculated values of some independent variables may be higher than the fitted value and the actual value of the spreads in the graphs.

Table 2: Estimation results for crises period (2007q3-2014q1) - All countries except Greece

VARIABLES	(1) FE	(2) FE Robust	(3) FE SW
debt	0.0416***	0.0416*	0.0416***
	(0.00514)	(0.0193)	(0.00825)
deficit	-0.0719***	-0.0719	-0.0719***
	(0.0255)	(0.0417)	(0.0217)
ba	9.143***	9.143***	9.143***
	(0.570)	(0.730)	(1.971)
uscorp	0.0146	0.0146	0.0146
	(0.0395)	(0.0269)	(0.0222)
lehman	-0.313	-0.313*	-0.313
	(0.283)	(0.143)	(0.207)
greece	-0.594**	-0.594***	-0.594***
	(0.277)	(0.170)	(0.147)
dville	-0.267	-0.267	-0.267
	(0.282)	(0.227)	(0.286)
ecb	1.058***	1.058**	1.058**
	(0.292)	(0.402)	(0.426)
Constant	-0.279	-0.279	
	(0.201)	(0.397)	
Observations	236	236	236
R-squared	0.730	0.730	0.730
Number of country	9	9	9
Country FE	YES	YES	YES

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Bid-ask spread seems highly statistically significant in all three estimations in crises period. The sign is still positive meaning that if the illiquidity of a government bond increases, investors ask a premium for compensation. In this period the size of this premium demanded by investors for liquidity risk is almost three times larger compared to previous period.

The striking detail in Table 2 is the statistical insignificance of US corporate bond spread during this period. As it was mentioned in the previous section this variable had a peak after the collapse of Lehman Brothers and during the global financial crisis and in normal circumstances it is expected to have an important influence on spreads. Despite its expected positive sign, the value of coefficient is smaller and is not statistically significant in any of three estimations even at 10 per cent level.

The signs of our dummy variables are opposite of the expectation. *lehman*, *greece* and *dville* are representing events that are expected to cause an increase on yield spreads.

However their signs are negative and only *greece* is statistically significant in three regressions. The sign of the *ecb* variable is expected to be positive but apparently it is positive in our regression. Since dummy variables are for control purposes we focus on our main variables of interest.

If we look at the composition of fitted values (Annex I) calculated according to the results presented in Table 2, we see the debt to GDP variable is the main determinant during the whole period. In addition to this fact we also observe that the determinants are differentiating for some countries after the first quarter of 2010 where the sovereign debt crisis starts. While for the core countries and some of the periphery countries such as Spain and to a certain extent for Italy the debt to GDP ratio remains as the main factor determining the level of spreads, for countries Ireland and Portugal the bid ask spread becomes the main factor between mid-2010 and mid-2012.

After looking at Eurozone countries as a whole, now we will do the same estimation for two sub groups, first for core countries and secondly for peripheral countries, since we expect different effects of independent variables on different country groups.

The estimation results for the core countries in crises period is summarized below in Table 3. As one can see, the results are different compared to the results given in Table 2 for the estimation with all countries in the sample.

The results for fiscal variables for core countries are considerably different compared to the results previous estimation for all countries. Especially debt to GDP ratio coefficient is smaller in value and statistically insignificant in all three equations. Furthermore expected deficit to GDP ratio coefficient looses its significance when we first control for autocorrelation and then for both autocorrelation and heteroscedasticty and also the value is smaller compared to the previous estimation. Both of the fiscal variables have expected positive signs. These results brings us to the conclusion that even it is an important determinant in Eurozone in general, investors do not consider a deterioration in governments' fiscal position in core countries as a source for credit risk.

Another important point in our estimation is the change in the value of the bid-ask spread coefficient. The coefficient almost doubles while remaining statistically significant and having its expected positive sign. When it is controlled for

heteroscedasticity and autocorrelation, the standard error increases considerably but the coefficient still remains statistically significant at 5 per cent significance level.

Table 3: Estimation results for core countries in crises period (2007q3-2014q1)

VARIABLES	(1) FE	(2) FE Robust	(3) SW
debt	0.00304	0.00304	0.00304
	(0.00598)	(0.0136)	(0.00563)
deficit	-0.0494***	-0.0494	-0.0494**
	(0.0173)	(0.0346)	(0.0216)
ba	15.31***	15.31**	15.31***
	(2.213)	(5.438)	(2.575)
uscorp	0.0522***	0.0522*	0.0522***
	(0.0171)	(0.0190)	(0.0177)
lehman	-0.253**	-0.253**	-0.253**
	(0.113)	(0.0824)	(0.113)
greece	-0.157	-0.157	-0.157*
	(0.111)	(0.0793)	(0.0905)
dville	-0.0106	-0.0106	-0.0106
	(0.112)	(0.0595)	(0.0536)
ecb	0.309***	0.309*	0.309**
	(0.110)	(0.118)	(0.136)
Constant	0.0867	0.0867	
	(0.110)	(0.182)	
Observations	134	134	134
R-squared	0.486	0.486	0.486
Number of country	5	5	5
Country FE	YES	YES	YES

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Yet another important result of the estimation for core countries is that, while global risk aversion coefficient is not significant both statistically and in terms of magnitude for all countries during the crises period, it is significant when the estimation is performed only for core countries and its value is almost four times higher compared to previous estimation. Again when we robustify the regression, the standard errors increase in a considerable extent but still the coefficient remains statistically significant at 10 per cent significance level.

The values of dummy variables decrease as well but they still remain insignificant in terms of their signs for core country group, as it was the case at the previous estimation.

The composition of fitted values (Annex I) is also different than the previous estimation when the estimation is done only for core country sub group. Graphical analysis shows us that the debt to GDP ratio, the main factor for the analysis with all countries has a very small share in fitted values for core countries. The main determinants for core country group are the global investors' risk aversion during the global financial crisis and the liquidity conditions for the sovereign debt crisis.

Table 4: Estimation results for periphery countries in crises period (2007q3-2014q1)

VARIABLES	(1) FE	(2) FE Robust	(3) SW
debt	0.0372***	0.0372	0.0372***
	(0.00823)	(0.0221)	(0.00936)
deficit	-0.102**	-0.102**	-0.102***
	(0.0420)	(0.0313)	(0.0255)
ba	9.082***	9.082***	9.082***
	(0.823)	(0.820)	(2.034)
uscorp	-0.0759	-0.0759*	-0.0759*
	(0.0883)	(0.0244)	(0.0419)
lehman	-0.611	-0.611*	-0.611
	(0.609)	(0.250)	(0.381)
greece	-1.094*	-1.094***	-1.094***
	(0.590)	(0.0655)	(0.118)
dville	-0.774	-0.774	-0.774
	(0.606)	(0.431)	(0.585)
ecb	2.451***	2.451***	2.451***
	(0.674)	(0.364)	(0.363)
Constant	0.251	0.251	
	(0.476)	(0.730)	
Observations	102	102	102
R-squared	0.774	0.774	0.774
Number of country	4	4	4
Country FE	YES	YES	YES

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

The estimation results for the periphery countries in crises period is summarized above in Table 4. The differences between the core countries and the periphery attract the attention at the first glance. The magnitude of coefficients in value and their statistical significance are very different in Tables 3 and 4.

The first difference between two country groups is about the fiscal variables. The value of the coefficient of the debt to GDP ratio variable is very high in periphery countries compared to core countries. And also this coefficient is highly significant in the first and third estimation of Table 4. When we control for heteroscedasticty and autocorrelation, the standard error increases due to the limited number of observations and the coefficient becomes insignificant. However, this result gives us an idea about the perception of credit risk of investors about the core and periphery countries and it is possible to say that debt to GDP ratio is a more important determinant for periphery countries compared to core countries.

Expected deficit variable has a similar statistical significance level for both country groups but the value of the coefficient is almost twice in periphery countries which is consistent with the result that we came through for the debt to GDP ratio above. Investors are more sensitive to deterioration in fiscal variables in periphery countries during the crises period.

Bid ask spreads are very significant in both country groups but the value of the coefficient is larger in core countries than the value for periphery countries. But as a difference, in periphery countries the standard error is far more smaller compared to core countries even when we control for heteroscedasticty and autocorrelation, meaning that statistically more significant in periphery. However, during the crises period government bond yield spreads are more sensitive to liquidity in core countries than periphery by looking at the values of coefficients.

Our last variable of interest, US corporate bond spread has a very different statistical significance level for different country groups. The coefficient for this variable is not very different in estimations but the standard errors are larger in periphery countries which clouds its significance. And also the sign of the coefficient becomes negative in periphery and gives the impression that global risk aversion is not an important determinant of spreads in the periphery while the situation is opposite in the core country group.

As a comparison between the core and the periphery countries in the crises period, it is possible to say that while the main determinants of the government bond yield spreads in core countries are liquidity of securities and the global risk aversion during this period, the fiscal variables such as debt to GDP ratio and expected deficit to

GDP ratio that reflects the credit risk of the government and the liquidity of securities are the main determinants for periphery countries.

Graphical analysis on the composition of fitted values (Annex I) supports the results given above. The share of debt to GDP ratio in fitted value remains very high in periphery countries over the course of the crises period. Especially for Italy and Spain the main determinant of the government bond spreads seems like the debt to GDP ratio. For Ireland and Portugal while the main factor is debt to GDP ratio until the half of the period, bid ask spreads becomes the most important factor with the sovereign debt crisis. During the second half of the period liquidity also affects the spreads in Italy and Spain in a limited extent.

5 Conclusion

The analysis presented in this paper was aimed to explain the reasons of the increase in the government bond yield spreads in Eurozone during the crises period that is starting with the global financial crisis in the third quarter of 2007 and continues with the European sovereign debt crisis after 2010. Our main assumption based on the literature was that there are three main determinants of government bond yield spreads which are the credit risk of the issuer government, the liquidity risk of the security and the global investors' risk aversion. For explaining roles of these factors we used a panel data regression with fixed effects and used the ratio of general government's debt to GDP and the expected budget deficit to GDP as proxies for credit risk, the difference between bid and ask prices of the government bonds as a measure for liquidity and US low-grade corporate bond spread for the general investors' risk aversion.

Our analysis has shown that the Eurozone government bond yield spreads were highly influenced by the international factors such as global investors' risk aversion during the pre-crises period which covers the quarters between the beginning of 2000 and the third quarter of 2007. We found evidence that during this period investors had underpriced the deterioration of fiscal positions of governments in the Eurozone and hadn't demanded a premium for the probability of default despite high debt to GDP ratios of some countries.

With the outbreak of the global financial crisis we observe a switch in the roles of determinants in the Eurozone. In the estimation that we do with all the countries in our dataset except Greece for the crises period, we observe that after the beginning of the financial turmoil in the world in the third quarter of 2007 the pricing of investors of fiscal deterioration had changed significantly and the debt to GDP ratio had become the most important determinant of the spreads during the period. With the beginning of the sovereign debt crisis in Eurozone in 2010 in some countries such as Ireland and Portugal, the liquidity contributed to a large extent to the interest rate differentials.

When we take a closer look at the role of these factors in different country groups we encounter with a different situation where the investors are discriminating countries according to their country specific properties. While the debt to GDP ratio is an important determinant of government bond yield spreads in periphery countries, it seems insignificant for the core countries. Namely, while investors are not concerned about the

fiscal deterioration in core countries, they demand a risk premium from periphery. Instead of fiscal situation, investors price the government bonds of core countries according to general risk aversion. While the global risk aversion seems like the main determinant of bond yield differentials in core countries especially during the global financial crisis, this factor seems insignificant for periphery countries during the whole crises period.

Liquidity conditions of bonds looks like the only factor that is influential for both core and periphery countries during this period. Especially it is an important determinant of government bond yield spreads in Austria, Belgium, Ireland and Portugal and in a certain extent in Italy and Spain during the sovereign debt crisis in Eurozone.

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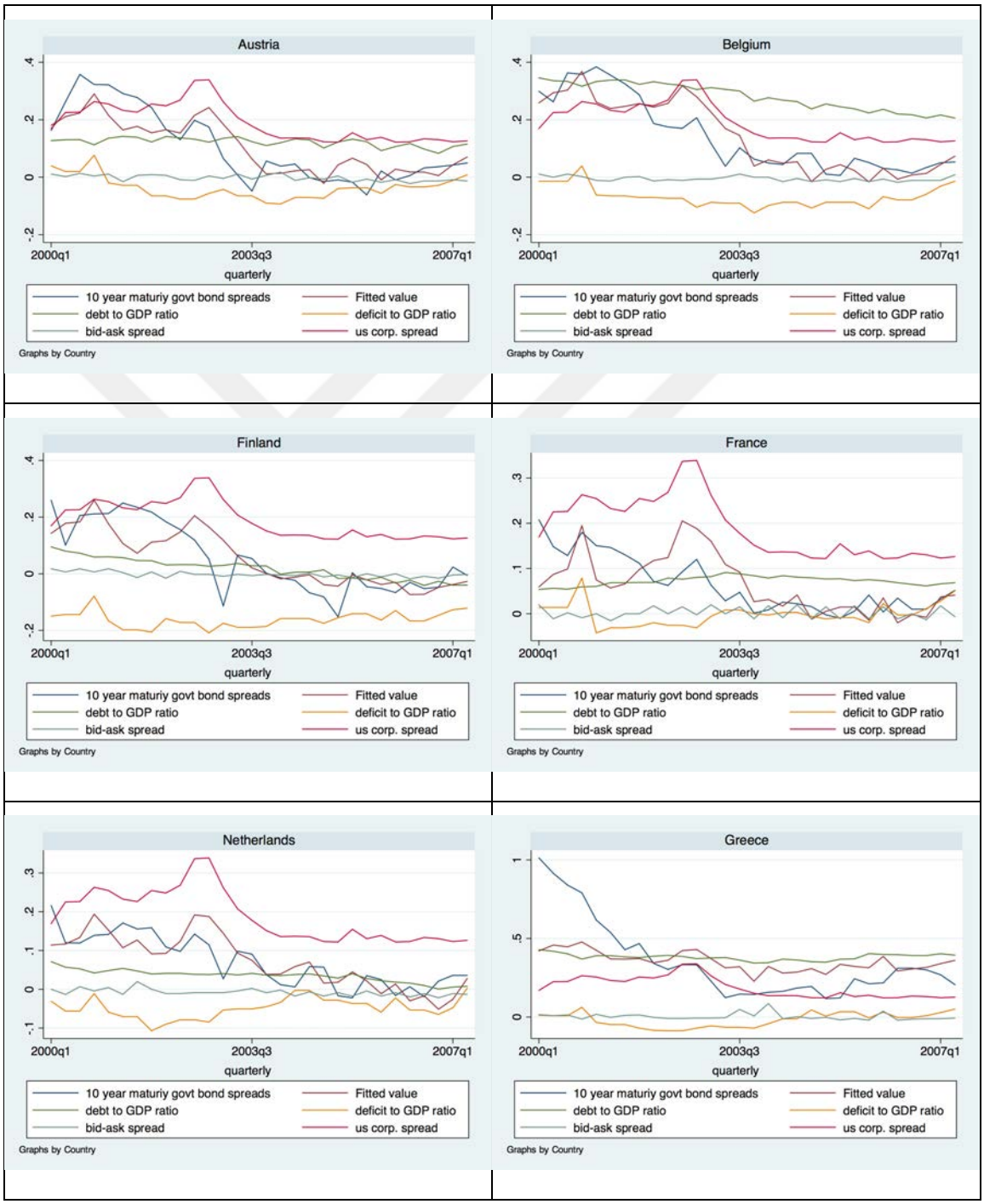
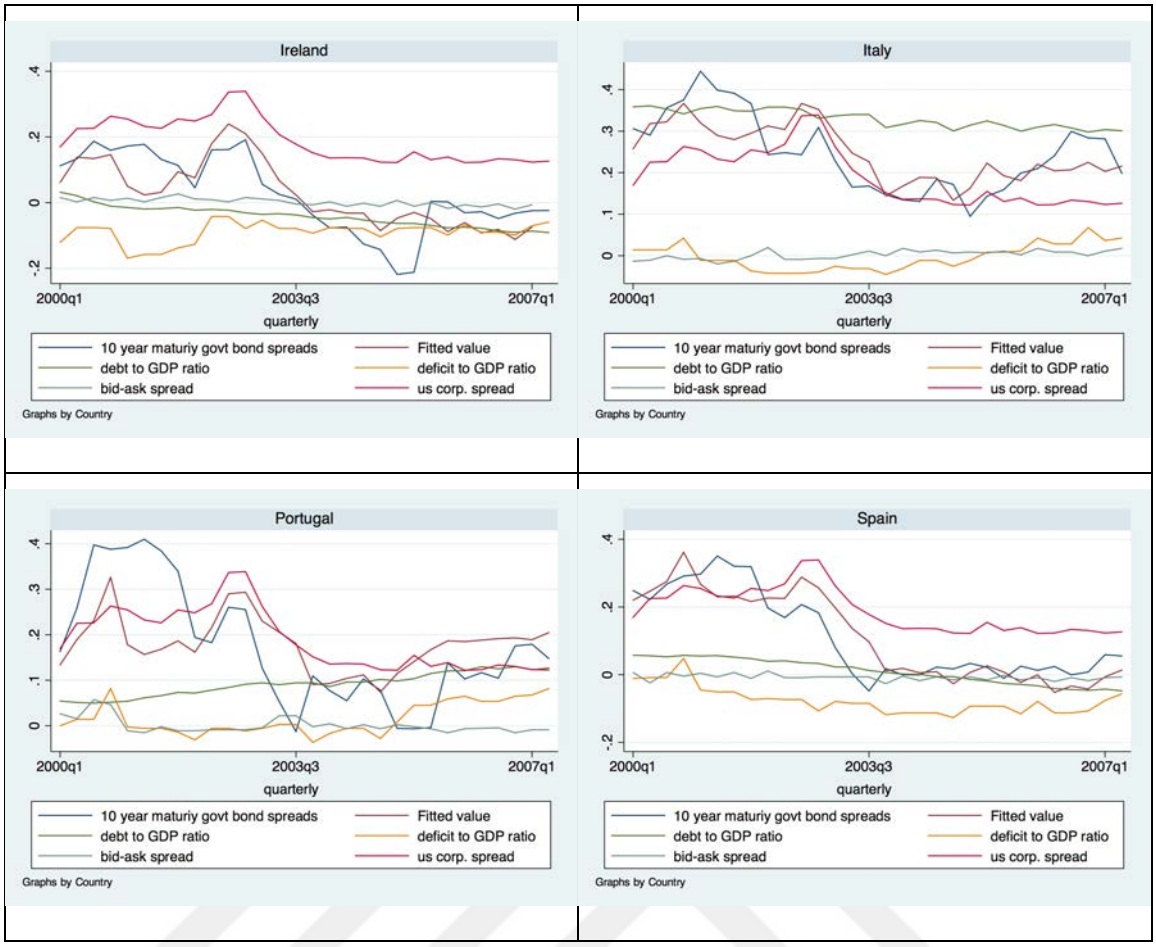
ANNEXES

ANNEX I

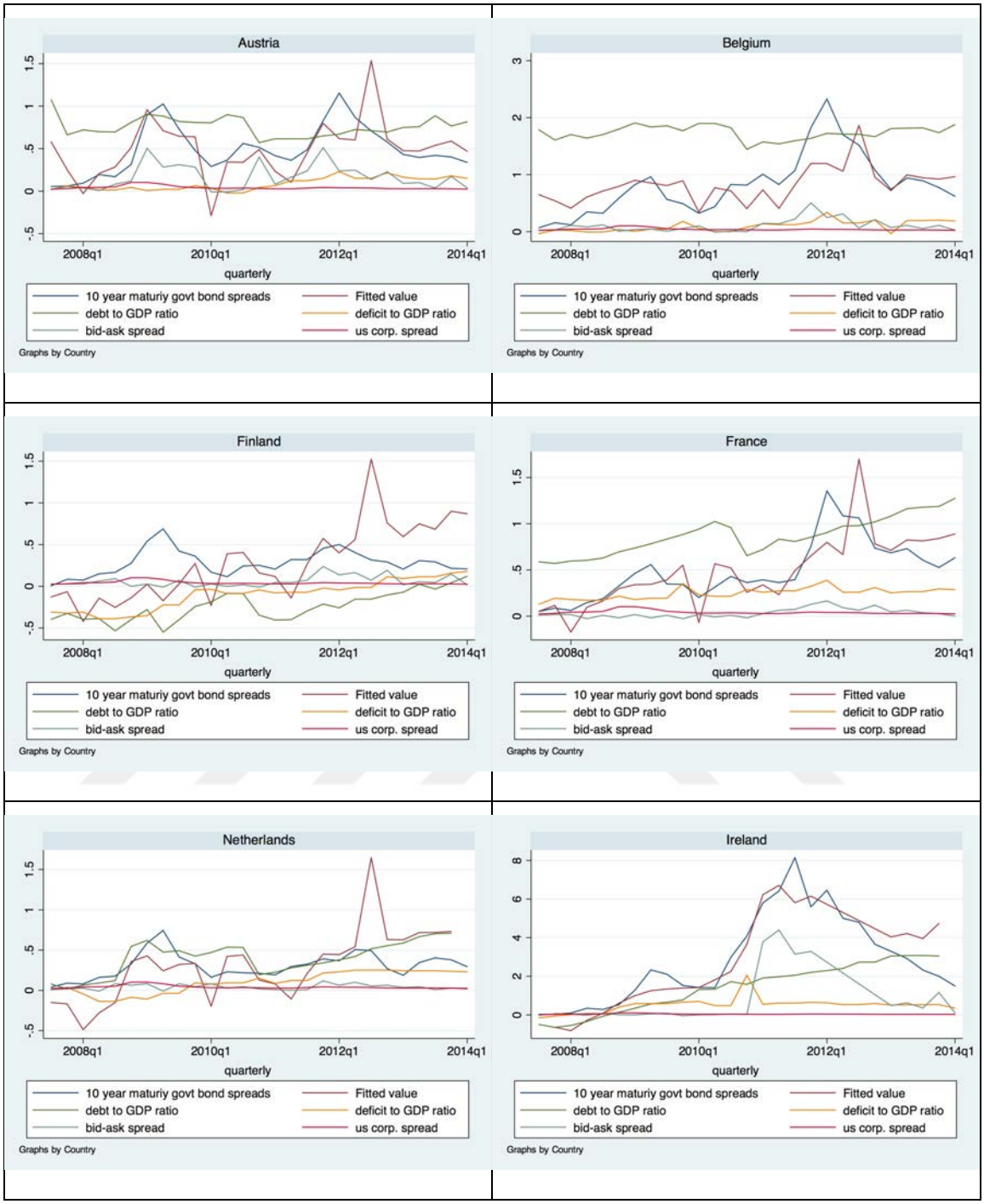
Composition of Fitted Values of Estimations

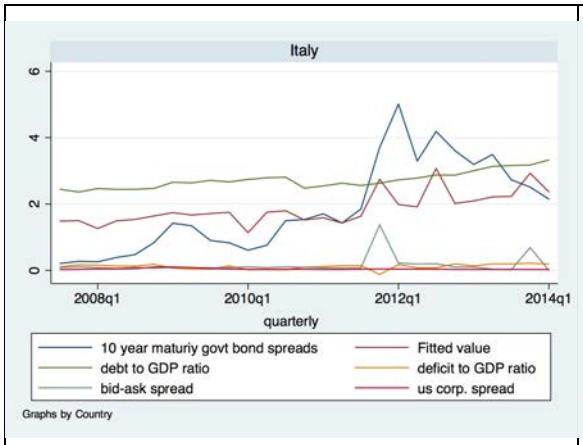
Composition of fitted values according to the results in Table 1

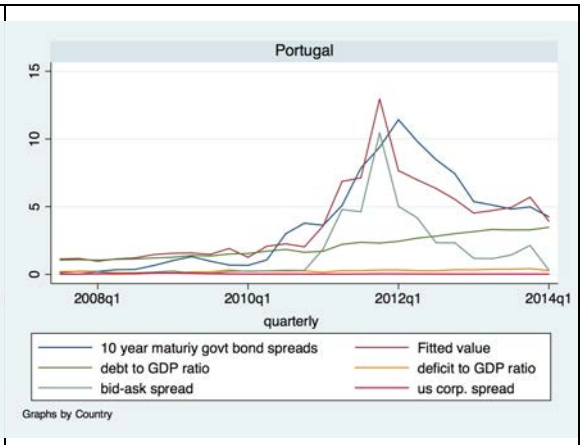


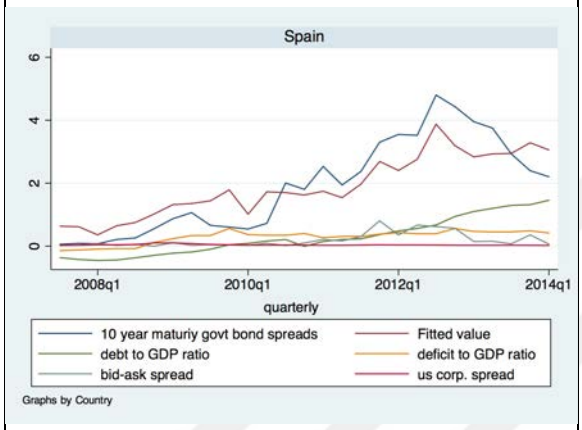

Ireland
Italy
Portugal
Spain
2000q1
2003q3
2007q1
quarterly
10 year maturiy govt bond spreads
Fitted value
debt to GDP ratio
deficit to GDP ratio
bid-ask spread
us corp. spread
Graphs by Country

Composition of fitted values according to the results in Table 2

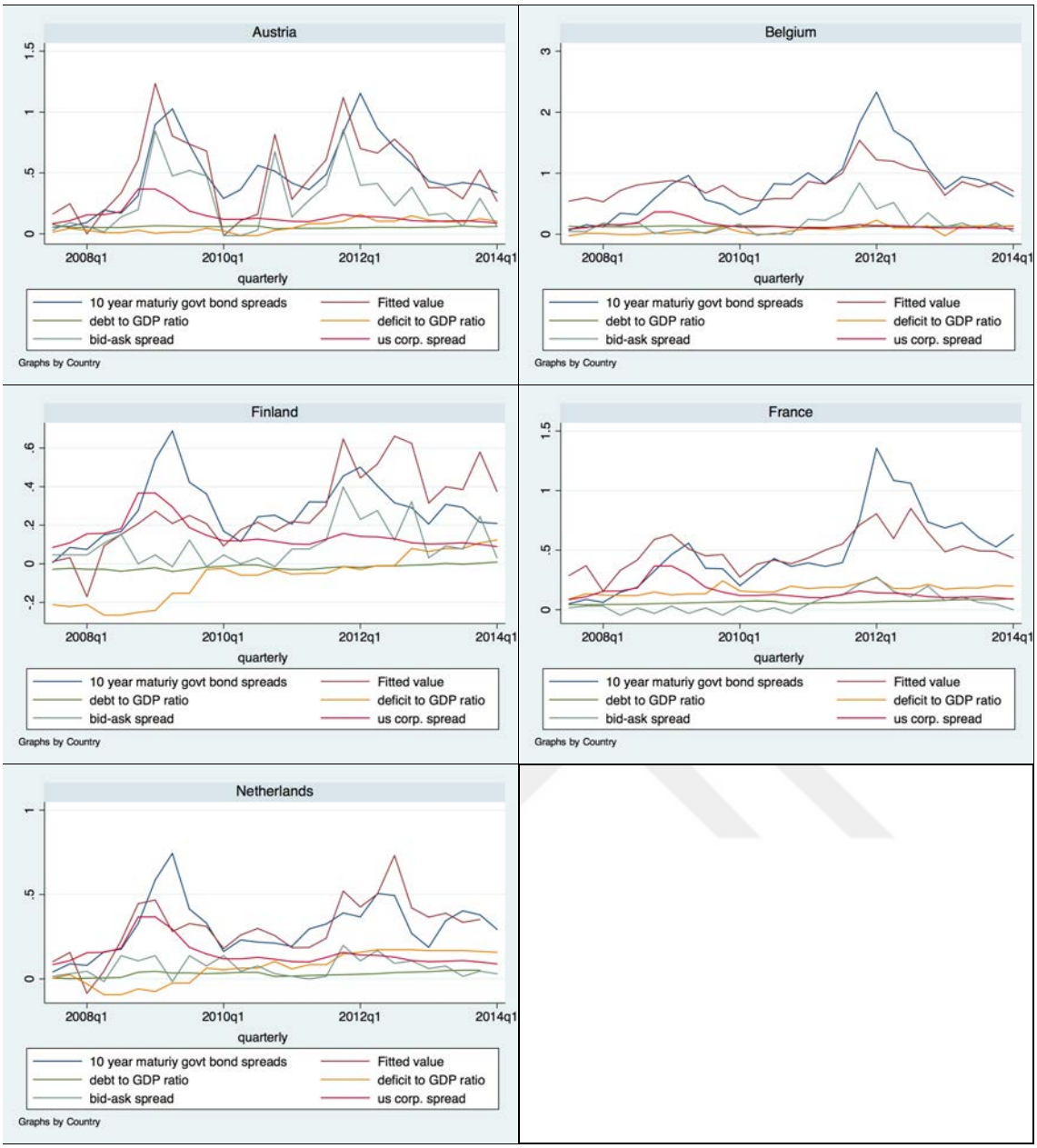



Italy
0
2
4
6
2008q1
2010q1
2012q1
2014q1
quarterly
10 year maturiy govt bond spreads
debt to GDP ratio
bid-ask spread
Fitted value
deficit to GDP ratio
us corp. spread
Graphs by Country

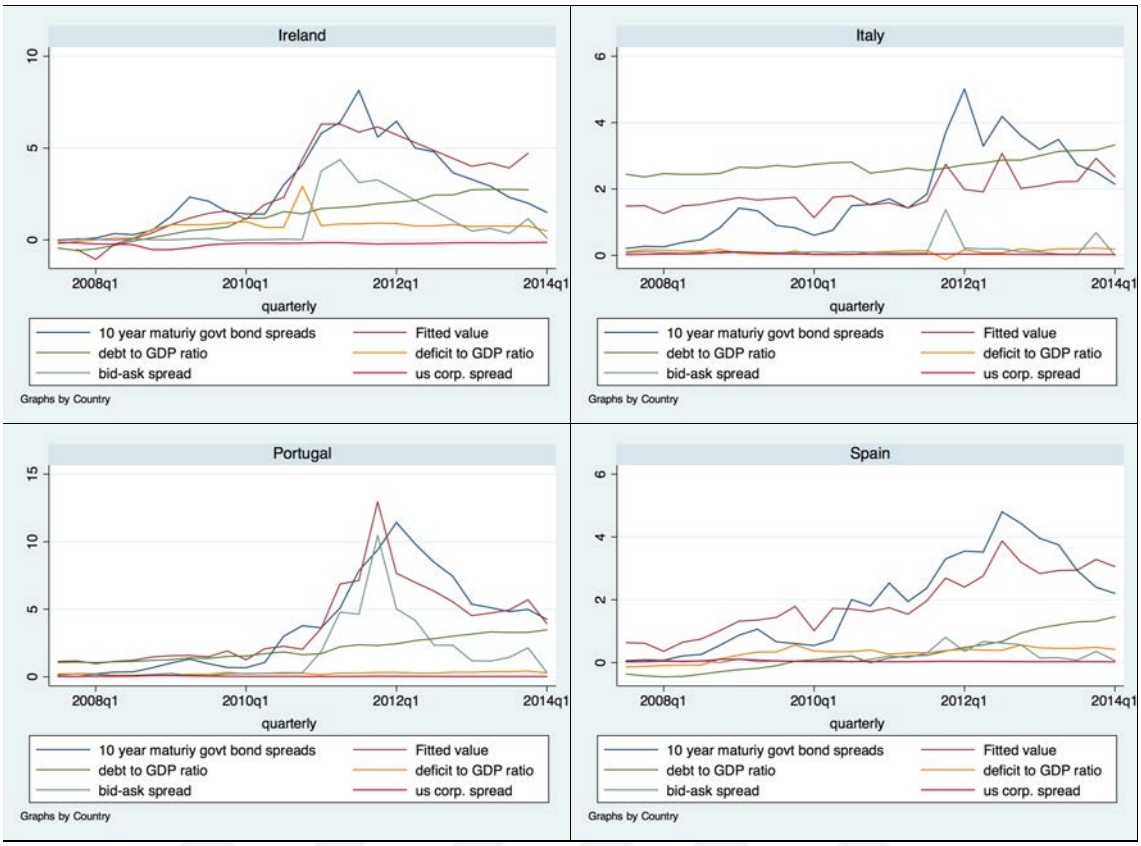

Portugal
0
5
10
15
2008q1
2010q1
2012q1
2014q1
quarterly
10 year maturiy govt bond spreads
debt to GDP ratio
bid-ask spread
Fitted value
deficit to GDP ratio
us corp. spread
Graphs by Country


Spain
0
2
4
6
2008q1
2010q1
2012q1
2014q1
quarterly
10 year maturiy govt bond spreads
debt to GDP ratio
bid-ask spread
Fitted value
deficit to GDP ratio
us corp. spread
Graphs by Country

Composition of fitted values according to the results in Table 3



Composition of fitted values according to the results in Table 4



ANNEX II

Data Description and Sources

Variable	Description	Source
Yield spread	Difference between the ten-year government bond yield of a Eurozone country and the ten-year German government bond yield in percent, quarterly frequency.	Datastream
Debt	Difference between the general government debt to GDP ratio of a Eurozone country and that of Germany in percent, quarterly frequency.	Eurostat
Deficit	Difference between the forecast of government net lending / borrowing as percentage of GDP of a Eurozone country and that of Germany in percent, semi-annual frequency.	European Commission
Bid-ask spread	Difference between the bid and ask quotations of ten-year government bonds, quarterly frequency.	Bloomberg
US corporate bond spread	Difference between the yield on Merrill Lynch US Corporate BBB Index and the yield on ten-year US treasury benchmark bonds in percent, quarterly frequency.	FRED (Federal Reserve Bank of St. Louis) - BofA Merrill Lynch Database