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The Crime of Fiscal Neglect and Punishment of High Rates

– A Panel Study for EMU

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Abstract

This paper examines long-term interest rates and fiscal liabilities within EMU in the context of the recent sovereign debt crisis; where Greece, Ireland, Italy, Portugal and Spain faced rising interest rates in contrast to the rest of the EMU. An assessment of the short and long-run properties of long rates, fiscal deficits and government debt are estimated for 11 EMU countries in the time span 1999-2015. This is done through different fixed-effects models, 2SLS and Panel-DOLS. No long-run relationship between the variables is found. Results also show that fiscal deficits have a positive effect on long rates and the interaction between deficits and debt enhance the overall impact on rates, in particular to fiscally vulnerable countries. Unexpectedly, government debt show a negative effect on interests, a result explained in the context of ECB's role as lender of last resort and the asymmetric effects among EMU members. In conclusion, results suggest a subjective punishment for fiscal inadequacy through long-term rates.

Key words: EMU, Long-term Interest Rates, Government Debt, Fiscal Deficits, GIIPS

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1 Introduction

In the late 2009, following the Greece election the newly appointed government reassessed the yearly deficit forecast, more than doubling the previous figures. In tandem with Greece, fiscal revenues in Ireland and Spain dropped sharply, resulting in larger than expected deficits (Lane, 2012). This marked the break-out to the European sovereign debt crisis, as it became evident several EMU[1] countries had ran consecutive deficits and accumulated debt prior to the crisis. Within less than a year both Greece and Ireland were bailed-out by the European Central Bank as they were unable to service their debt and Portugal followed shortly after (Lane, 2012). In order to assign the guilty, attention has ranged from blaming inept fiscal governing in the GIIPS[2] countries, irrational market reactions driving up yields, credit agencies faulty ratings and all the way to proposing this to be a healthy market reaction punishing those behaving badly (De Grauwe, 2010; Featherstone, 2011; Aizenman et al, 2013; De Grauwe, 2013). On the other hand, both Belgium and Italy joined EMU without fulfilling the minimum debt level, tailed by France and Greece which piled up debt since the early 2000s. In addition, building up to the crisis government bond rates had been kept low although debts had risen steadily for a majority of EMU countries, thus fuelled excessive borrowing due to the low cost of debt (Lane, 2012). As it will become clear, underestimating the effect of markets inability to incorporate fiscal fundamentals had dire consequences.

Going back to when EMU was implemented, one of the motives was to provide financial stability through common monetary policy and elimination of exchange risk (EMI, 1995). In contradiction, historically the way out of excessive public debt has often been assigned to currency devaluation. Moreover, fiscal policy continued to be a national matter with two conditions: First, the Stability and Growth Pact which imposed restrictions upon fiscal deficit and government debt[3]. Second, nations could not be bailed-out in the case of default. These conditions have been challenged to be both vague and even insufficient to prevent countries to not run deficits (Manganelli and Wolswijk, 2009; Gali, 2010; Beck and Prinz, 2012). The first requirement was violated by Italy, Belgium and Greece in the moment they joined the EMU; the former two due to holding debt levels above the required 60 percent and the Greece because of fiscal deficits

[1] EMU will be discussed in the context of phase three, launched on 1 January 1999 introducing the euro (ECB, 2016a).
[2] This was a term coined to incorporate the most troubled countries during the crisis, namely: Greece, Italy, Ireland, Portugal and Spain (Dergiades et al, 2014)
[3] Stability and Growth Pact, further information see: ECB (2016b)

breaching 3 percent. In addition, Portugal and Spain had a history of high debts just recently lowering their levels below said requirement. In the years following the beginning of EMU, debt levels rose steadily within the union and the maximum deficit of three percent were violated by a number of countries This fiscal laxity argued to be a consequence of ECB being unable to impose demands upon recurrent violators; partly due to France and Germany both dodging repercussions to their on violations (Lane, 2009; Buti et al, 2003). Also, during these boom years running up to 2007, the market seemed to be indifferent regarding fiscal liabilities. Hence, the long-term interest rates which converged in the starting days of the EMU, kept the same for all EMU countries until 2008, regardless of fiscal stance.

The homogeneity in-between countries regarding low interest rates enabled the excessive borrowing due the low cost, even though debts levels indicated considerably higher risk. In hindsight, long rates mispriced the risk of government debt to the extent that Greece and Portugal were unable to finance their large yearly deficits whilst Ireland and Spain boomed their housing market (Lane, 2009). In the latter case, both countries became reliant on tax revenues from the construction sector, consequently the years of fiscal order resulted in a recoil. When the crisis hit, long rates raised exponentially for countries deemed prone to default, raising the price of debt. Furthermore, countries who carried unsustainable debt could not seek funding from IMF without help from the private sector (Lane, 2009). A natural response by the markets would be an all over risk-adjustment through rising interest rates. But, due to the overarching scare that rising interest rates would pull the whole EMU into a recession, the ECB initiated open market operations to buy up government debt in order to push rates down. This action was directed asymmetrically among member countries, conditional to if said bonds held a good enough rating. This arbitrary help has opened to discussion whether some countries are indirectly getting punished through high interest rates (Lane, 2009; De Grauwe, 2010; Kopf, 2010). More precise, as spreads rose it became harder for the GIIPS countries to seek funding compared to the rest of EMU. Arguably, the blame was assigned to countries holding large amount of fiscal liabilities, punished through high interest rates. All the same, the ambivalent reaction from long rates within the EMU and the apparent persistence to turn the crisis around, economists has sought-after answers to which effect fiscal fundamentals actually has on long-term interest rates and how these affected the recent crisis.

In this paper, I will analyse the effect government debt and fiscal deficit has on long-term interest for 11 EMU countries during the years 1999-2015. More distinctly,

the emphasis lies on both the short and long-run effects and how debt interacts with deficits. Additionally, I will examine potential disparities in the outcome following the EU debt crisis and in particular the GIIPS countries. This will be done using both cointegration analysis (long-run) and panel regressions (short-run) to provide cohesive results. The purpose of this paper can be summarized to:

Is there a disparity to how fiscal liabilities affect long-term interest rates within EMU?

Theory generally suggests a positive relationship between fiscal deficits and long-term rates in the short-run, excluding an increase due to expansionary policy. Similarly debt also has positive relationship to long rates through crowding-out effects or rise in risk-premia. However, empirical provides evidence which is mixed to whether the effects are positive or negative. This might have to do with country-specific effects, credibility, the historical fiscal record or unique characteristics of policy-makers – all of which are hard to incorporate in general equilibrium models. In order to evaluate the short-term effects a series of panel regressions with appropriate dummies and specifications are used to evaluate specific effects and provide robustness. This includes a number of Fixed-Effects models using robust errors, Generalized Least Squares (GLS), and Two-Stage Least Squares (2SLS). The long-run effects will be examined through cointegration testing and further applying Panel-DOLS. Through all regressions, focus will be put on the effect on long-term interest rates that government debt, fiscal deficits and an interactive variable between the two might have.

This paper adds to current research in a number of ways. First, by applying analysis to a recent sample of EMU countries in contrast to previous studies applied to single countries, the OECD or the EMU convergence before the debt crisis – thus missing out on the specific effects from the aftermath of the crisis. Secondly, it proposes the hypothesis of both a short and long-term disparity to effects of holding fiscal risk within the EMU. It also applies previous research and expands it, most notably by including a variable of interaction in between government debt and fiscal deficits. Lastly, as most research has focused solely on the short-term effect, I will provide a long-term assessment through Panel-DOLS.

Results indicate no long-term effect between government debt and long rates. In the short-run, the interactive effect between fiscal deficits and government debt is positive, affecting the GIIPS countries to a larger extent. This supports the hypothesis of a disparity in the short-run and a further discussion examining the causes of the EMU

debt crisis is presented. Some limitations to both the short and long-term estimation should be acknowledged. First, due to data being quarterly, unavailability of expected variables which has been proven effective in earlier studies has been excluded, most notably projected fiscal standings. Also, the paper's purpose sets limitation in time and imposes a problem to distinguish cointegrating relationships. Lastly, as long-term interest rates are affected by numerous other channels than debt and fiscal deficit, modelling such a variable is by default challenging.

The remainder of this paper is structured as follows. First, in the next section I present previous research. In section 2 I describe the channels of impact to long interests. In Section 3 the methodology and data is presented. In Section 4 model specification and estimation will be discussed. In section 5 results are presented and lastly in section 6 some concluding remarks are made.

1.1 Previous Research

In earlier studies, several efforts have been done in order to examine the effects between fiscal liabilities and long interest rates. In most studies, either long-interest rates or corresponding spread are modelled against both government debt and fiscal deficit various types of panel-regression specifications. There has also been substantial amount of literature written on the theoretical foundations of public debt, fiscal deficits and long interests. In this section, the combination of the empirical and theoretical endeavours done by foregoing researchers will be outlined.

Typically, estimating the effects of fiscal fundamentals on long rates are either a panel regression or cross-sectional matter for the short-run and some sort of cointegration analysis is the norm regarding the long-run properties. This method has been predominately successful in terms of providing robust estimates, although varying in magnitude across studies. In Laubach (2009) it was found that expected values of fiscal deficits had larger impact than current deficits. Results indicate long rates are raised by 20-29 basis points by a one percent change in expected deficit and by 3-4 basis points by a similar change in expected debt. Comparable results for projected debt and deficit is found by Engen and Hubbard (2004). Advantages of incorporating projected variables can be assigned by capturing expectations of the current fiscal stance and match the forward-looking markets. Thus, models that are predictive propose that countries can hold a large debt and keep low interest if their projected fiscal situation is sustainable. Results from projected regression has been tested against a theoretical

simulation in a general equilibrium framework, supporting both the empirical results and the underlying theory (Engen and Hubbard, 2004; Kinoshita, 2006).

A drawback to projected variables is the restrictions in terms of availability and frequency. Nevertheless, work has been done without the use of expected fiscal variables, instead relying on present values. Once again, the results in Laubach (2009) propose that nominal values have a smaller effect than projected. Using current values, Ardagna et al (2007) examines 16 OECD countries, finding a 10 basis points effect due to a one percent change in deficits. In the same paper, several hypotheses are tested regarding non-linear effects from debt, the effect from an overarching institution or country and also dealing with the endogeneity issues using IV estimation for variables likely to suffer from reverse causality. Results indicate that all said estimates are significant parameters in determining long interest rates, suggesting asymmetry in the effects both from the parameters and the relationship to the overarching policy-maker.

Similar results regarding asymmetry or more precise debts levels is found by Faini (2006); results show that unsustainably high debts levels can differ between countries and will affect interest rates exponentially if breached. In the same paper, he also proposes critique to theory simulated results (Engen and Hubbard, 2004) due to the empirically weak assumption of a Cobb-Douglas economy, thus underestimating the effects of fiscal deficits. Returning to high debt-levels being an important factor; in Drudi and Prati (1999) where Italy, Ireland, Belgium and Denmark is analysed for the years 1970-1990 this is examined. Their findings indicate it is crucial to when fiscal deficits happen as well as the condition of debt when both factors are at a "fragile" state. Even though estimated separately, their results indicate it is the sustainability between debt and deficit that determine the effect on long interests. Last, Baldacci and Kumar (2010) use a panel estimation of both advanced and emerging economies. Their main finding adding to previous research is that the initial fiscal position will determine to which extent the impact high debt has on interest rates.

The long-term relationship between long rates and fiscal fundamentals is sparsely researched empirically. Studies can be divided between theoretical based (Kinoshita, 2006; Laubach, 2003; Engen and Hubbard, 2004) and empirically oriented (Poghosyan, 2010; Ardagna, 2007). Theoretical studies rely on the assumptions and to which extent the parameter values can be estimated. Their results indicate that there is a small positive effect of debt upon interest rates. In the empirical attempts to evaluate

the long-run effect, Poghosyan (2010) employs a middle-ground PMG[4] estimation which accounts for both the cointegrating long-term effects as well as the short-term effects. A positive relationship between long-rates and government debt is found, indicating that yields will increase by 2 basis points following a one percent change in government debt. However, the results are based on lose assumptions of non-stationary; most notably panel-unit root tests propose widely different results regarding stationarity.

Lastly, econometric techniques used in this paper can be assigned to Pedroni (1999) for developing panel cointegration and the work by Saikkonen (1992) and Stock and Watson (1993) for defining the Panel-DOLS estimator. The latter has not been used in similar studies evaluating long rates and government debt whilst Pedroni's tests are used in Poghosyan (2010).

2 Long-term Interest Rates: Channels of Impact

In order to examine the effects fiscal deficits and government debt has on long-term interest it is suitable to evaluate the wide array of theory on the topic paired with representative empirical data. The assumptions prevailing for different theories will alter based on which channels that interest rates are affected through and how the dynamics work in the short respectively long run. Evaluating both at the same time is reasonable since debt is the accumulated past deficits. Following sections will be divided into three parts; (i) discuss the importance in the role of government debt and fiscal policy have on interest rates, (ii) examine the conflicting evidence regarding the role of fiscal liabilities, (iii) provide an explanation to the term-structure for long interests rate and the influence from ECB to said structure.

2.1 The Importance of Fiscal Fundamentals

Both government debt and fiscal deficits have central parts in macroeconomic models. However, predicting the effects it might have on interest rates is quite the task. It is suitable to start with a standard production function where debt is exogenous and an increase in government debt will crowd-out capital. This is due to private investors facing higher interest rates when government debt rise, will put less resources in capital, implicitly decreasing the capital-stock and leading to a higher marginal product of capital and increasing interest rates (Engen and Hubbard, 2004). Important to note at this stage is that debt is merely accumulated debt, hence a change in debt is by

[4] Pooled Mean Group.

definition corresponding deficit. Thus, deficit is often analysed as the short-run and government debt for the long-run (Elmendorf and Mankiw, 1998). Furthermore, the economy is presumed to be classical in the long-run (crowding-out) but Keynesian in the short-run. The short-run effects are typically seen through the standard IS-LM framework where an increase in fiscal deficits is a result of government spending, thus increasing the aggregate demand. Hence, an increase in fiscal deficit (spending) shifts the aggregate demand curve upwards to a point of higher interest rates. However, the idea is that government spending stimulates the economy and increase output, counteracting the increase in the debt ratio. Therefore, there can be a discrepancy if interest rates increase as a consequence to expansionary fiscal policy in contrast to increasing deficits due to laxity (Bernheim, 1987).

Elmendorf and Mankiw (1998) discuss four additional ways in which government debt might interact with fiscal deficits and interest rates. First, government debt is priced through long-term interest rates, or, the ability to service held debt. Therefore, high debts levels might raise doubt regarding debtholders ability to service their obligations; consequently rates adjust to compensate for the high risk. Action to unexpected rise in interest can be taken by central banks through expansionary monetary policy, lowering interest rates in the short-run and while returning to their original state in the long-run. Consequently, such actions tend to raise inflation and lower interest rates. In context of EMU and current sovereign debt crisis, ECB took a position as lender of last resort to ensure low interests[5]. Secondly, government debt can limit further financing, especially if debts are high and there is a need to borrow, in particular during crisis. Looking back at history, governments stuck in such a position has tried to finance its way out of such matter with the help of central banks using seigniorage. This is however a case of the past due to numerous cases of hyperinflation and consequently the benefit of independent central banks are currently the norm. As for EMU and recent crisis, countries stuck in this position have been unable to conduct monetary policy and unable to fund sovereign debt due to high interests (Lane, 2009). Thirdly, availability to borrow money will affect in the way fiscal policy is conducted. This might hurt budget discipline or provide incentives for short-sighted policies. Economists as early as Wicksell (1896) tackled this issue, as he said if financing were supported by a majority of voters, financing would probably be a possibility. The problem is much like the Ricardian, namely the lack of future tax payers vote in current deficit

[5] In 2012, ECB took the role as "lender of last resort" in order to ensure liquidity within EMU (De Grauwe, 2013)

accumulation, or likewise, future debt level. Again in context to recent developments in the EMU, prior governments in several countries have been building up debt, enabled by low rates possible through the euro and the combination of ignorance and expedience (Lane, 2009). Lastly a fourth aspect is proposed, with a more globally integrated economy, international flexibility and confidence might be hurt by deficits or a high enough debt (Feldstein, 1986). The effects due to fallen reputation reflect lower credibility by the international markets, lowering the demand for domestic bonds and increasing the long rates. This was one of the problems which pushed several of indebted countries within the EMU to default, as they were unable to turnaround capital from the market (Lane, 2009).

2.2 Taking the Opposing View

Previous section provides a summary to what is expected by fiscal deficit and public debt; however the conventional view has been challenged throughout the years. Foremost by a benchmark theorem in economics, namely the Ricardian Equivalence, implying that there is no difference between financing public spending by debt or taxes[6]. If the theorem holds, it simply states that government spending and the accumulated version in terms of debt will have no effect on the economy in the long run. Elmendorf and Mankiw (1998) discuss the importance of this theorem in the context of fiscal spending. If a change in fiscal expenditure does not affect the economy in the long-run this also holds for interest rates. At a first glance the theory is more relatable to permanent-income theory; nonetheless it holds implications to issuing of government debt and the discussion of forward-looking policy.

In Barro (1974) the equivalence idea was applied to government bonds, proposing a tax-cut funded by selling of bonds were just a term of redistribution, leaving net wealth unchanged. What is telling regarding the Ricardian world is the wide array of critique which opened a debate to whether debt will affect the economy or not. The critique can be assigned the assumptions regarding intergenerational distribution. Thus, debt taken on today is a way to move today's tax-burden into the future. This leads to a higher income of today and will alter the interest rates. A counter-argument was proposed by Barro (1974) as he said today's generations will care about their future families and be unwilling to put a high tax-burden in their hands. Further critique can

[6]First proposed by David Ricardo in 1820, elegantly illustrating that financing can be done through either taxes or debt for the same present value (Sørensen & Whitta-Jacobsen 2010: 440-443).

be summarized to the myopic behaviour of consumers. There are a number of different utility profiles, some might use a lower tax today due to being credit constrained, others will act short-sighted and be unaware of future tax-hikes if political climate change or fail to recognize higher tax burden of tomorrow (Mankiw and Elmendorf, 1998). Taking a look at the EMU, one would think the Ricardian view was held as consensus. Fiscal irresponsibility has been raised as one of the main perpetrators to the sovereign debt crisis. Both Greece and Portugal increased their government consumption and held yearly deficits running up to the crisis. Barro's bond proposition is also contradicted, as issuing of government debt can result in further complications than repayment, in the case of EMU this would be default. Yet, support for the Ricardian case is found in Plosser (1982) and (1987), thus indicate that the zero effect cannot be rejected entirely.

2.3 Term-structure and the Role of ECB

Determining the long-term interest rates in the economy is represented by the average of expected and current interest rates assuming risk-neutrality.[7] If there are risk-averse investors a suitable risk-premia need to be added. Plotting a yield curve will thus differ with expectations from market participants; keep flat for expected constant interest rates, slope upwards if growth is expected to increase and downwards if the economy is expected to slow down. Hence, short-term interest rate according to the expectations hypothesis determines long-term interest. In order to understand how this might affect long-term interest one should consider that most Central Banks apply versions of the Taylor rule to set their interest rates (Sørensen & Whitta-Jacobsen 2010). Without going further into said rule, being outside the scope of this paper, this rule simply tells us that interest rates are affected by monetary policy and further deviations from natural output and inflation.

Within the EMU, the ECB conducts monetary policy for all the member countries. Just as most central banks, their pronounced focus lies on keeping financial stability through an inflation target. When the sovereign debt crisis hit the economy was already in financial crisis. Thus, to prevent EU from going into a recession the ECB held the interests low through open market operations, purchasing government bonds (De Grauwe, 2013). Quantitative easing in this matter is used in several highly indebted countries in the likes of US, Japan, UK and now within EMU (Lane, 2009). In this

[7] Assuming risk-neutrality, $i_t^{long}=\frac{1}{n}(i_t+i_{t-1}^e \ldots i_{t+n-1}^e)$, this can applied for any underlying asset. For full discussion and derivation see Sørensen and Whitta-Jacobsen (2010: 463-464).

quartet, EMU is a clear outsider being a monetary union, providing the alternative of different effects to different countries. If the effect from such an operation can ensure sustainability, the can push rates down even though holding high debt. Another aspect the possibility of different effects is a new trilemma proposed by Beck and Prinz (2012), which states there is an impossibility to have fiscal sovereignty, independent monetary policy and a no bailout clause within a currency union. These three are all a part of the EMU standard and would thus lead to failure in one of the aspects. When the debt crisis unravelled, the no-bail out clause was breached for Greece, Ireland, Portugal and Spain. Given this specific assumption, incentives points towards an unsustainable union and would also imply there needs to be one or several scapegoats. In this case, both IMF and ECB had standards to bonds holding a certain rating in order to ensure liquidity (Lane, 2009). Countries without this possibility faced higher interest rates not reaping the benefits other countries had from these open market operations.

3 Data

The analysis is performed for 11 EMU countries covering years 1999-2015 using quarterly data. Included countries are the following: Austria (AUT), Belgium (BEL), Germany (DEU), Finland (FIN), France (FRA), Greece (GRC), Ireland (IRL), Italy (ITA), Netherlands (NDL), Portugal (PRT) and Spain (ESP). Countries denoted by i=1, 2,…N and time follows t=1, 2,…T where N marks the 11 countries and T marks the 68 quarters included. All countries except Greece were a part of the originating EMU members and Luxemburg is excluded due to data limitations. However, due to Greece being a major part in the EU sovereign debt crisis, also joining EMU reasonably early in 2001 and focus will lie on the effect after the crisis broke out, Greece is included in the analysis. The time period stretches from the start of the EMU in January 1999 until the fourth quarter of 2015. This is a relatively short time-period which might affect the results of our analysis, foremost the cointegration analysis.

Three variables and their interactions are in focus in the analysis: Long-term interest rates (LTI_{it}), Government debt $(GDEBT_{it})$ and Government deficit ($GDEF_{it}$). All values are nominal and both *GDEBT* and *GDEF* are as a ratio of nominal GDP. Also, an interactive variable between *GDEBT* and *GDEF* is constructed by INT_{it}[8]. In addition, using common practice a series control variables are added based on theory and earlier research, these are: Inflation (INF_{it}), Short-term interest rate (STI_{it}) and

[8] Simply the product of $GDEF_{it} \times GDEBT_{it} = INT_{it}$.

GDP growth *($GDPG_{it}$)*. There are no missing values and thus the panel is strongly balanced. All variables used are collected using DataStream and extracted from Oxford Economics' databank. In following sections there will be a brief presentation of descriptive statistics followed by an empirical presentation of the data.

3.1 Descriptive Statistics

Here, a brief presentation of the descriptive statistics is done. In Table 3.1 variable characteristics are presented. As seen, none of the variables has missing observations and all variables have a total of 748 observations. The whole panel has an average debt level of about 62 percent and an average quarterly deficit of 2.85 percent. Deviation between lowest debt ratio of 12.9 percent and the highest of 132 percent suggests some heterogeneity in fiscal liabilities between countries. Also, the largest deficit reached 29.1 percent compared to the largest surplus of 10 percent. Long-term interests have a mean of roughly 4.3 percent and differ from the lowest value of 0.31 percent to highest of 25.4 percent. Integration order informs whether the certain variable is stationary or not. Those variables integrated of order one will be estimated in differences, explained more carefully in the next section.

Table 3.1 Descriptive Statistics

Variable	Number of obs.	Mean	Std. Dev	Min	Max	Integration order
Long-term interest rate	748	0.04295	0.0233	0.0031	0.2540	I(1)
Debt-to-GDP ratio	748	0.6198	0.2626	0.1289	1.3172	I(1)
Deficit-to-GDP ratio	748	-0.0285	0.0436	-0.2931	0.1034	I(0)
Interactive variable	748	-0.0294	0.0309	-0.3266	0.0335	I(0)
Inflation	748	0.0194	0.0145	-0.0609	0.0663	I(1)
Short-term interest rate	748	0.0229	0.0173	-0.0001	0.1080	I(0)
GDP growth	748	0.0036	0.0108	-0.0685	0.0619	I(0)

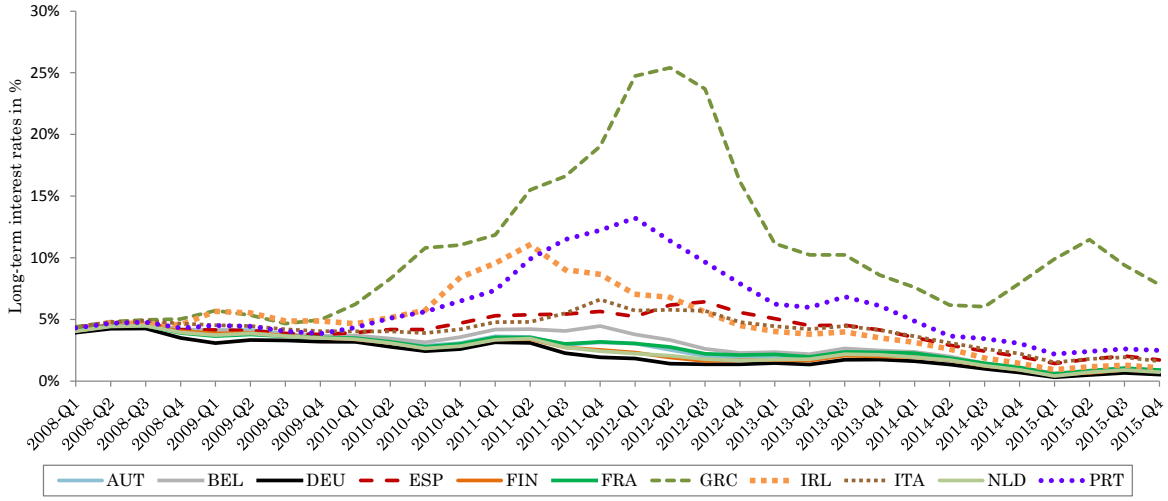
Note: All variables are from *Oxfords Economics*, using quarterly data. All variables are expressed in percent. Unit root tests can be found in the Appendix under Table 4.2.

3.2 Data Overview

In this section data will examined closer in order to understand estimation procedure and provide an intuitive explanation to the developments within the EMU. Government debt will be presented in different timestamps chosen to represent certain events. Only one such break will be done within the regression analysis later, marking the start of the debt crisis. The four timestamps are: The first quarter of 1999 that marks the start of EMU, the first quarter of 2005 marks the high point during the boom with no effects of the crisis yet seen, the fourth quarter of 2009 marks the outbreak followed by Greece election in October the same year and last the fourth quarter of 2015 which is simply marks the end of the available data series. This is a practical simplification of the events for this time period nonetheless it does provide adequate information in this instance.

The long-term interest is the dependent variable in further analysis. During starting years of EMU interests fully converged. Only Greece deviated before their accession in 2001 and then converged leading up to the crisis. A clear break is seen in 2009 but signs started to erupt in early 2008. In Figure 3.1, long rates from 2008 to the end period are displayed. Throughout the crisis years it can be seen that the GIIPS countries have the highest interest rates. Greece went from below 5 percent to a peak above 25 percent in 2012, Portugal rose to around 15 percent also in 2012, Ireland peaked during the second quarter of 2011 with above 10 percent, both Spain and Italy went slightly above 5 percent but did not take off like the three previously mentioned. However, both Spain and Italy deviated with around 5 percent from the remaining countries not being a part of the GIIPS group. These countries also saw an overall decrease of interest rates from slightly below 5 percent to a steady decreasing rate, reaching below 1 percent during 2014. In the end period, the GIIPS countries, with the exception of Greece, have also shown signs of convergence to lower interests.

Figure 3.1 Long-term interest rates, all countries



Source: Oxford Economics

Furthermore, taking a look at fiscal standings, they will be analysed at said timestamps expressed in present values. In Table 3.2, debt-to-GDP ratio is presented for all countries. Bold numbers marks at which timestamp they first breached the acceptable 60 percent level decided by the Stability and Growth pact. Only Germany can be excluded for breaching this limit during the evaluated years. Both Belgium and Italy had this debt level upon entering the EMU and were followed at next timestamp in 2005 by both France and Greece. In contrast to interest rates, debt ratios are high for the majority of countries. Both Ireland and Spain had seemingly low debt ratios when the crisis started, although with a steep slope upwards between the last two timestamps, which changed 45 to 85 percent for Spain and 32 to 72 percent for Ireland. Portugal reached 60 percent at the start of the crisis and was representing the median level of debt when the crisis broke out. Noteworthy are the progression of Austria, Belgium and France which are well above Ireland and Spain at all timestamps and more or less exceeds Portugal for all periods. Belgium is in the end of the sample at 118 percent of GDP and France at 115 percent at GDP, not far away from Greece's 122 percent.

Table 3.2 Debt-to-GDP ratio

Timestamp	AUT	BEL	DEU	ESP	FIN	FRA	GRC	IRL	ITA	NLD	PRT
1999-Q1	0,47	**0,92**	0,41	0,36	0,38	0,56	0,43	0,24	**0,78**	0,47	0,29
2005-Q1	0,56	0,83	0,48	0,32	0,32	**0,66**	**0,63**	0,16	0,82	0,44	0,43
2009-Q4	**0,76**	0,90	0,53	0,45	0,37	0,82	0,88	0,32	0,99	0,53	**0,60**
2015-Q4	0,91	1,18	0,52	**0,85**	**0,64**	1,15	1,22	**0,72**	1,32	**0,71**	0,97

Source: Oxford Economics

The quarterly fiscal deficits are presented in Table 3.3, also displayed as percent of GDP. In this case, it would be illogical to choose a certain time and these will instead be presented as yearly averages. Numbers marked with bold text marks yearly deficits which breached the 3 percent advised by the Stability and Growth pact in at least three consecutive years and the dotted line marks the years after the crisis started. In this case, Greece and Portugal are running large deficits on a yearly basis since the start and Greece fail to have a single period under the 3 percent mark. Italy is slightly above or at the mark for the majority of years. Both Ireland and Spain saw a break in 2008 having 7 respectively 6 percent in deficits that year. In their case, it had to do with both of them being largely affected by the mortgage crisis, having an excessive construction sector[9]. In addition, France has had above the acceptable level since 2008 and both Netherlands and Belgium has had consecutive deficits after the crisis.

Table 3.3 Deficit-to-GDP ratio, Yearly Averages

Year	AUT	BEL	DEU	ESP	FIN	FRA	GRC	IRL	ITA	NLD	PRT
1999	-0,03	-0,01	-0,01	-0,01	0,02	-0,02	**-0,06**	0,05	-0,02	0,01	-0,03
2000	-0,02	0,00	0,01	-0,01	0,07	-0,01	**-0,04**	0,07	-0,01	0,02	-0,03
2001	-0,01	0,00	-0,03	0,00	0,05	-0,02	**-0,05**	0,02	-0,03	0,00	**-0,04**
2002	-0,01	0,00	-0,03	-0,01	0,03	-0,03	**-0,07**	0,01	-0,03	-0,01	**-0,04**
2003	-0,02	-0,02	-0,04	0,00	0,02	-0,04	**-0,09**	0,02	-0,03	-0,02	**-0,05**
2004	-0,05	-0,03	-0,03	0,00	0,02	-0,03	**-0,08**	0,03	-0,04	-0,01	**-0,06**
2005	-0,02	0,00	-0,02	0,02	0,03	-0,03	**-0,06**	0,03	-0,04	0,00	**-0,06**
2006	-0,02	0,00	0,00	0,02	0,04	-0,02	**-0,06**	0,03	-0,03	0,01	**-0,04**
2007	-0,01	0,00	0,01	0,01	0,05	-0,03	**-0,07**	0,00	-0,02	0,01	-0,02
2008	-0,02	-0,02	-0,01	**-0,06**	0,03	**-0,04**	**-0,12**	**-0,07**	-0,03	0,00	**-0,05**
2009	-0,05	**-0,05**	-0,05	**-0,11**	-0,03	**-0,07**	**-0,15**	**-0,15**	-0,05	**-0,05**	**-0,10**
2010	-0,04	**-0,04**	-0,03	**-0,09**	-0,02	**-0,06**	**-0,09**	**-0,24**	-0,04	**-0,04**	**-0,11**
2011	-0,02	**-0,04**	0,00	**-0,09**	-0,01	**-0,05**	**-0,10**	**-0,07**	-0,03	**-0,04**	**-0,07**
2012	-0,02	**-0,05**	0,00	**-0,10**	-0,03	**-0,05**	**-0,10**	**-0,04**	-0,03	-0,03	**-0,06**
2013	-0,02	-0,03	0,00	**-0,07**	-0,03	**-0,04**	**-0,11**	-0,02	-0,03	-0,03	**-0,04**
2014	-0,03	-0,03	0,00	**-0,06**	-0,03	**-0,04**	**-0,04**	0,00	-0,03	-0,02	**-0,07**
2015	-0,02	-0,02	0,01	**-0,05**	-0,03	**-0,04**	**-0,07**	0,01	-0,03	-0,02	**-0,04**

Source: Oxfords Economics

The data would suggest a somewhat arbitrary picture to why certain countries have suffered from high interest rates. In common for the GIIPS countries have been the combination of high debt levels and years of consecutive deficits. Both Spain and Italy has had lower interests than Ireland, Greece and Portugal. This is although Spain and Ireland have seemingly similar fiscal profiles and Italy holding high debt levels since the start. In addition, France which has had both high debt and high deficits show no positive effect on interest rates. Just by looking at the data, this might imply some sort

[9] See Lane (2009)

of "large" country bias which would indicate they are less likely to fail or have some sort of characteristic which make them less prone to the risk-adjustment.

4 Model Specification and Estimation

In this section, different model specifications, stationary tests, cointegration properties and endogeneity issues are considered. First, the baseline model is presented as follows:

$$LTI_{it}=\alpha_i+\beta_1 GDEBT_{it}+\beta_2 GDEF_{it}+INT_{it}+\Gamma' C_t+u_{it} \quad (1)$$

where the dependent variable LTI_{it} is the long-term interest rate, α_i is the country-specific fixed effects, $GDEBT_{it}$ is government debt-to-GDP ratio, $GDEF_{it}$ is the fiscal deficit-to-GDP ratio and INT_{it} is the interactive term between the two. The vector Γ' captures estimates from variables within vector C_t . This vector is specified as: $\{C_t=STI_{it}, INF_{it}, GDPG_{it}\}$ and involves control variables where STI_{it} is the 3-month short-term interest rate, INF_{it} is the nominal inflation and $GDPG_{it}$ is the GDP growth expressed in percent. Lastly, u_{it} is an error-term assumed to be uncorrelated with all said variables[10]. This model is estimated with a fixed effects model including individual-specific intercept to account for omitted time-invariant characteristics in-between individuals[11].

While the fixed effects model provides a sound start, there are some issues to be tackled. First, the countries in the estimation are likely to show signs of heteroscedasticity. Specifically the error-term, u_{it}, is likely to differ between countries holding different amount of debt and deficit. Second, variables in the sample might be determined by past values and thus show signs of autocorrelation. For example, government debt is the accumulated value of past deficits and next periods value will thus depend on past values. These issues will be evaluated in different ways; first by including robust standard errors in the fixed effect model in order to correct for heteroscedasticity. In order to deal with both problems at the same time, Generalized Least Squares (GLS) technique is applied as a robustness check. Of course, due to

[10] This is assumed for the non-lagged models (Verbeek, 2012: 377:378)
[11] See (Verbeek, 2012: 374-376).

variance-covariance structure of errors being unknown, the estimation will follow the Feasible Generalized Least Squares (FGLS) estimation[12].

A third issue with the baseline regression are the suspicion of endogeneity. This is accounted for in earlier studies (Ardagna et al, 2007; Faini, 2006) and in a similar fashion, a Two-Stage Least Squares (2SLS)[13] is estimated using the lagged explanatory variables as instruments.

4.1 Unit Root and Stationarity Properties

Panel unit-root tests are performed for all panels of variables. Several such tests are available and tests are chosen such that lag length for augmented Dickey-Fuller regressions can be specified other than one. Since data are quarterly and similar studies has detected several variables to be integrated of first order (Laubach, 2009; Faini, 2006; Ardagna et al, 2007), it is intuitive to assume quarterly data might show persistence for up to four periods. First, Im-Pesaran-Shin (IPS) test for unit root is performed and to provide further robustness Levin-Lin-Chu (LLC) test is included. These tests are presented in Table 4.1 (see Appendix) for each of the variables.

All tests indicate that government debt and long-term interest are non-stationary at a 1 percent significance level. Additionally, in IPS test the short-term interest rate is non-stationary and in LLC test inflation is non-stationary. Since other unit-roots test available for panels only account for first difference stationarity, these are the most decisive estimates available. In the preceding estimations, short-term interest rates will be treated as non-stationary and inflation as stationary, following IPS estimation. This is based on the theory behind term-structure proposed in section 2.3, namely that long-interest rates are determined by the accumulated short-term interest rates, proposing them as a good control variable for cointegration tests and further Panel-DOLS. However, the estimates and conclusions drawn from cointegration are to be taken with prudence.

[12] FGLS estimates the unknown variances from sample data and residuals, applying a weight to the regression variables. FGLS for panels is a random effects estimator which possesses the benefits from both the fixed effects and within estimation, provides more efficient and unbiased estimates than OLS (Verbeek, 2012: 382-384)

[13] See Baltagi (2008: 120-124)

4.2 Panel Cointegration

According to Im-Pesaran-Shin unit root test, long-term interest rate, government debt and short-term interest are significantly non-stationary. Thus examining their cointegrating relationship is possible. More precise, it is the cointegrating relationship between the dependent variable LTI and two the explanatory variables GDEBT and STI. Seminal work in the area of panel cointegration was introduced and developed by Pedroni (1997; 1999) and most recently in Westerlund (2007). In Westerlund (2007) it is shown his method for panel cointegration provides a more efficient estimation of the cointegrating vector when dealing with heterogeneity among panels. Hence, Westerlund's test for panel cointegration is used. The test performs four different cointegration tests in order to determine the possibility of cointegration both at an individual and panel level. The number of leads and lags are chosen to 2 to 3, this due to the AIC criteria for lag length ending up between 2 and 3 regardless of higher lag selection. These results are presented in Table 4.2 (see Appendix).

First, for the individual level STI has a significant error-correction term of -2.311 one individual test and -3.772 at one panel test. GDEBT has error-correction terms of -4.624 and -3.937 which are both significant for panel level. Test-statistics for the two combined are significant -1.928 at one individual test and -7.729 and -9176 for both panel levels. Error-correction terms show that the speed of adjustment and are negative, in accord with results in Westerlund (2007). Since cointegration was found at a panel-level for STI and GDEBT as well as the two combined, results motivate further analysis of the long-run relationship.

4.3 Panel Dynamic Ordinary Least Squares (DOLS)

A modest amount of studies has tried to apply error-correction panel modelling in order to determine the long-term relationship between government debt and long rates.[14] The benefit of using Panel-DOLS is the introduction of higher order integration than one, thus suiting particularly well for quarterly data. Developed by Saikkonen (1992), Stock and Watson (1993) and Kao and Chiang (2000), Panel-DOLS estimates the long-run error-correction for a system of cointegrated variables assuming long-run homogeneous covariance structure between cross-sectional units. In Kao and Chiang (2000) it is also shown Panel-DOLS exhibit less bias than similar estimators. Numbers of leads and lags

[14] In Poghosyan (2010) a PMG estimation technique is used.

are chosen to two and four, reasoning with macroeconomic intuition estimators following a half to one year persistence. Results are presented in the next section.

4.4 Additional Specifications

Proposed by earlier studies and in the data section, there are both empirical as well as intuitive reasons to apply certain variables for this case. Most notably are the previous research (Ardagna et al, 2007; Faini, 2006) that propose a certain level of debt will have is necessary and the possibility of non-linear effects from fiscal variables. Four new variables are created for this purpose; first two variables that are the quadratic value of GDEBT and GDEF. Secondly, GDEBT and GDEF are subtracted by their median value and then raised by 2, to point out if the exponential effect is larger for fiscally constrained countries. These variables are specified as $GDEBT^2$ and $GDEF^2$ for regularly squared as well as $GDEBT^{*2}$ and $GDEF^{*2}$ when subtracted by median then squared.

Secondly, the long-term interest rates converged when the EMU was implemented and maintained at a steady rate for the years following. Hence, the time period will be evaluated after 2009, marking the outbreak of the debt crisis within EU. Additionally, the five countries Greece, Italy, Ireland, Portugal and Spain experienced the sharpest rise in interest, thus specific regressions that compare the GIIPS countries with non-GIIPS are performed. This is done by dummies dividing the estimation into the following six specifications: The full sample for the whole period, GIIPS countries for the whole period, non-GIIPS countries for the whole period, the GIIPS after 2009, the non-GIIPS after 2009 and the full sample after 2009. Groups are chosen based on empirical outcome and the data presented.

4.5 Instrumental Variables and Endogeneity

Another possible issue for the baseline model is endogenous variables. As seen in the theory section, there is a good case for the selected variables affecting long-term interest rates. However, there is also reason to believe higher interest rates by themselves can lead to problems to service debts, this due to higher market risk-premium that lead to higher price on debt. This possible issue with reverse causality will result in endogenous regressors and the error-term will be correlated with the explanatory variables, leading

to biased and inconsistent results[15]. In addition if the true process is dynamic, applying fixed effect estimation results in an overestimation of the true marginal effect.[16]

In order to tackle this potential problem with reverse causality, instrumental variables will be used to provide alternative estimates. Discussion regarding instruments in dynamic panels is discussed by Bond (2002); pointing out that one does not have to seek far for appropriate instruments. The endogeneity can be solved by using lagged explanatory variables as instruments.[17] Of course, an important restriction for a good instrument is that there are correlation between the explanatory variables and its respective instrument. In similar studies (Ardagna et al, 2007; Faini, 2006) variables specified in the baseline model are suitable to be instrumented by their lagged values.

Our instrumental variables chosen will be lagged by one or two periods, depending if differenced or not. This is a limitation chosen to avoid the issue of excessive amount of instruments[18]. Consequently, in test runs including additional instruments in terms of third and fourth lagged value, the significance dropped for a majority of the variables. Also, other useful GMM techniques such as system GMM are problematic due to the relatively long time dimension, also being prone to excessive instruments.

5 Results

In this section, results are presented for both the short and long-term effects. First the long-term results will be presented followed by the short-term. First in Table 5.1, results from the Panel-DOLS regression are presented. For both specifications government debt is insignificant at all confidence levels. In contrast, short-term interest is significant at a 1 percent level for both specifications and the results are similar in both estimates and standard-error.

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[15] See Verbeek (2012: 146-147)

[16] First, considering our dependent variable follows a dynamic model: $y_{it}=\beta x'_{it}+\gamma y_{i,t-1}+\alpha_i+u_{it}$, it is clear that the lagged dependent variable will be correlated with the individual-specific effect α_i. Secondly, if a first difference estimator is used, $y_{i,t-1}$ will be correlated with $u_{i,t-1}$ (Verbeek, 2012: 396-397)

[17] Assuming a basic model: $y_{it}=\beta x'_{it}+v_{it}$, where x'_{it} contains a vector of explanatory variables. If suspected that x'_{it} is correlated with v_{it} which is the shock of the same period. Given x'_{it} is treated as endogenous it follow the dependent variable symmetrically, thus making lagged values of x'_{it} acceptable instruments (Bond, 2002).

[18] Too many instruments might lead to small sample bias or poor estimation of variance matrix (Verbeek, 2012: 403-404)

Table 5.1 Panel-DOLS

Variables	(1) DOLS	(2) DOLS
GDEBT	0.0231	0.0206
	(0.0189)	(0.0202)
STI	0.479***	0.482***
	(0.0928)	(0.0991)
Observations	693	649
R-squared	0.078	0.140

Note: Model (1) and (2) includes GDEBT and STI based on IPS unit root tests. Model (1) includes two lags and leads and Model (2) includes four lags and leads. Significance: ***p<0.01 **p<0.05 *p<0.1

Next are the short-term results. Once again, these are divided into the six following groups: (1) Show the full sample for the full time period (2) includes the GIIPS-countries for the full time period (3) includes the non-GIIPS countries for the whole period (4) includes the GIIPS restricted to the time period 2009-2015, (5) includes only the non-GIIPS countries restricted to the time period 2009-2015 and lastly (6) all countries in the sample other restricted to the time period 2009-2015.

In Table 5.2, the first variable GDEBT is weakly significant in a majority of the specifications and show a negative effect for all estimates. It is significant at a 5 percent level for the non-GIIPS countries, for the whole sample and the GIIPS after 2009. Next, GDEF is significant for all specifications except for the non GIIPS countries after 2009. The effect from GDEF is clearly higher for the GIIPS countries, spanning from 5.93 basis points effect on interest over the whole time period and 17.6 basis points after 2009. This compared to 1.83 basis point effect for rest of the EMU during the whole period. Further, looking at the interactive variable, INT, it has similar significance as GDEF. The effects for the GIIPS countries are 3.87 basis points for the whole period and 19.4 basis points after 2009, which means the interactive term is higher than GDEF after the crisis. This can be compared to 2.85 basis points for rest of EMU and an insignificant result after the crisis. Results from the full specification indicate there are slightly smaller effects if the whole sample is included compared to only the GIIPS countries. However, there are clear differences between GIIPS and the rest of EMU. All the control variables behave as predicted in terms of signs and show mixed significance.

Table 5.2 Baseline Fixed Effects Model

Variables	All (1)	GIIPS (2)	Non-GIIPS (3)	GIIPS* (4)	Non-GIIPS* (5)	All* (6)
ΔGDEBT	-0.0949*	-0.0990	-0.0708***	-0.116	-0.0731**	-0.110*
	(0.0485)	(0.0618)	(0.0125)	(0.0679)	(0.0194)	(0.0531)
GDEF	0.0485***	0.0593***	0.0183**	0.176***	0.0515	0.157***
	(0.00814)	(0.00569)	(0.00513)	(0.0374)	(0.0398)	(0.0286)
INT	0.0347***	0.0387**	0.0285*	0.194**	0.0666	0.170***
	(0.00448)	(0.00957)	(0.0141)	(0.0477)	(0.0579)	(0.0337)
ΔSTI	0.163**	0.151*	0.109***	0.892*	0.0972	0.451**
	(0.0514)	(0.0692)	(0.0198)	(0.338)	(0.0995)	(0.187)
GDPG	-0.0653	-0.0894	0.000788	-0.0819	-0.0102	-0.0875
	(0.114)	(0.172)	(0.0148)	(0.228)	(0.0224)	(0.179)
INF	0.0671**	0.0959**	0.00334	0.192**	0.0126	0.143**
	(0.0238)	(0.0275)	(0.0178)	(0.0490)	(0.0132)	(0.0460)
CONSTANT	-0.00135*	-0.00241*	-7.04e-05	-0.00153*	-0.000523	-0.00193**
	(0.000687)	(0.00108)	(0.000405)	(0.000563)	(0.000336)	(0.000701)
Observations	737	335	402	135	162	297
R-squared	0.120	0.132	0.163	0.259	0.121	0.219
Number of countries	11	5	6	5	6	11

Note: Regression (1)-(3) includes the full time period while (4)-(6) includes the time period 2009-2015. Robust standard errors in parentheses, significance: *** p<0.01, ** p<0.05, * p<0.1

Next in Table 5.3, two sets of exponential variables for government debt and fiscal deficit are added. First, looking at the baseline variables they provide similar estimates as the previous regression both in terms of significance and effects. Moreover, the exponential effects of debt are only significant for non-GIIPS countries. In contrast, both non-linear variables for deficit are significant looking at the whole sample and the GIIPS countries over the whole period. The significant effects from debt are negative and the significant results for deficit are positive. All exponential variables added change in terms of significance between specifications of the dummy, providing somewhat inconclusive results. Most notably is the non-significance after the crisis in the majority of specifications.

Table 5.3 Baseline Model and Exponential Effects

Variables	All (1)	GIIPS (2)	Non-GIIPS (3)	GIIPS* (4)	Non-GIIPS* (5)	All* (6)
ΔGDEBT	-0.0947*	-0.0982	-0.0709***	-0.115	-0.0719**	-0.109*
	(0.0494)	(0.0641)	(0.0128)	(0.0688)	(0.0196)	(0.0539)
GDEF	0.0301**	0.0306	0.00549	0.150	0.0652**	0.130***
	(0.0114)	(0.0152)	(0.0104)	(0.0983)	(0.0223)	(0.0410)
INT	0.0554***	0.0601**	-0.00949	0.196***	0.0399	0.172***
	(0.0102)	(0.0183)	(0.0373)	(0.0422)	(0.0615)	(0.0323)
ΔSTI	0.146**	0.133	0.112***	0.863*	0.0998	0.430**
	(0.0646)	(0.0859)	(0.0182)	(0.338)	(0.0987)	(0.184)
GDPG	-0.0723	-0.105	-0.000452	-0.0911	-0.0136	-0.0937
	(0.112)	(0.171)	(0.0147)	(0.246)	(0.0234)	(0.180)
INF	0.0649**	0.0911*	5.19e-05	0.193**	0.00174	0.142**
	(0.0262)	(0.0336)	(0.0183)	(0.0643)	(0.0132)	(0.0522)
$GDEBT^2$	-0.000126	0.00155	-0.00268**	-0.00107	-0.00236	-0.000111
	(0.00210)	(0.00400)	(0.000555)	(0.00364)	(0.00125)	(0.00153)
$GDEF^2$	0.149***	0.197*	-0.219	0.0966	-0.359	0.0912
	(0.0203)	(0.0733)	(0.139)	(0.244)	(0.347)	(0.0843)
$GDEBT^{*2}$	0.000821	0.000957	-0.00393	-0.000694	-0.00606**	-0.00142
	(0.00235)	(0.00360)	(0.00215)	(0.00644)	(0.00220)	(0.00334)
$GDEF^{*2}$	0.153***	0.172***	-0.112	0.0874	-0.326	0.0935
	(0.0315)	(0.0239)	(0.150)	(0.254)	(0.289)	(0.0843)
CONSTANT	-0.00119*	-0.00181	0.000224	-0.000693	0.000372	-0.00120
	(0.000584)	(0.00108)	(0.000388)	(0.00273)	(0.000482)	(0.00113)
Observations	737	335	402	135	162	297
R-squared	0.128	0.139	0.165	0.260	0.128	0.220
Number of countries	11	5	6	5	6	11

Note: The non-starred exponentials are the squared value of debt and deficits. The corresponding starred values are subtracted by the sample median value for each sample before squared. Robust standard errors in parentheses, significance: *** p<0.01, ** p<0.05, * p<0.1

5.1 Robustness Testing

The short-term results provided in the preceding section are all estimated with the fixed-effects OLS estimator. In order to provide robustness to estimates, reinforcing regressions has been done in order to test for both autocorrelation and possible

endogeneity. Only the 2SLS estimation will be presented in this section, while the FGLS and lagged explanatory variable inference can be found in the Appendix.

First, looking at Table 5.4 Wooldridge's test for autocorrelation within panels is shown and results indicate there are autocorrelation between the dependent and explanatory variables. However, since Wooldridge's test cannot be performed for differenced variables and the first-difference stationary variables has been estimated in by their first difference, there are reason to believe this might have corrected partially for this autocorrelation. To examine this further, in Table 5.5 results from FGLS estimation can be seen. Comparing these with the baseline model shows there are small differences between the two coming to GDEBT. Looking at GDEF and INT, their estimates are somewhat lower and the same for the overall significance. As both the fixed effect model and GLS account for heteroscedasticity, the first through robust standard errors and the other through chosen weights, the gain to be found are through lower variance and loss of autocorrelation (Verbeek, 2012)[19]. However, estimates deviate within the range of the baseline model, proposing the problem of autocorrelation to not be severe in the sense of estimates.

Furthermore, the intuitively opposite sign of government debt raise warning signs regarding misspecification. However, in Table 5.5 casual inference is presented by adding lagged values to government debt and testing the possibility of a delayed effect. Results indicate that both the first and second lag is insignificant whilst the fourth lag is significant and also alters to a positive effect. This is an intuitive one year lagged effect. Hence, the lagged value of government debt might be a better value for further studies or including a proxy to the lagged debt. However, including lagged explanatory variables in the baseline model can provide additional bias or endogeneity issues (Bellemare, 2015) and are thus left out.

Additionally, there might be endogeneity which makes the baseline bias and inconsistent. In the regression estimated in previous section, the most apparent would be reverse causality between LTI and GDEBT. In Table 5.6 results from 2SLS estimation are presented. In accord, with reverse causality, the baseline model seems to overestimate the true effect (Verbeek, 2012)[20]. However, the 2SLS has similar issue as the GLS estimation, providing scattered results in terms of significance. In addition, both INT and GDEF lose significance and the interactive variable change sign. As it is hard to provide good instruments, these estimates provide a critical view on the earlier

[19] See Verbeek (2012: 101-102)
[20] See Verbeek (2012: 147)

estimates. The choice of using lagged explanatory variables as instruments and a slight loss in significance follows similar studies (Faini, 2006; Ardagna et al, 2007).

In conclusion, the robustness check provides a critical view to the estimates presented by the fixed effects model. However, in the original model both heteroscedasticity and autocorrelation are accounted for to some degree. The most significant change between estimation methods is the loss of significance using instruments. Also, the inference regarding lagged values of government debt brings critique to the specification of current debt and proposes prudence regarding interpretations. Nonetheless, the estimates by earlier research and the FGLS estimates are within similar magnitude as the baseline model, thus providing some robustness to the initial results.

Table 5.7 Instrumental variables 2SLS

Variables	**All** (1) 2SLS	**GIIPS** (2) 2SLS	**Non-GIIPS** (3) 2SLS	**GIIPS*** (4) 2SLS	**Non-GIIPS*** (5) 2SLS	**All*** (6) 2SLS
ΔGDEBT	-0.0307***	-0.0451***	-0.0146	-0.0506**	-0.155*	-0.0427***
	(0.0104)	(0.0152)	(0.0225)	(0.0249)	(0.0882)	(0.0162)
GDEF	0.0314*	0.0330	0.00372	0.0638	0.154	0.0713
	(0.0181)	(0.0299)	(0.0356)	(0.0806)	(0.153)	(0.0463)
INT	-0.0654***	-0.107***	0.0488	-0.0415	0.644	-0.0341
	(0.0251)	(0.0366)	(0.0672)	(0.0900)	(0.399)	(0.0552)
INF	0.0822***	0.0949***	0.0142	0.201***	0.286**	0.180***
	(0.0149)	(0.0228)	(0.0255)	(0.0736)	(0.129)	(0.0395)
ΔSTI	0.0171	-0.0539	0.399***	-0.177	0.948*	-0.0561
	(0.0557)	(0.0955)	(0.142)	(0.558)	(0.574)	(0.254)
GDPG	-0.0855***	-0.115***	-0.0145	-0.199*	0.170	-0.134**
	(0.0224)	(0.0350)	(0.0376)	(0.111)	(0.126)	(0.0602)
CONSTANT	0.00159***	0.00276**	0.000814	0.00653***	0.00601	0.00285***
	(0.000611)	(0.00114)	(0.000961)	(0.00238)	(0.00368)	(0.00109)
Observations	715	325	390	125	150	275
Number of countries	11	5	6	5	6	11

Note: All explanatory variables are instrumented with their first or second lag depending if differenced or not. If differenced, the second lagged is used. Standard errors in parentheses, significance: *** p<0.01, ** p<0.05, * p<0.1

5.2 Discussion

In contrast to conventional theory, a negative relation between long rates and government debt were found for most specifications. A positive effect was found for both fiscal deficits and the interaction in-between deficits and debts. In addition, no long-term effects were found from government debt within the EMU. Results also indicate that the countries within GIIPS were influenced by their fiscal liabilities to a larger degree than the rest of EMU. Also, the interactive term enhances the effect after the crisis for both the GIIPS countries and the full sample estimation. Notable are the non-significant effect for Non-GIIPS countries during the crisis. These findings and the brief data display suggests there are arbitrary discrepancies between countries in terms of long rates response to fiscal difficulties.

Furthermore, effects are in accord to previous studies in terms of magnitude for fiscal deficits while the results for government debt are not alike (Faini, 2006; Ardagna et al, 2007; Laubach, 2009). But, studies in the review include samples before the sovereign debt crisis of 2009 and most of them for a different set of countries. As examined within the data section, the debt issued by governments is quite homogenous all over the sample, above 60 percent levels for the majority of countries. No particular differences are found between France and Belgium compared to Greece and Portugal. This would indicate, as do the regression results, that government debt alone might be redundant in terms of affecting interest rates. The negative effect of debt may be an effect of the ECB's efforts of holding interest rates down through open market operations, providing an overall negative effect as a consequence of increased demand in government bonds issued by EMU countries (De Grauwe, 2013). Furthermore, one of the disparities between the GIIPS and non-GIIPS countries is the effect of fiscal deficits. After the 2009, GIIPS had a 17.6 basis point effect compared to the insignificant counterpart for rest of EMU. This result indicate that the importance of fiscal deficits for this given time period. In addition, the results presented from the interactive variable propose that it is the combined sustainability of debt and deficit that matters, thus assign government debt shared significance. More precise, for the GIIPS countries, in particular after 2009 the effect from said interaction is 19.4 basis points, in contrast to the no significance for non-GIIPS countries.

Previous section suggests a difference in terms of how fiscal liabilities affect long rates within EMU. Interestingly, the effects seem to be somewhat arbitrary considering the data, especially for the countries France and Belgium with similar debt

and deficits as those affected the most after 2009. Nevertheless, the characteristics of the GIIPS are distinctively different in three ways: First, both Spain and Ireland were affected by a liquidity crisis in their respective bank sectors, which is not included for in the model (Lane, 2009). Second, both Greece and Portugal are exceptions in terms of consistent fiscal deficits, which also are indicated by the results to have a large positive effect on interests. Last, Italy had the largest debt when crisis hit and had consistently running 3 percent or slightly above deficits. A realistic assumption due to the situation especially in Greece but also in Ireland and Spain where unknown facts came up to surface, Italy's fiscal standings might provoke a similar anticipation regarding their ability to service debt. The last sentence has been a common explanation to why the effects might have been absent for Belgium and France, namely a disparity in anticipated national ability to service debts (Kopf, 2010). Unfortunately, variables including expectations are not taken into consideration in the models used in this paper and are thus proposed for further studies.

The disparity in long rates and the consequences it brings has opened up for a discussion, asking if there has been an ambiguous penalty assigned to the GIIPS countries. Looking back at theory, the structure within the EMU might be untenable and countries with certain characteristics less prone to provide responsibility, possessing unfavourable historical factors, representing a smaller economy or other country specific factors, might be exposed to interest rates hikes than others. In addition, ECB's open market operations have favoured countries with "good" debt, another factor which indirect penalize countries holding "bad" debt (Lane, 2009). Of course, the opposing view involves problems with moral-hazard and that the market learns by example. Nonetheless, if such a self-regulating mechanism do not work equally for all participants within the system, criticism towards such a mechanism is fair.

In conclusion, if EMU were constructed with the partial goal of financial stability, this paper suggests fiscal liabilities have asymmetric effects on interest rates within EMU and over time. After 2009, the GIIPS countries were particularly affected by high interest, which can be interpreted as a market penalty. In addition, if the penalties for fiscal carelessness are to be equal, long-term interest rates suggest otherwise, favouring countries such as Belgium and France over Greece and Portugal. Consequently nations afflicted the most by high interests has fewer options to recover due to the common monetary policy. Lastly, answering the purpose of the paper, that our results indicate a disparity between countries within the EMU and propose a restructuring of fiscal policy matters within the union.

6 Conclusion

This paper has evaluated short and long-run effects between long-term interest rates and fiscal liabilities within EMU. Attention to which channels that impact long rates are presented and the method applies fixed effect models and cointegration technique's to test determinants. Particular specifications are made to capture the disparities in the aftermath of EU's sovereign debt crisis and between countries.

Next, the data is examined through a graphical display; pointing out both similarities and discrepancies between the GIIPS countries and the rest of EMU. Furthermore, results from the baseline model point towards the importance of fiscal deficit as well as the interaction between debt and deficit in order to find the effect on long rates. Additionally, the partial effect of government debt is significantly negative, going against conventional theory. Cointegration for government debt is found within the whole panel but was insignificant in the Panel-DOLS, thus no long-term effects of debt upon interest rates were found. This is in accordance to the Ricardian view, however, a result to be taken with caution due to the need for a more comprehensive model. Results also indicate an overall higher effect from fiscal liabilities for the GIIPS countries than the rest of EMU.

The asymmetric effects within the EMU, although similar fiscal standings, suggests there are intangible factors that affect interests rates. In addition, the response from ECB by acting as lender of last resort seemed to affect countries in regard to the presumed fiscal sustainability. The negative effect found from government debt is interpreted alongside the interactive term; the former indicates debt can have a zero effect and the latter points towards that sufficiently high debt alongside deficit reinforces an increasing effect for long rates.

To sum up, results provide both intuitive and conflicting answers. Discussion of the results is based on theoretical considerations and events before and after the crisis. Results are built on the fiscal standings within the country, however, missing certain aspects such as expectations and other macroeconomic factors – thus results are to be interpreted with prudence.

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Appendix

Tables and figures are listed in order of appearance in the paper. They are numbered by chapter of appearance and order of appearance. First table is a variables description

Table 1 Description: Variables and Sources

Variable	Explanation	Expected outcome	Source
Dependent variable			**DataStream**
Long-term interest rates (LTI)	10 year interest rates (quarterly)		Oxford Economics
Explanatory variables			
Government Debt-to-GDP ratio (GDEBT)	Nominal debt divided by nominal GDP (quarterly)	Positive (+)	Oxford Economics
Fiscal Deficit-to-GDP ratio (GDEF)	Nominal deficits divided by nominal GDP (quarterly)	Positive (+)	Oxford Economics
Inflation (INF)	Nominal inflation (quarterly)	Positive (+)	Oxford Economics
Short-term interest rate (STI)	3 month interest rates (quarterly)	Positive (+)	Oxford Economics
GDP growth (GDPG)	Yearly change in Gross domestic product (quarterly)	Negative (-)	Oxford Economics

Table 4.1 Unit Root Tests

Variables	Test: LLC	Unadj. t-value	Adj. t-value	AIC lag average	p-value
LTI		-2.575	2.593	2.18	0.995
GDEBT		0.990	4.132	2.09	1.0000
GDEF		-6.398	-2.248	3.18	0.012**
IVAR		-5.699	-2.059	3.00	0.020**
INF		-6.727	-0.142	3.73	0.444
STI		-6.354	-2.555	1.18	0.005***
GDPG		-11.707	-7.868	1.45	0.000***
Variables	**Test: IPS**		**W-t-bar**	**AIC lag average**	**p-value**
LTI			2.080	2.18	0.981
GDEBT			6.916	2.09	1.000
GDEF			-3.433	3.18	0.000***
IVAR			-1.861	3.00	0.031**
INF			-2.001	3.73	0.022**
STI			-1.151	1.18	0.125
GDPG			-9.577	1.45	0.000***

Note: First, the **Levin-Lin-Chu (2002)** test applied testing for the H_0: Panels contain unit roots and the alternative H_a: Panels are stationary. Second, the **Im-Pesaran-Shin (2003)** tests the H_0: All panels contain unit roots with alternative H_a: Some panels are stationary. For both the LLC and IPS test the Akaike Information Criterion (AIC) is selected in order to determine lag length within the Augmented Dickey-Fuller (ADF) equations. As in earlier studies, the hypothesis is tested at a 95% confidence level. Significance: ***p<0.01 **p<0.05 *p<0.1

Table 4.2 Cointegration Tests

Cointegration (LTI and)	G_t	G_a	P_t	P_a
GDEBT	-0.364	-1.266	-4.624***	-3.937***
STI	-2.311***	-4.043	-3.772**	-2.244*
ALL	-1.928**	-5.360	-7.729***	-9.176***

Note: Westerlund's panel cointegration test is applied. Cointegration is checked for government debt, short-term interest rates and both variables at the same time (ALL). It does test four different hypotheses, testing whether the error correction term is significant both at the whole panel and within the individual panels. G_t and G_a test for cointegration for at least one of the panels. If H_0 is rejected at least of the panels are cointegrated. P_t and P_a pools the information over cross-sectional units, thus a rejection of H_0 should be taken as evidence of cointegration for the panel as a whole. Significance: ***p<0.01 **p<0.05 *p<0.1

5.4 Wooldridge's Panel Autocorrelation Test

Test	**Test Statistic**
F(1, 10)	188.979
Prob>F	0.00000

Note: Null-hypothesis: no first order autocorrelation. This null is rejected at a one percent level.

Table 5.5 FGLS

Variables	**All** (1) FGLS	**GIIPS** (2) FGLS	**Non-GIIPS** (3) FGLS	**GIIPS*** (4) FGLS	**Non-GIIPS*** (5) FGLS	**All*** (6) FGLS
ΔGDEBT	-0.0935***	-0.0972***	-0.0694***	-0.124***	-0.0730***	-0.116***
	(0.0120)	(0.0183)	(0.0135)	(0.0274)	(0.0180)	(0.0183)
GDEF	0.0413***	0.0540***	0.0121	0.113***	0.0159	0.0975***
	(0.0116)	(0.0185)	(0.0120)	(0.0347)	(0.0257)	(0.0232)
INT	0.0294*	0.0358	0.0142	0.102**	0.00185	0.0796***
	(0.0163)	(0.0249)	(0.0190)	(0.0438)	(0.0297)	(0.0288)
ΔSTI	0.158***	0.146	0.112**	0.863*	0.101	0.439*
	(0.0601)	(0.115)	(0.0437)	(0.493)	(0.110)	(0.236)
GDPG	-0.0643***	-0.0836**	0.00316	-0.151	-0.00913	-0.127**
	(0.0242)	(0.0396)	(0.0227)	(0.0984)	(0.0404)	(0.0593)
INF	0.0619***	0.0920***	0.00496	0.167***	0.0115	0.126***
	(0.0156)	(0.0265)	(0.0141)	(0.0588)	(0.0210)	(0.0341)
CONSTANT	-0.00118**	-0.00223**	-0.000200	-0.00208	-0.00101*	-0.00229**
	(0.000468)	(0.00101)	(0.000345)	(0.00191)	(0.000551)	(0.000965)
Observations	737	335	402	135	162	297
Number of countries	11	5	6	5	6	11

Note: In this table, FGLS estimation is performed of the baseline model. Regression (1)-(3) includes the full time period while (4)-(6) includes the time period 2009-2015 Standard errors in parentheses, significance: *** p<0.01, ** p<0.05, * p<0.1

Table 5.6 Fixed effects, Lagged Debt

Variables	All (1)	GIIPS (2)	Non-GIIPS (3)	GIIPS* (4)	Non-GIIPS* (5)	All* (6)
ΔGDEBT	-0.113**	-0.131**	-0.0626***	-0.222**	-0.101***	-0.187***
	(0.0374)	(0.0425)	(0.00993)	(0.0489)	(0.0135)	(0.0379)
ΔGDEBT(-4)	0.0867***	0.104**	0.0181*	0.0940***	0.0102	0.0824***
	(0.0250)	(0.0230)	(0.00878)	(0.0113)	(0.0142)	(0.0153)
ΔGDEBT(-2)	-0.0177	-0.0310	0.0108	-0.0634	-0.0202**	-0.0411
	(0.0272)	(0.0311)	(0.00885)	(0.0307)	(0.00518)	(0.0293)
ΔGDEBT(-1)	-0.0207	-0.0275	-0.0193	-0.0662	-0.0946***	-0.0501**
	(0.0125)	(0.0167)	(0.0167)	(0.0356)	(0.0152)	(0.0213)
GDEF	0.0426***	0.0575***	-0.0190	0.0562	-0.0541	0.118**
	(0.00928)	(0.0125)	(0.0101)	(0.0729)	(0.0547)	(0.0477)
INT	0.0683***	0.0969**	-0.0545*	0.188**	-0.133	0.186***
	(0.0208)	(0.0277)	(0.0249)	(0.0644)	(0.0785)	(0.0446)
ΔSTI	0.138	0.114	0.138**	1.682	0.0765	0.769
	(0.102)	(0.114)	(0.0393)	(1.319)	(0.127)	(0.580)
GDPG	-0.112	-0.149	-0.0306**	-0.220	0.0433*	-0.159
	(0.114)	(0.163)	(0.00948)	(0.379)	(0.0203)	(0.216)
INF	0.0883**	0.126*	0.0165	0.428**	0.0593	0.279**
	(0.0322)	(0.0513)	(0.0134)	(0.109)	(0.0330)	(0.0968)
Constant	-0.00186**	-0.00339*	0.000161	-0.0122*	-0.00258*	-0.00895*
	(0.000728)	(0.00136)	(0.000361)	(0.00447)	(0.00114)	(0.00419)
Observations	693	315	378	115	138	253
R-squared	0.206	0.246	0.161	0.434	0.307	0.357
Number of countries	11	5	6	5	6	11

Note: The purpose in this estimation is to provide inference to the sign of GDEBT. Regression (1)-(3) includes the full time period while (4)-(6) includes the time period 2009-2015. Robust standard errors in parentheses, significance: *** p<0.01, ** p<0.05, * p<0.1