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FISCAL POLICY EFFECTS ON LONG-TERM INTEREST RATES: A CROSS-COUNTRY STUDY

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Abstract

Negative side effects of the banking crisis in USA have spread around the world and created an economic turmoil. A threat of possible sovereign defaults has forced several EU governments to stabilize its public finance in order to regain confidence of financial markets' participants. Strict austerity measures have been proposed as an instrument to signalize about positive changes in fiscal policy. Therefore, this study is designed to measure the influence of fiscal processes, namely the accumulation of budget deficits and public debts, on long-term sovereign bonds' yields. It relates to the Ricardian Equivalence hypothesis, Keynesian and non-Keynesian theories, which often occur in similar research papers. A selected sample consists of 26 EU member states, including two Baltic countries, for a time span from 2001Q1 to 2011Q4. Both OLS and GLS regressions, together with several panel tests, are performed to ensure robustness of empirical findings. Results demonstrate a significant causal relation between fiscal policy indicators and long-term sovereign bonds' yields. In addition, the functional form between the public debt's level and country's borrowing costs is non-linear, which implies a necessity to suppress the accumulation of sovereign debts across EU member states. Also, empirical findings indicate the existence of significant spill-over effects in the region, caused by changes in the aggregate EU public-debt-to-GDP ratio, which requires further financial, economic and political cooperation among EU countries. In addition, macroeconomic indicators, namely short-term interest rates, the real GDP growth and inflation rates, tend to be significant determinants of long-term sovereign bonds' yields.

Keywords: Fiscal policy, long-term interest rates, austerity measures, public deficit, public debt, European Union, GLS and OLS regressions.

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Table of Contents

1. Introduction

The primary objective of this study is to estimate the impact of the accumulation of fiscal deficits and public debts on long-term interest rates. The accumulation of deficits and debts are depicted by such indicators as deficit-to-GDP and debt-to-GDP ratios, and long-term interest rates are described by sovereign bonds' yields. The collapse of the banking sector in USA has spread a contagion around the world (Lander, 2008). European banks have been forced to accept enormous losses and request rescue packages from national governments. Otherwise, it might have provoked a further and much stronger chain of bankruptcies in the region. As a result, European countries have encountered a substantial rise in their sovereign debt levels, caused by increasing borrowing in the financial markets (Eurostat, 2012). In addition, the strengthening crisis and declining economic activity have led to even higher budget deficits, which consequentially caused the sovereign debt crisis in Europe. For some EU member states costs of rescuing the banking sector has been so enormous that sovereign debts grew to rather unsustainable levels. Countries like Greece, Spain, Portugal, Italy and Cyprus have been striving to regain investors' confidence and austerity measures have become a political trend for fighting the crisis.

On the other hand, some economists have started to argue about an inappropriate design of the European Monetary Union (EMU), which did not allow EMU countries to solve their issues through the currency depreciation (Bootle, 2012). Monetary policy is implemented collectively with the European Central Bank (ECB) and depends on joint decisions. Hence, fiscal policy actions have become the major instrument of somehow influencing country's borrowing costs. However, this task becomes unbearable for several EU member states, which have been continually maintaining budget deficits, within the constraints of the Stability and Growth Pact (SGP), and accumulating public debts prior the sovereign debt crisis (Moutot, Rother, Schuknecht, & Stark, 2011). As a result, the banking crisis converted to the sovereign debt crisis not only because governments have been forced to raise debts significantly in order to cover the costs of supporting their banking system, but also fiscal policies before the crisis in many cases used to be unsustainable, or even irresponsible. Currently, apart from fiscal improvements, further financial and economic cooperation, Eurobonds, and stricter punishments have been promoted as feasible solutions for the after-crisis situation (European Commission, 2012). Therefore, this study tries to estimate the impact of fiscal processes on long-term sovereign borrowing costs.

Traditionally, there are several contradicting theories in this field, which does not allow us to predict the systematic relation between accumulating budget deficits and public debts and long-term interest rates. This situation occurs due to varying suggestions for sources of impact, or even absolutely opposite arguments. Keynesian and non-Keynesian theories could be an excellent example, where the relation between fiscal policy and yields of sovereign debt securities is displayed based on contradicting concepts (Cizkowicz & Rzonca, 2005). On the other hand, theoretically it is rather clear that long-term interest rates affect investment decisions in the economy, which corresponds to changes in capital accumulation, productivity, and the expected economic growth (Howe &Pigott, 1991). Hence, the sovereign debt crisis in Europe and the lack of one strong theoretical framework provide incentives for the empirical analysis, which corresponds to the research question:

Research Question: How the development of EU member states' interest rates for long-term government bonds is related to changes in fiscal policy indicators, such as primary-budget-deficit-to-GDP and public-debt-to-GDP ratios?

Regardless of the existing ambiguity in these relationships, one could expect a decrease in the primary-budget-deficit-to-GDP ratio to cause a lower value of country's long-term sovereign debt yields, while the public-debt-to-GDP ratio is anticipated to indicate an opposite causal relation. Both measurements are fundamental in describing fiscal processes, which corresponds to the first hypothesis:

Hypothesis I: Both fiscal policy indicators, namely primary-budget-deficit-to-GDP and public-debt-to-GDP ratios, are significant determinants of long-term sovereign bonds' yields.

Several authors in the related empirical studies have detected a significant non-linear relationship between a size of public debts and yields of sovereign debt securities (Ardagna, Caselli, & Lane, 2007). This functional form implies that financial markets' participants require additional risk premium for countries with relatively high public-debt-to-GDP ratios, which leads to the second hypothesis:

Hypothesis II: There is a significant non-linear relationship between both fiscal policy indicators, namely public-debt-to-GDP and the primary-budget-deficit-to-GDP ratios, and long-term sovereign bonds yields.

In addition, an aggregate level of public indebtedness across EU member states could lead to significant movements in separate country's borrowing costs, which has been entitled as a spill-over effect (Clayes, 2005). For instance, sovereign bonds yields for countries with

relatively stable fiscal processes might be influenced by the accumulation of public debts in the related economies, due to an increase in risk aversion among financial markets' participants, which corresponds to the third hypothesis:

Hypothesis III: An increase in the overall EU public-debt-to-GDP ratio causes a significant spill-over effect on individual country's sovereign bonds yields.

Also, authors of the related literature tend to concentrate on a total sample of countries, while less attention is dedicated for specific regional and economic factors, which could account for some variation in sovereign bonds' yields. For instance, the currency regime, period of sovereign debt crisis, or regional situation might significantly influence long-term borrowing rates, which leads to the fourth hypothesis:

Hypothesis IV: Long-term sovereign bonds' yields vary significantly across EU member states due to some specific factors, namely the currency regime, geographical region, and period of the sovereign debt crisis.

Sovereign bonds' yields with a maturity of around 10 years have been used as the main dependent variable throughout this research paper. However, one might argue that an alternative dependent variable, namely real long-term interest rates (Edey, Kennedy, & Orr, 1995), swaps' spreads (Ardagna, Caselli, & Lane, 2007), or expected bonds' yields (Laubach, 2009), could lead to different empirical findings, which corresponds to the fourth hypothesis:

Hypothesis V: An inclusion of alternative dependent variables, namely spreads between long-term interest rates and short-term interest rates, or yields of Germany bunds, does not significant influence coefficients for fiscal policy indicators in the baseline regression specification.

The following parts are dedicated to the literature review, methodology, empirical findings and discussion, and conclusions. In addition, a brief summary of the major relevant research papers, panel tests, selected variables and regressions' coefficients are provided in Appendices. The main purpose of this study is to ascertain if fiscal processes, namely the accumulation of budget deficits and public debts, determinate long-term sovereign bonds' yields, and to formulate some suggestions for policy makers.

2. Review of literature

Even though the relation between fiscal processes and long-term interest rates has always received a considerable amount of attention from researchers, the sovereign debt crisis has strengthened a necessity to analyze this topic further. One must be aware of theoretical and methodological differences in the empirical literature, which essentially causes diverse results and leads to endless debates among economists and politicians. This literature review begins with an introduction of general theories and their connection to the proposed research question. Then, empirical findings of related studies will be presented, which are separated in term of three distinct methodological approaches. Such arrangement should allow us to observe effects of fiscal processes on sovereign bonds' yields from different perspectives.

2.1. Theoretical Background

The primary purpose of this part is to provide a sufficient theoretical background for the relation between fiscal policy and long-term interest rates. The Ricardian equivalence hypothesis, Keynesian and non-Keynesian theories frequently occur in similar studies and could form some valid expectations for the potential causal relationship. In addition, these theories invoke contradicting arguments, which provides a rationale for the empirical analysis.

2.1.1. The Ricardian equivalence hypothesis

The Ricardian equivalence hypothesis has been initially introduced by Barro in 1974 (Feldstein, 1986) and later tested in the majority of research papers related to fiscal processes and country's borrowing costs (Baldacci & Kumar, 2010). The further section generally refers to Barro's study *The Ricardian Approach to Budget Deficits* (Barro, 1989), where author explicitly describes the Ricardian equivalence hypothesis and several former theories.

Former theories used to argue that increasing budget deficits raise long-term interest rates through the reduction in national savings in a closed economy model. This situation occurs because private households do not provide a sufficient amount of savings to offset the corresponding decline in public savings, caused by increasing budget deficits. As a result, the total supply of savings in the economy decreases, which generates an upwards pressure on long-term interest rates. Consequentially, a new higher rate of borrowing diminishes investment incentives for private companies, reduces capital accumulation, and harms the

potential economic growth in a long-run, which refers to the crowding-out effect (Kumar & Woo, 2010).

In an open economy model, increasing budget deficits do not cause higher interest rates due to corresponding capital inflows from foreign countries, which fill a gap between public and private savings. This theory holds only if the domestic country is not sufficiently large to influence an overall level of interest rates in the region, or worldwide. Although in the open economy model long-term interest rates remain constant, the domestic country encounters negative changes in its current account balance and higher indebtedness to foreigners. Hence, according to these arguments, budget deficits leads to an increase in borrowing costs in the closed economy situation through lower total national savings. However, such conditions are rather implausible in the present times. On the other hand, in the open economy situation budget deficits do not cause higher long-term interest rates due to foreign capital inflows.

The Ricardian equivalence hypothesis introduces an assumption of forward-looking private households. Increasing budget deficits do not raise long-term interest rates due to rational expectations about higher future taxes. One might anticipate the domestic country to fully repay its liabilities in the very long-run, which would require additional income collected from taxes. Hence, private households increase their savings to offset the current decrease in public savings, while the total supply of savings in the economy remains unchanged. As a result, the domestic country avoids the potential crowing-out effect, foreign capital inflows and the declining current account balance. Basically, the Ricardian equivalence hypothesis states that private households, residing in the domestic country with a relatively high level of public debt, are expected to voluntarily devote more funds for savings, compared to other nations (Grennes & Strazds, 2013). As a result, fiscal processes do not impact long-term interest rates, independently from the openness of the economy.

The Ricardian equivalence hypothesis has encountered an intense critique from both economists and politicians. The pivotal argument against this theory is the implausible assumption of forward-looking private households, who devote a precise lump-sum amount of money to offset the expected future increase in taxes (Feldstein, 1986). It necessarily requires an altruistic behaviour to transfer funds throughout an indefinite number of generations (Bernheim, 1987), regardless of the limited lifetime of individuals (Barro, 1989). On the other hand, Grennes and Strazds (2013) have actually detected a significant correlation between country's sovereign debt level and the amount of private households'

savings. Although it does not necessarily support the assumption of forward-looking individuals, the Ricardian equivalence hypothesis might actually hold in practice, meaning that residents of the domestic county adjust their spending behaviour based on country' fiscal policy decisions, while long-term interest rates might be influenced by other factors only.

Another argument against the Ricardian equivalence hypothesis is related to foreign capital inflows to the domestic country. It requires sovereign debt bonds being perfect substitutes and the unrestricted movement of capital, which contradicts to some empirical findings (Feldstein, 1986). For instance, prior the recent sovereign debt crisis, Group of Seven countries (G-7) used to encounter especially low interest rates, regardless of constant budget deficits and accumulating public debts (Hauner& Kumar, 2006). The fundamental determinant of this situation has been enormous capital inflows from abroad. In addition, several authors detect a significant relation between the current account balance and country's borrowing costs (Edey, Kennedy, & Orr, 1995). Although these arguments reject the Ricardian equivalence hypothesis, fiscal processes still could have no impact on long-term interest rates due to foreign capital inflows in the open economy situation.

Empirical evidence for the existing crowding-out effect also contradicts to conclusions of the Ricardian equivalence hypothesis (Kinoshita, 2006). It indicates that under conditions of the open economy, budget deficits have no effect on long-term interest rates. However, continuing budget deficits leads to higher long-term interest rates, which consequentially causes the crowding-out effect by diminishing investment incentives for private individuals and harming the potential economic growth (Clayes, 2005). These negative effects could be diminished via sound fiscal decisions, or stimulating monetary policy, which are expected to reduce country's borrowing costs (van Rompuy, 2012).Although the majority of relevant studies tend to reject the Ricardian equivalence hypothesis, several authors reveal that fiscal policy effects on sovereign bonds' yields could be largely mitigated by foreign capital inflows, or some offsetting movements in public and private savings.

2.1.2. Keynesian and Non-Keynesian theories

Keynesian and non-Keynesian theories have been explicitly presented in the study of EU member states, namely *Non-Keynesian Effects of Fiscal Contraction in New Member States* (Cizkowicz & Rzonca, 2005). It should provide a different perspective for the relation between fiscal processes and long-term interest rates, compared to the Ricardian equivalence hypothesis.

According to the Keynesian theory, decreasing budget deficits leads to higher borrowing costs, because financial markets' participants negatively evaluate austerity measures. The primary rationale indicates that lower government spending, or increasing taxes, leads to a few times stronger negative impact on aggregate demand due to the multiplication effect (Boussard, de Castro, & Salto, 2012). For instance, if a government reduces its public spending for construction projects, related private enterprises start to lay-off their employees (Auerbach & Feenberg, 2000). Unemployed workers apply for social benefits, which are lower compared to their previous income. As a result, aggregate demand shrinks due to reductions in both government spending and private consumption. Hence, financial markets' participants negatively evaluate austerity measures and actually raise long-term interest rates, as a value of the total output in the economy declines. In other words, based on the Keynesian theory, decreasing budget deficits leads to higher sovereign bonds' yields, and vice versa, due to emerging negative expectations about the future GDP growth by financial markets' participants

Contrarily, the non-Keynesian theory argues that decreasing budget deficits causes a lower value of long-term interest rates, because of the positive signalling effect to financial markets' participants about improvements in fiscal processes (Buti & Pench, 2012). Still, these actions must be perceived as credible, and the accumulation of public debts is required to stop permanently, rather than indicate temporary corrections (Edey, Kennedy, & Orr, 1995). In addition, austerity measures implemented for this purpose could lead to the further accumulation of public debts, while sovereign bonds' yields remain constant, until country's credibility is restored (Boussard, de Castro, & Salto, 2012). According to the non-Keynesian theory, the source of these budget deficit reductions also matters, as only public spending cuts leads to a lower value of long-term interest rates (Schaltegger & Weder, 2010). For instance, if a government decreases wages for public sector employees, it reduces costs pressure in the whole economy. Consequentially, the domestic country gains competitiveness compared to foreign countries. Therefore, spending cuts during the crisis period are associated with faster recovery and more stable fiscal conditions afterwards (Alesina & Ardagna, 2010). On the other hand, increasing taxes have an opposite effect, due to rising labour costs in the whole economy, which leads to a loss of competitiveness. This relation between decomposed budget deficits and borrowing costs has been already analyzed some related empirical studies (Akitoby & Stratmann, 2008).

The Ricardian equivalence, Keynesian and non-Keynesian theories provide several revealing conclusions. Firstly, financial markets' participants might negatively evaluate austerity measures and increase sovereign bonds' yields due to the possibility of declining aggregate demand and total output, while credible positive changes in fiscal processes could lead to lower yields of sovereign debt securities. Secondly, decreasing government spending, rather than rising taxes could actually encourage financial markets' participants to reduce country's borrowing costs, because of the expected gain in competitiveness. Finally, sovereign bonds' yields could remain unchanged independently from fiscal policy actions if changes in public spending are offset by movements in savings of private households, or foreign capital inflows. Therefore, the relation between fiscal processes and long-term interest rates is ambiguous based on key related theories.

2.2. Methodological approaches and empirical findings

Fiscal policy effects on long-term interest rates are generally measured using three distinct approaches. The vast majority of related studies analyze historical data, which is beneficial due to availability of possible variables and sample countries. On the other hand, some authors argue that research papers, which incorporate forecasted data, theoretically provide more legitimate results (Laubach, 2009). It allows them to capture expectations of financial markets' participants and removes the misleading impact of economic cycles. Also, it is possible to apply a perspective of the event study, which measures the impact on long-term interest rates, caused by specific budget deficit reduction laws, or related news (Elmendorf, 1996). The next three parts present advantages and disadvantages, empirical findings, and conclusions of these methodological approaches. The main related studies and their results are and briefly summarized in Appendix 1.

2.2.1. Historical data

An extensive number of studies tend to analyze historical data over relatively long time periods, for both advanced and emerging economies (Baldacci & Kumar, 2010).This methodological approach allows researchers to test a wide range of variables, which could potentially affect long-term interest rates, and incorporate country and time fixed effects (Caggiano& Greco, 2011). It provides unrestraint opportunities for authors to analyze new economic theories and indicators, while constantly supplementing the existing literature. On the other hand, Laubach (2009) argues that historical data could not capture expectations about changes in fiscal policy and macroeconomic conditions, which might be an essential

factor for financial markets' participants, when determining yields of sovereign debt securities.

Previous investigations on fiscal processes and long-term interest rates used to provide rather ambiguous conclusions. Gale and Orszag (2003) have gathered empirical findings from 31 related studies, which utilize historical data, and concluded that approximately an equal share of authors argues about both significant and insignificant relations between countries' borrowing costs and fiscal policy indicators. The major reason for inconclusive results could be substantial economic and financial changes during a second half of the previous century, which has been characterized by low inflation rates, financial liberalization, growing capital flows among countries, and structural reforms (Edey, Kennedy, & Orr, 1995). All these processes tend to appear in separate countries at different time periods, rather than being a momentary change, which might have negatively affected empirical findings of studies, which use historical data of the previous century (Brook, 2003).

More recent studies argue about significant fiscal policy effects on long-term interest rates. Baldacci and Kumar (2010) have analyzed the relationship between public-debt-to-GDP and budget-deficit-to-GDP ratios and 10 years government bonds' yields. Their sample consists of 31 advanced and developing economies, for a time period from 1980 to 2008. Authors have concluded that both fiscal policy indicators, together with macroeconomic variables, except the GDP growth rate, are significant determinants of country's long-term borrowing costs. In addition, the initial fiscal, institutional and structural conditions, which are measured by several dummy variables, have been proved to matter. Other researchers confirm that budget deficits for countries with less developed financial markets are usually evaluated stricter by financial markets' participants, which causes an upwards pressure on long-term interest rates (Ardagna, Caselli, & Lane, 2007). Such unequal treatment of nations occurs when financial markets' participants attempt to ensure against liquidity shortages and possible sovereign defaults (Feldstein, 1986). As a result, economies with undeveloped financial markets encounter higher yields of bonds. For instance, Latin American countries are demanded to maintain more sustainable budget balances in order to reduce their borrowing costs (Aisen & Hauner, 2008).Hence, financial markets' conditions are significant determinants of sovereign bonds' spreads (Akitoby & Stratmann, 2008).

Ardagna, Caselli and Lane (2007) in a study of 16 OECD countries, for a time span from 1960 to 2002, have analyzed historical data and concluded that fiscal policy processes influence nominal long-term interest rates. Interestingly, authors have argued that the public-

debt-to-GDP ratio and sovereign bonds' yields are having a non-linear relationship, which indicates some additional issues for countries with a high public debt level. For instance, financial markets' participants might require higher risk premium for countries with above median sizes of public debts. On the other hand, some EU member states have actually benefited from the sovereign debt crisis and received lower yields of bonds, when funds have been transferred from troubled economies, such as Greece, Ireland, and Portugal, to more secure ones, namely Germany, Denmark, Finland, and Netherlands (Schuknecht, von Hagen, &Wolswijk, 2010). These financial processes indicate a necessity to stabilize public finance conditions and put upwards pressure on long-term interest rates (Caceres, Guzzo, &Segoviano, 2010). In addition, the non-linear functional form could also appear between the budget-deficit-to-GDP ratio and yields of sovereign debt securities (Baldacci & Kumar, 2010), which requires further investigation. Finally, Ardagna, Caselli and Lane (2007) have introduced a dynamic VAR model, which reveals the long-lasting impact of fiscal policy processes on nominal long-term interest rates.

Caggiano and Greco (2011) in their study of 12 Eurozone member states have indicated that a level of the public debts is a significant determinant of changes in spreads between yields of country's 10-years bonds and Germany bunds. Quarterly historical data from 2000Q1 to 2009Q4 has been analyzed, while testing a wide range of fiscal, macroeconomic and financial indicators. In addition, authors have argued that the current account balance, real effective exchange rate, and financial factors are significant determinants of sovereign bonds' spreads. According to Caggiano and Greco (2011), financial markets' participants tend to determine long-term interest rates based on the public-debt-to-GDP ratio, because it incorporates the risk of sovereign default. Also, this fiscal policy indicator deviates severely across countries, starting from less than 10 to over 200 percents (The Wall Street Journal, 2012). In case of an increasing probability of default, financial markets' participants substantially raise country's borrowing costs and ensure themselves against potential losses. According to Arghyrou and Kontonikas (2011), this situation has occurred in Greece in 2009, when financial markets' participants started to question its ability to repay liabilities, which led to a substantial increase in sovereign bonds' yields. Hence, the accumulation of public debt is expected to be closely monitored by financial markets' participants and influence changes in long-term interest.

A maturity of sovereign debt securities could also influence long-term interest rates and country's borrowing patters (Benigno, Giavazzi, & Missale, 1997). Caggiano and Greco

(2011) have indicated that financial markets' participants are more concerned about short-term debts compared to long-term liabilities, when determining countries' borrowing costs. Stable economies tend to avoid possible variation in short-term interest rates and issue securities with a longer maturity. On the other hand, economies which are encountering issues related to potential insolvency behave in an opposite manner, and expect to reduce their borrowing costs during the roll-over process (Benigno, Giavazzi, & Missale, 1997). Empirical findings support arguments that the maturity of sovereign debt securities influences bonds' spreads. Therefore, an intentional reduction in the average maturity of sovereign debt securities should be expected to cause higher long-term interest rates, because of a more frequently approaching need of refinancing.

Schuknecht, von Hagen, and Wolswijk (2010) in their analysis of 15 EU member states, for a period from 1991 to 2009, have concluded that higher risk premium on sovereign bonds will be required after the recent crisis, due to a general increase in risk aversion. As financial markets' participants tend to evaluate the accumulation of public debt more carefully, it leads to larger spill-over effects, which has been detected in similar studies (Ardagna, Caselli & Lane, 2007). An increase in the overall public-debt-to-GDP ratio in the region, or worldwide, could potentially raise long-term interest rates for separate countries (Clayes, 2005). Hence, relatively small economies have less control over their own borrowing costs, which are determined by the largest countries (Kremer, Paesani, &Strauch, 2006). As a result, empirical findings provide some arguments for international agreements, namely the Stability and Growth Pact in Europe, in order to govern and diminish these spill-over effects (Faini, 2004). Financial markets' participants would be expected to reduce long-term interest rates if counties are collectively implementing fiscal policy decisions, and there is no significant threat of potential disturbances in the region.

Historical data provides numerous possibilities to analyze long-term sovereign bonds' yields, while the recent studies have generated some new questions, which will be answered in the further analysis. On the other hand, this methodological approach is still rather limited in measuring expectations of financial markets' participants, which is achieved in the analysis of forecasted data.

2.2.2. Forecasted data

Authors tend to argue that forecasted data is theoretically more suitable to investigate the relation between fiscal processes and long-term interest rates. It allows us to avoid some negative effects of interchanging business-cycle and assist in directly capturing expectation

of financial markets' participants (Laubach, 2009). For instance, Blanchard (1991) argues that long-term interest rates depend on the current public-debt-to-GDP ratio and all anticipated future budget deficits, meaning that the existing budgetary situation does not influence country's borrowing costs. This statement is consistent with the Ricardian equivalence hypothesis, which introduces forward looking private households (Barro, 1989). Hence, governments which are currently implementing conservative fiscal policy decisions might encounter higher sovereign bonds' yields when financial markets participants' foresight a substantial increase in their budget deficits (Boussard, de Castro, & Salto, 2012). However, one must realize possible disadvantages of this methodological approach, which are related to data accessibility. The majority of studies that analyze forecasted data focus on USA statistics, because other countries usually lack reliable projections for all necessary variables, and it would be difficult to undertake a cross-country analysis (Brook, 2003).

A summary of empirical results from earlier studies indicates that in most cases the analysis of forecasted data detects significant effects of expected budget-deficit-to-GDP and public-debt-to-GDP ratios on long-term interest rates (Gale & Orszag, 2003). Authors have reviewed 17 different research papers, while only one could not capture the significant relationship between fiscal processes and country's borrowing costs. On the other hand, their samples usually consist from USA only, and results might not be applicable to other countries due to some specific domestic factors. More recent studies tend to develop a broader sample and include some emerging economies, while fiscal policy indicators appear to be even stronger determinants of long-term interest rates (Nickel, Rother, & Rulke, 2009).

Laubach (2009) has analyzed the relation between expected fiscal policy processes and long-term interest rates for the USA for a time span from 1976 to 2003. Annual and semi-annual forecasted data has been gathered from the Congressional Budget Office (CBO) and the Office of Management and Budget (OMB). Author concludes that fiscal policy indicators are significant determinants of country's borrowing costs. An anticipated increase in budget deficits indicates the future growth of aggregate demand, and raises the current interest rates (Feldstein, 1986). It creates a pressure to utilize monetary policy instruments, such as short-term interest rates, and balance upcoming macroeconomic changes. Hence, a potential increase in government spending reduces the stimulating effect of monetary policy during the economic downturn (Canzoneri, Cumby, & Diba, 2002). This is a significant concern for countries in the Eurozone, because monetary policy is implemented by the ECB, while fiscal processes vary across member states (Kremer, Paesani, & Strauch, 2006).

Laubach (2009) also indicates that the GDP growth, inflation, and equity premiums determine long-term sovereign bonds' yields in USA.

2.2.3. Event study

The last methodological approach has been described as the event study, which is rarely performed in similar research papers. It requires a specific situation, which would signalize about substantial changes in fiscal processes and cause significant movements in country's sovereign bonds' yields. Elmendorf (1996) has argued that financial markets' participants motivate their investment decisions based government's legislative actions. Therefore, author has analyzed changes in borrowing costs caused by the announcements of Gramm-Rudman-Hollings law in 1985 and Budget Enforcement Act in 1990 in USA. Both laws have been introduced to lower public spending and decrease budget deficits, which have established expectations about potential improvements in fiscal processes (Elmendorf, 1996). Hence, the event study allows researchers to capture expectations of financial markets' participants, which according to Laubach (2009) it is a fundamental determinant of long-term interest rates, and could not be measured from historical data. Elmendorf (1996) concludes that an anticipated decrease in public spending leads to lower real long-term borrowing costs, and vice versa, which is consistent with empirical findings of other two methodological approaches. News about budget deficit reduction laws have led to predicted changes of real long-term interest rates in 21 cases out of 23 (Elmendorf, 1996). However, the event study might be performed rarely due to several potential drawbacks. It is rather difficult to identify the precise timing of news related to budget deficit laws, and isolate non-fiscal policy specific events (Elmendorf, 1996). Hence, empirical findings might provide an arguable relationship between fiscal processes and long-term interest rates. Also, it would be even more complicated to perform the event study in a cross-country analysis, for instance EU member states, due to a considerable amount of extrinsic factors.

In conclusion, the more recent literature in this field tends to argue about significant fiscal policy effects on long-term interest rates, independently from selected variables and methodological differences. These empirical findings contradict to the Ricardian equivalence hypothesis and raise some new questions about non-linear relationships and spill-over effects, which could provide some arguments for further financial and economic cooperation between EU member states (European Commission, 2012). The sequential part presents an outline of the methodology applied in this research paper, including the selection of sample countries and the baseline regression.

3. Methodology outline

The following section introduces econometric techniques and variables used in the panel analysis of 26 EU member states. It enables us to investigate the proposed research question and hypotheses, detect potential non-linear relationships between fiscal policy indicators and long-term sovereign bonds' yields, spill-over effects across the region, country and time specific differences. Similar methodological approaches could be recognized in related studies written by Ardagna, Caselli, and Lane (2007), Baldacci and Kumar (2010), or Akitoby and Stratmann (2008). This research paper contributes to the existing literature, because it incorporates the broadest available sample of 26EU member states, together with a sub-sample for two Baltic countries, and analyzes additional dummy variables, which has not been performed in any of the previous works. Variables for the regression analysis have been selected based on suggestions from similar studies, which has already been presented in the literature review part. It allows us to expect some critical insights about fundamental determinants of long-term interest rates, including the major fiscal policy and macroeconomic processes. Results will be reviewed in the part of empirical findings and summarized in Appendices. The next few sections explain the choice of sample, the baseline specification, variables, and panel tests, which ensure robustness of the estimates.

3.1. Sample selection

Quarterly historical data has been gathered from the Eurostat statistical database for the period from 2001Q1 to 2011Q4, which provides 44 observations for each variable in total. The sample consists of 26 European countries, namely Belgium, Czech Republic, Denmark, Germany, Ireland, Spain, France, Italy, Cyprus, Latvia, Lithuania, Luxembourg, Hungary, Malta, Netherlands, Austria, Portugal, Poland, Slovakia, Finland, UK, Sweden, Greece, Bulgaria, Romania, and Slovenia. It is necessary to notify that Estonia has been excluded from the analysis, because it does not have an adequate indicator to measure long-term bonds' yields, due to the relatively short maturity of sovereign debt's securities (European Central Bank, 2012). In addition, the collected panel data is unbalanced, as some countries lack observations for several quarters. Eurostat (2012) provides shorter time series of long-term sovereign bonds' yields for Bulgaria, Romania and Slovenia. However, these three countries have still been included the analysis, because it allows us to increase a number of observations, which corresponds to the essential purpose of this study, which requires the broadest available sample of EU member states. The selected bundle of economies is assumed to vary significantly in terms of macroeconomic and fiscal policy conditions. A

single statistical source, namely Eurostat (2012), ensures comparability of variables included in the analysis (Appendix 2), which will be presented explicitly in the sequent parts.

3.2. The baseline specification

The baseline regression in this research is as follows:

$$LTIR_{it} = \alpha + \beta_1 BUDG_{it} + \beta_2 PUBL_{it} + \beta_3 LnSTIR_{it} + \beta_4 LnHCPI_{it} + \beta_5 RGDP_{it} + u_{it} \quad (1)$$

It is necessary to notify that fixed effects have been incorporated in the baseline specification to measure potential country and time specific factors. It should lead to more reliable estimates, compared to a study of individual countries (Gujarati, 1995). Ln indicates variables, which have been transformed by taking a natural logarithm, in order to follow the normal statistical distribution.

Long-term interest rates (LTIR) have been included in the baseline regression as a dependent variable, and correspond to yields of sovereign bonds with a residual maturity of approximately 10 years (Eurostat, 2012).As it has been mentioned in the literature review part, variations in a value of LTIR could arise from unequal development of fiscal and macroeconomic conditions across separate countries. Therefore, several fundamental indicators have been included in the baseline regression as independent variables to measure these processes.

Public-debt-to-GDP (PUBL) and seasonally-adjusted primary-budget-deficit-to-GDP (BUDG) ratios have been selected to reflect fiscal policy conditions for each EU member state in the sample. The PUBL ratio represents a total gross debt of the general government as a share of GDP and at the end of each quarter (Eurostat, 2012). An increase in the PUBL ratio is expected to cause a higher value of LTIR, because country's capability to repay all liabilities becomes questionable as the public debt accumulates. Therefore, regressions' coefficients for the PUBL ratio ought to have a positive sign. One potential drawback of this variable emerges from the fact that changes in the PUBL ratio could be influence by changes in a value of country's GDP, while a size of the public debt remains unchanged (de Grauwe & Ji, 2013). Hence, the PUBL ratio might be correlated with another independent variable, namely the real GDP growth rate, which worsens the reliability of empirical findings.

The BUDG ratio has been estimated by the adding the interest-expenses-to-GDP ratio to the seasonally-adjusted government's budget-deficit-to-GDP ratio for each quarter:

$$BUDG_{it} = \frac{Seasonallyadjustedbudgetdeficit_{it}}{GDP_{it}} + \frac{Interestexpenses_{it}}{GDP_{it}} \qquad (2)$$

Therefore, the BUDG measurement corresponds to a primary-budget-deficit-to-GDP ratio and reflects country's budgetary situation prior interests are paid to financial markets' participants, who are holding sovereign debt securities. Such fiscal policy indicator allows us to avoid potential endogeneity between both PUBL and BUDG ratios, because the primary-budget-deficit-to-GDP measurement does not depend on a current size of country's public debt (Ardagna, Caselli, & Lane, 2007). In other words, the government is required to pay interests based on the previous quarter's PUBL ratio, while the BUDG ratio indicates the current total budget deficit or surplus prior interest payments. An increase in the BUDG ratio implies either lower budget deficit, measured with a minus sign, or larger surplus, measured with a plus sign. As a result, all coefficients for the BUDG variable are expected to have a negative sign when the LTIR measurement is analyzed as a dependent variable. Financial markets' participants should decrease long-term borrowing costs for EU member states, which achieve lower budget deficits, or reach larger budget surplus (Hypothesis I). It is worth mentioning that Eviews 6 statistical software has been utilized to perform the seasonal adjustment for the BUDG ratio by an additive Census X11 adjustment method. Throughout the analysis, both PUBL and BUDG indicators are expected to provide a proper reflection for fiscal policy conditions across EU countries.

Short-term interest rates (STIR), harmonized index of consumer prices (HICP) and real GDP growth rates (RGDP) have been included in the baseline regression to describe fundamental macroeconomic processes. The STIR variable corresponds to monetary policy and it is measured by interbank interest rates for deposits with a maturity of three months (Eurostat, 2012).An increase in a value of the STIR indicator represents more expensive borrowing for all economic units, including governments, and might be anticipated to cause to a higher value of the LTIR measurement. Therefore, coefficients for the STIR variable in the baseline regression should have a positive sign. A potential drawback is related to the argument that financial markets' participants might also be concerned about anticipated changes in monetary policy and the current inflation expectations, which have not been captured in this research paper.

Quarterly HICP measurement has been obtained by estimating an average value of three monthly observations, which provides a common measurement for variation in consumer prices across EU member states. Inflation reduces the purchasing power of bonds'

interest payments and financial markets' participants require higher yields to compensate for an increasing level of prices. A higher value of the HICP indicator should force to require additional premium for borrowing and increase the value of LTIR. Hence, coefficients for the HICP variable are anticipated to have a positive sign in the regression analysis. As it has been mentioned previously, the current HICP index does not incorporate expected changes in inflation, which could be particularly important for financial markets' participants.

The RGDP measurement corresponds to a growth rate of the real gross domestic product, compared to the previous period (Eurostat, 2012). An increase in the RGDP indicator is expected to cause a lower value of LTIR, because it reflects an increasing potential to improve fiscal policy conditions and higher capacity for servicing public liabilities. Hence, coefficients for the RGDP variable should have a negative sign in the regression analysis. It is rather complicated to avoid potential endogeneity issues between the RGDP measurement and other dependent variables. For instance, both PUBL and BUDG ratios include a size of country's nominal GDP as their denominator, while changes in a real and nominal value of GDP might be correlated. This issue could be mitigated by including instrumental variables, which will be presented in further parts. The following section introduces some additional indicators, which allows us to test regional differences, potential non-linear relationships, and spill-over effects across EU member states.

3.3. Additional variables

In the literature review part it has been mentioned that both PUBL and BUDG ratios could be having a non-linear relationship with a value of LTIR, while this issue could be examined in two distinct ways (Hypothesis II). The first option is to generate squared values of public-debt-to-GDP ($PUBL^2$) and primary-budget-deficit-to-GDP ($BUDG^2$) ratios, and include them in the baseline specification. One might expect coefficients with positive signs for the $PUBL^2$variable, and negative for the $BUDG^2$ measurement. An existing rationale to account for these non-relationships implies that financial markets' participants could decide to require higher long-term interest rates for countries with sizeable PUBL ratios, because of increasing risks of sovereign default. On the other hand, an opposite relationship occurs for EU member states with high BUDG ratios, which indicates either increasing budget surplus, or lower deficits. Therefore, $PUBL^2$ and $BUDG^2$measurements have been included in the analysis to test Hypothesis II.

The second method, which is applied to detect potential non-linear relationships, suggests including and testing dummy variables that split countries based on a median value of public-debt-to-GDP (PUBLM) and primary-budget-deficit-to-GDP (BUDGM) ratios in the selected sample. For instance, in this study the PUBLM measurement is equal to 49.45 percents and the BUDGM variable is equal to -0.29 percents. Further calculations could be expressed as mathematical formulas (3-4), which explain dummy variables for countries with the above median public-debts (MP) and budget-deficits (MB):

$$DP = (PUBL - PUBLM)^2 * MP; \quad (3)$$

$$If\ PUBL > PUBLM, then\ MP = 1, and\ 0\ otherwise;$$

$$DB = (BUDG - BUDGM)^2 * MB; \quad (4)$$

$$If\ BUDG > BUDGM, then\ MB = 1, and\ 0\ otherwise.$$

Countries with above median PUBL and BUDG ratios are assumed to be charged with a higher value of LTIR. However, coefficients for both indicators must have expected signs. One could anticipate a negative sign for the DB variable and positive sign for the DP indicator, while the rationale is identical to the one, previously mentioned for $BUDG^2$ and $PUBL^2$ measurements. Potential non-linear relationships could acknowledge policy makers if financial markets' participants require additional premiums, when a country has an above median value of BUDG or PUBL ratios.

Possible spill-over effects could be measured via so called EU average indicators (i.e. EPUBL). Essentially, it corresponds to a weighted average value of each variable included in the baseline regression. For instance, the EU average public-debt-to-GDP variable (EPUBL) has been estimated by adding a fraction each country's PUBL ratio, based on a corresponding size of its real GDP, while excluding the country of investigation. Hence, EU average variables reflect an aggregate situation in the region and could be significant determinants of LTIR for individual EU member states. The primary attention has been concentrated on the public-debt-to-GDP ratio (Hypothesis III). Negative changes in troubled economies, such as Spain, Portugal, Ireland, Greece or Cyprus, might boost borrowing costs across all EU member states, due to close economic and financial integration in the region. Therefore, a significant positive coefficient for the EPUBL variable could encourage policy makers to reconsider possible spill-over effects, and their potentially harmful influence on separate country's sovereign bonds' yields. Fundamental macroeconomic indicators, such as regional inflation or real-GDP growth, might also affect long-term interest rates for an individual EU

member state. An increase in the EHICP measurement should cause a higher value of LTIR. On the other hand, the real-GDP growth rate in EU signalizes about improving macroeconomic conditions, which might decrease risk aversion and encourage financial markets' participants to reduce borrowing costs for separate countries.

Several dummy variables have been generated to test Hypothesis I (Appendix 2). The D_{euro} indicator is set to 1 if country is a member of the Eurozone, and 0 otherwise. One could expect countries with euro as their national currency to have a lower value LTIR, due to the moderate exchange rate risk and relatively positive perception of financial markets' participants. The D_{crisis} dummy variable is designed to capture the potential raise in a value of LTIR during the recent sovereign debt crisis. It splits the sample into the pre-crisis (2001Q1-2007Q4) and crisis (2008Q1-2011Q4) periods. D_{west}, D_{east}, D_{south} and D_{north} dummy variables have been included to analyze the existing differences in a value of LTIR caused by some specific regional factors. One could anticipate Western European countries to encounter the lowest borrowing costs, compared to other EU member states, due to enduring economic and financial stability. Also, a sub-sample consisting of two Baltic states, namely Lithuania and Latvia, has been investigated in the baseline regression specification (Appendix 10). All results are presented in the part of empirical findings, and summarized in Appendices.

3.4. Robustness of empirical estimates

Both the first and the second lag of independent and dependent variables have been incorporated into the model as instrumental variables (IV). The inclusion of lagged values could possibly reduce the correlation between regressors and regressands, and ensure more robust empirical estimates (Gujarati, 1995). For instance, LTIR and PUBL variables might encounter endogeneity, because a significant increase in country's borrowing costs causes a faster accumulation of its public debt, due to higher interest expenses. This two-way causal effect reduces the reliability of empirical results (Ardagna, Caselli, & Lane, 2007). Hence, lagged values of dependent and independent variables could diminish these biases. Coefficients for fiscal and macroeconomic instrumental variables are expected to have identical signs to those presented in the baseline specification. However, GLS estimates for instrumental variables must be analyzed deliberately, because of potential non-stationarity in the panel (Ardagna, Caselli, & Lane, 2007).

Another possibility to test robustness of empirical estimates is to include an alternative left-hand-side variable. Results would indicate if values of regressions'

coefficients rely on a choice of the dependent variable, which could explain potential mismatch across related studies. Therefore, a spread between long and short term interest rates (LTIR-STIR), and a spread between Germany's and other EU member states' borrowing costs (LTIR-$LRIT_{bunds}$), have been analyzed as alternative dependent variables. Fixed effects have been incorporated into the model with the expectation of no significant changes in regressions' coefficients for independent variables (Hypothesis IV).

3.5. Tests from the panel data

Diagnostic tests for the panel data have revealed a necessity to control for several econometric issues, in order to obtain robust empirical estimates. First of all, Im-Pesaran-Shin unit root test detects non-stationarity in all variables, except the primary-budget-deficit-to-GDP ratio and the real GDP growth rate, at the 5% significance level (Appendix 3). The null hypothesis, which could not be rejected, states that all panels contain unit roots, while alternatively some panels are stationary. Fisher's unit root test, which is based on the augmented Dickey-Fuller test, has provided opposite results. The null hypothesis for unit roots could be rejected at the 5% level for the majority of variables, while the alternative hypothesis states that at least one panel is stationary. Econometrists argue that Fisher's test is superior compared to Im-Pesaran-Shin unit root test, because it does not require a balanced panel and allows us to include lags (Baltagi, 2005). However, both unit root tests provide ambiguous results in terms of stationarity in variables of the baseline regression. Westerlund's test for cointegration indicates that the null hypothesis of no cointegration in the panel could not be rejected at the 5% level (Appendix 3). According to Ardagna, Caselli& Lane (2007), OLS method is not appropriate if variables are cointegrated. However, it is common in similar studies to compare estimates from both OLS and GLS regressions (Hauner & Kumar, 2006), which has been applied throughout this analysis as well.

Hausman's test for fixed and random effects has indicated a necessity to include fixed effects in the model (Appendix 3). It is based on the comparison of two separate regression specifications, which incorporates either fixed, or random effects. The null hypothesis, which has been rejected at the 5% significance level, states that differences are not systematic. Therefore, country specific factors are influencing sovereign bonds' yields. Time-fixed effects have also been included in the model after rejecting the hypothesis, at the 5% significance level, that coefficients for separate quarters are jointly equal to 0. Pesaran's test has revealed a potential cross-sectional dependence across the panel. The null hypothesis states that residual values are not correlated, which has been rejected at the 5% significance

level. However, it is not possible to control for the cross-sectional dependence in the unbalanced dataset. Wooldridge's test has indicated a serial correlation in the panel, which might lead to inaccurate value of the R^2 measurement and relatively low regression's coefficients. The null hypothesis of no first-order autocorrelation has been rejected at the 5% significance level.

Two distinct econometric techniques have been applied in this research based on results from panel tests and suggestions in previous studies. OLS regressions with country and time fixed effects, corrected for heteroscedasticity, and GLS regressions, which control for serial correlation. The GLS method could be considered as appropriate, because the number of countries is smaller than the number of time periods in the panel. However, one could expect empirical estimates to deliver rather optimistic standard errors. The selected option to run both OLS and GLS regressions has been introduced in similar studies, which attempt to detect the relation between fiscal policy and country's long-term bonds' yields (Hauner & Kumar, 2006).The following part presents empirical findings and provides answers to both research question and hypotheses.

4. Empirical findings and possible implications

This part is designed to present empirical findings from the regression analysis and provide possible implications for policy makers. Separate sections have been arranged in the same order, which has been introduced in the methodology outline. In addition, results from regressions have been summarized in Appendices.

4.1. Fiscal policy indicators

Throughout the analysis both fiscal policy indicators, namely primary-budget-deficit-to-GDP and public-debt-to-GDP ratios, tend to be significant determinants of long-term sovereign bonds' yields (Hypothesis I). In OLS regressions, an increase in the BUDG ratio by one percentage point causes a lower value of LTIR from the minimum of 1.7 to the maximum of 14.1 basis points (Appendix 4-7). One the other hand, GLS regressions provides lower coefficient with the minimum value of 0.1 and the maximum of 2 basis points. As a result, EU member states could actually reduce their sovereign bonds' yields by implementing stricter budgetary policy and signalizing to financial markets' participants about ongoing improvements, which could reduce the risk aversion in the region. These results essentially contradict with the Ricardian equivalence hypothesis, which indicates that under any

conditions budget deficits are not influencing long-term interest rates, due to an assumption of forward-looking private households.

Empirical findings reveal that according to OLS regressions, the BUDG indicator is a more important determinant of sovereign bonds' yields compared to the PUBL measurement. An increase in the PUBL ratio by one percentage point leads to a higher value of LTIR from the minimum of 0.2 to the maximum of 7.5 basis points. On the other hand, coefficients in GLS regressions are lower with the minimum value of 0.1 and the maximum of 6 basis points. As a result, the accumulation of public debts across EU member states leads to higher sovereign bonds' yields. Hence, it does not allow us to reject Hypothesis I, which states that both fiscal policy indicators are significant determinants of long-term borrowing costs. Such results correspond to the more recent studies, which tend to detect a similar causal relationship (Ardagna, Caselli & Lana, 2007; Caggiano & Greco, 2011; Baldacci & Kumar, 2010). In addition, this study does not capture expectations of financial markets participants' about changes in fiscal processes, which could strengthen the current empirical findings.

As a result, policy makers should pay serious attention to a level of sovereign debts and budget deficits. Any decisions which cause a significant rise in these fiscal policy indicators should be considered cautiously, as it could have negative effects on sovereign borrowing costs. In case a sovereign debt level is already high, policy makers may consider implementing austerity measures in order to avoid the situation, when sovereign bond yields rise to unsustainable levels. Hence, empirical findings provides a rationale for international organizations, namely the IMF and ECB, to require significant public spending cuts for countries, which request for rescue packages(Breidthardt & Strupczewski, 2012). Austerity measures implemented through changes in fiscal processes could lead to declining long-term sovereign bonds' yields. In addition, these results allow us to further analyze the remaining hypotheses. The next part reviews results for fundamental macroeconomic indicators, which has been included in the baseline regression.

4.2. Macroeconomic indicators

All macroeconomic indicators included in the regression analysis are significant determinants of long-term sovereign bonds' yields. Firstly, a one percent increase in the STIR measurement causes a higher value of LTIR from the minimum of 1.4 to the maximum of 2 basis points in OLS regressions. Similar coefficients occur in GLS regressions with the minimum value of 1.1 and the maximum of 2.1 basis points. These empirical findings

indicate that raising short-term interest rates actually translate into higher sovereign bonds' yields. As a result, central banks could diminish a potential increase in country's borrowing costs via stimulating monetary policy actions. Therefore, it provides a rationale for the decision of ECB to decrease interbank market rates during the sovereign debt crisis (Suoninen, 2012). On the other hand, policy makers should be aware that during the period of economic growth, central banks might decide to increase short-term interest rates in order to control inflation. As a result, rise in the STIR measurement could add additional pressure on sovereign bonds' yields and worsen situation in terms of sovereign debt management.

Secondly, the inflation rate is itself a significantly determinant of long-term sovereign bonds' yields. According to OLS regressions, a one percent increase in the HICP index corresponds to a higher value of LTIR from a minimum of 0.8 to the maximum of 3.7 basis points. In GLS regressions, coefficients are again lower, with the minimum value of 0.2 and the maximum of 1.7 basis points. These empirical findings reveal that financial markets' participants require additional premium for a decrease in the purchasing power of bonds' interest payments. At the current situation, inflation rates across EU member states are relatively low. However, it creates a potential threat of higher sovereign bonds' yields during the post-crisis period. Currently, troubled economies in the Southern Europe do not have to be concerned about a possible pressure on a price level due to weak aggregate demand. On the other hand, countries with fixed exchange rate regimes, which are not able to control their money supply, must stabilize fiscal policy conditions before the potential raise in inflation. This issue is particularly important for the Baltic States, which used to have substantial inflation rates prior the crisis (Swedbank, 2011).

Lastly, changes in the real GDP growth rate cause movements in sovereign bonds' yields. In OLS regressions, an increase in the RGDP measurement by one percentage point leads to a lower value of LTIR from the minimum of 3.8 to the maximum of 19.9 basis points. On the other hand, coefficients in GLS regressions are lower with the minimum of 3.2 and the maximum of 5 basis points. The real GDP growth rate reflects higher capacity for public debt servicing and potentially improving fiscal policy conditions. These results again provide supportive arguments for stimulating monetary policy, rather than loose fiscal policy during the economic downturn. For instance, currently the ECB determines rather low short-term interest rates, which, according to empirical findings of this study, decrease yields of long-term sovereign bonds. On the other hand, loose fiscal policy, in terms of accumulating budget deficits and public debts, causes higher country's borrowing costs, and could invoke

the sovereign default. Hence, monetary policy is more appropriate during the economic downturn, because it allows policy makers to avoid increasing long-term interest rates. However, monetary policy alone is not a panacea for solving issues related to higher sovereign bond yields. For instance, some Eurozone member counties are still striving to reduce their borrowing costs, although the ECB is implementing rather loose monetary policy (Suoninen, 2012). It is necessary to support these efforts via coordinated fiscal policy, in term of austerity measures, and structural reforms, such as creation the banking union.

4.3. Non-linear relationships

Non-linear relationships between fiscal processes and sovereign bonds' yields have been tested based on two distinct methods (Appendix 5). The first method has included squared values of both fiscal policy indicators ($BUDG^2$ and $PUBL^2$), while the second suggests testing whether EU member states, with above median primary-budget-deficit-to-GDP (BUDGM) or public-debt-to-GDP (PUBLM) ratios are charged with higher long-term interest rates. One could anticipate significant non-linear relationships between yields of sovereign bonds and both fiscal policy indicators due to an increasing risk aversion of financial markets' participants, as budget debt and public debts accumulate excessively (Hypothesis II).

OLS and GLS regression specifications have provided common results for $PUBL^2$ and $BUDG^2$ indicators. Even though both variables have expected signs, only the public-debt-to-GDP ratio has a significant non-linear effect on sovereign bonds' yields. Hence, it allows us rejecting Hypothesis II, which states that both fiscal policy indicators have a non-linear mentioned functional form with countries' borrowing costs. As a result, the further accumulation of public debts in countries with the currently high PUBL ratio, could lead to even faster growth in a value of LTIR. On the other hand, increasing primary budget surplus, or decreasing deficits are evaluated evenly by financial markets' participants, despite possible variation in percentages.

Regressions with above median dummy variables for PUBL and BUDG ratios support the argument, which states that from fiscal policy indicators, the public-debt-to-GDP ratio has a non-linear relationship with sovereign bonds' yields only. These findings are consistent with other empirical studies in this field, which have been performed for a different sample of counties (Ardagna, Caselli, & Lane, 2007). As a result, policy makers should be aware that long-term interest rates start to increase at a higher pace if the public debt accumulates to an

above median threshold, which increase a possibility of sovereign default. It is has been visible in some southern-European countries, namely Portugal, Spain and Italy, during the sovereign debt crisis, when financial markets' participants started to doubt their ability to repay all liabilities. Hence, policy makers should strive to avoid reaching the above median value of the public-debt-to-GDP ratio, or diminish the existing indebtedness via fiscal austerity measures.

4.4. Spill-over effects

Potential spill-over effects have been tested based on EU variables (i.e. EPUBL), while regressions' coefficients are presented in Appendix 6. The essence of constructing these indicators has been introduced in the methodology, while the primary objective is to measure whether sovereign bonds' yields for separate EU member states are significantly influenced by the overall fiscal and economic conditions in the region (Hypothesis III). This causal relationship could be explained through changes in risk aversion among financial markets' participants, regardless of processes occurring in individual countries.

Empirical findings indicate that changes in the weighted average ratio of public debts in the region influence borrowing costs for an individual country. Hence, these results do not allow us to reject Hypothesis III, which argues about a presence of spill-over effects in the sample of 26 EU member states. An increase in the EPUBL measurement by one percentage point leads to a lower value of LTIR equal to 39.8 basis points in OLS, and 29.8 basis points in GLS regressions. Results are again consistent with conclusions from related empirical studies, which tend to detect spill-over effects in different samples of countries (Ardagna, Caselli, & Lane, 2007; Faini, 2004; Kremer, Paesani, & Strauch, 2006). Therefore, policy makers should be aware of uncontrollable risk premium required by financial markets' participant. An increasing risk aversion in the region harms even those countries, which are implementing sound fiscal policy decisions. Hence, there is a need to implement coordinated fiscal and economic policies in order to reduce spill-over effects. The issue of the existing spill-over effect has been already recognized at the highest political level in Europe; while there are many feasible reforms on the agenda (van Rompuy, 2012). Policy makers understand that it is rather impossible to deal with the current crisis without further financial, fiscal and political integration.

Empirical findings for other EU variables provide rather ambiguous conclusion in both OLS and GLS regressions. Despite coefficients being insignificant, EBUDG and

ERGDP variables have the expected signs. More precisely, the overall real GDP growth rate in the region appears to influence countries sovereign bonds' yields, according to GLS regressions, at the 10% significance level. Hence, it is plausible that economic recovery in EU could reduce the total risk aversion among financial markets' participants and lead to lower borrowing costs of individual counties. Currently, mostly non-Eurozone member are recovering, which prevents from decreasing sovereign bond yields due to the raising total GDP in the region (Eurostat, 2012). Other EU indicators, namely ESTIR and EHIC, have provided mixed coefficients in both OLS and GLS regressions.

4.5. Specific dummy variables

Several dummy variables have been incorporated in the analysis to test the impact of currency regimes, the sovereign debt crisis and regional factors on bonds' yields. One could anticipate these conditions' significantly affecting country's borrowing costs.

First of all, EU member states which has euro as their currency, tend to encounter lower yields on sovereign debt securities. According to empirical findings, a spread varies from 42.3 to 69.9 basis points in OLS, and from 70.6 to 108 basis points in GLS regressions. Related studies also indicate that members of the Eurozone tend to have lower borrowing costs (Faini, 2004). Therefore, it provides a rationale for countries under the fixed currency regime, such as Lithuania and Latvia, to join the Eurozone and significantly decrease their borrowing costs. However, it is necessary to remember that lower borrowing costs for these countries could lead to irresponsible fiscal policy and unsustainable indebtedness. Results of such processes are visible in some Southern European countries, such as Greece. On the other hand, the Eurozone membership provides many additional opportunities for sustainable development in the future.

Secondly, empirical findings provide ambiguous results about changes in bonds' yields during the sovereign debt crisis. OLS regressions indicate that during the period from 2008Q to 2011Q4, borrowing costs for EU member states increased by around 29 basis points. On the other hand, GLS regressions provide much lower coefficient, which are also insignificant at the 5% level. An explanation for the increasing sovereign bonds' yields during the financial crisis implies a higher risk aversion among financial markets' participants. On the other hand, relatively low, or even insignificant, coefficients for this variable could be explained by movements of funds across EU member states. For instance, during the sovereign debt crisis financial markets' participants used to transfer their resources

from troubled economies to more secure countries, which implement sound fiscal policy decisions (Schuknecht, von Hagen, &Wolswijk, 2010). Hence, coefficients for the total sample might not have increased as severely as one could expect.

Finally, spreads in yields of sovereign bonds have been analyzed based on some regional factors. It is necessary to notify that a breakdown of countries is provided in Appendix 2. Both OLS and GLS regressions indicate that Western European countries have the lowest borrowing costs compared to all other regions. According to OLS regressions, for Southern European countries spreads are from 61.1 to 69.6 basis points, for Northern European countries from 52.6 to 74.4 basis points, and for Eastern European countries from 69.2 to 111.6 basis points higher compared to Western European countries. Even larger coefficients occur in GLS regressions, where Southern European countries are charged with from 83.3 to 93.8, Northern European countries from 150.8 to 173, and Eastern European countries from 121.1 to 214.1 basis points higher yields of sovereign bonds compared to Western European countries. Results could be explained via unequal development of separate regions. For instance, the majority of Eastern European countries have joined the EU only in the last decade, which could indicate different financial and economic conditions, and corresponds to this substantial spread in sovereign bonds' yields (European Union, 2013). On the other hand, Lithuania and Latvia have been included in the group of Northern European countries (United Nations Statistics Division, 2013), which might have caused such a high spread in borrowing costs compared to the Western European region. In addition, spreads for Southern European countries is relatively low compared to other regions, because it incorporates the pre-crisis period, while some of these countries are members of the Eurozone. Hence, it is difficult to argue about potential implications of such empirical findings.

4.6. The Baltic countries

A sub-sample for two Baltic countries, namely Lithuania and Latvia, has been incorporated in the analysis in order to compare empirical findings with the total sample of 26 EU member states. Results of the baseline regression are summarized in Appendix 10.

In the chosen sub-sample, both fiscal policy indicators tend to have a significant impact on sovereign bonds' yields. On the other hand, coefficients of the baseline regression tend to be larger compared to those based the total sample of 26 EU member states. According to OLS regressions, an increase in the BUDG ratio by one percentage point causes a lower value of LTIR from the minimum of 29.8 to the maximum of 66.1 basis points. Coefficients for

GLS regressions are lower once again, with the minimum of 14.8 to the maximum of 35.6 basis points. Therefore, policy makers in the two Baltic countries should be aware that their sovereign bond yields are more sensitive to changes in budget deficits, compared to the total sample of EU countries.

The accumulation of public debts is an important determinant of borrowing costs for the two Baltic countries. According to OLS regressions, a one percentage point increase in the PUBL ratio causes a higher value of LTIR from the minimum of 10.2 to the maximum of 20.2 basis points. Coefficients for GLS regressions are rather similar, with the minimum value of 5.2 and the maximum of 21.5 basis points. Hence, a size of public debts in Lithuania and Latvia could lead to a more severe increase in sovereign bonds' yields compared to other EU member states. Latvia could be a good example as during the acute phase of the crisis, it has completely lost the access to international borrowing and has been forced to ask the European Commission and the IMF for financial support (Eglitis, 2013). Hence, policy makers in these two Baltic countries may consider rather strict laws related to budget deficits in order to avoid the potential severe increase in sovereign bond yields during the period of crisis (Mongelli, 2010).

4.7. Instrumental variables

Lags of selected fiscal and macroeconomic variables have been generated and included into the model to reduce correlation between regressors, and control for the potential omitted variable bias (Appendix 8). Hence, one could expect more reliable estimates in OLS regressions. However, coefficients for GLS regressions should be evaluated cautiously, due to potential non-stationarity in the panel data.

OLS regressions with instrumental variables indicate that the BUDG ratio is no longer a significant determinant of sovereign bonds' yields. However, an increase in the PUBL ratio still leads to a higher value of LTIR from the minimum of 1.1 to the maximum of 1.8 basis points. Hence, an impact of fiscal processes on country's borrowing costs decreases, compared to other regression specifications. It allows us to rejected Hypothesis I, which states that both accumulating budget deficits and public debts influence sovereign bonds yields. Financial markets' participant could be more interested in ongoing fiscal processes, rather than observing the current value of the BUDG ratio. In addition, results are consistent with the Ricardian equivalence hypothesis, which indicates that budget deficits are not affecting long-term borrowing costs. At the same time, policy makers should primarily focus

on the accumulation of public debts, which remain a significant determinant of sovereign bond yields.

An inclusion of instrumental variables in the baseline specification indicates that lagged values of sovereign bonds' yields itself are significant determinants of the current borrowing costs. One might consider an autoregressive analysis of long-term sovereign bond yields, which has been already performed in similar studies (Ardagna, Caselli, & Lane, 2007). In addition, lags of the real GDP growth rate and short-term interest rates also influence sovereign bonds' yields.

4.8. Alternative dependent variables

Spreads between long-term sovereign spreads and short-term interest rates (LTIR-STIR), and yields of Germany's bunds (LTIR-$LTIR_{bunds}$) have been selected as alternative dependent variables. According to Hypothesis V, an introduction of other measurements for long-term interest rates should not significantly influence the previous empirical findings. Otherwise, results could be biased due to a choice of the dependent variable.

OLS regressions reveal that the BUDG ratio has no significant impact on sovereign bonds' yields, regardless of which indicator is used as an alternative dependent variable (Appendix 9).Similar results occur for GLS regressions as well. Hence, one could state that financial markets participants are not considering the current level of budget deficits, when determining country's borrowing costs. A possible explanation has been proposed by Blanchard (1991), who argues that only anticipated budget deficits are significant determinants of sovereign bond yields, because it leads the accumulation of public debts. However, empirical estimates of this study are based on historical data and could not incorporate expectations of financial markets' participants. As a result, the selection of LTIR-STIR and LTIR-$LTIR_{bunds}$ measurements as regressands in other research papers could lead to the rejection of Hypothesis I, which states that both fiscal policy indicators influence country's borrowing costs. Therefore, the current conclusions for accumulating budget deficits should be evaluated cautiously due to potential robustness issues.

On the other hand, the PUBL ratio remains a significant determinant of sovereign bond yields, even after the inclusion of alternative dependent variables. According to OLS regressions, an increase in the PUBL ratio by one percentage point causes a lower value of LTIR-STIR or LTIR-$LTIR_{bunds}$ from the minimum of 6.4 to the maximum of 9 basis points. GLS regressions provide lower coefficient with the minimum value of 3.1 and the maximum

of 5.8 basis points. These results do not significantly differ with those, which incorporated long-term sovereign bonds' yields as the dependent variable. Still, it is reasonable to reject Hypothesis V, because after the inclusion of new regressands, the primary-budget-deficit-to-GDP ratio is no longer a significant determinant of country's borrowing costs.

The following section concludes this research paper and reiterates the major implications for policy makers based on empirical findings.

5. Conclusions

The financial crisis in USA has caused a long-lasting turmoil in the banking sector around the world. Several European governments have been forced to rescue their financial sector and accept rapidly accumulating budget deficits and debts. This situation has led to the sovereign debt crisis in Europe, while the path of recovery is still unclear. Governments have been suggested to apply austerity measures and stabilize public finances. The existing theories in this field tend to provide rather contradicting arguments and there is no general solution for the troubled economies. Hence, this research paper has evaluated the effects of fiscal processes on long-term sovereign bond yields and provided several possible implications of empirical findings to policy makers.

Fiscal policy processes, namely the accumulation of budget deficits and public debts tends to significantly influence long-term sovereign bond yields. Policy makers should be aware that irresponsible fiscal policy could lead to increasing borrowing costs, while austerity measures could be applied to countries with relatively high levels of budget deficits and public debts. In addition, the accumulation of public debts is charged with higher long-term sovereign interest rates, when its level researches the above median threshold. It corresponds to rising risk aversion among financial markets participants due the increasing possibility of sovereign default. Hence, policy makers should implement rather conservative fiscal policy in order to avoid the potential negative changes in borrowing costs. These conclusions are consistent with the more recent empirical literature, which tend to detect similar causal relationships. In addition, the non-Keynesian theory provides the most plausible theoretical explanation for sources of impact. On the other hand, the accumulation of budget deficits is an arguable determinant of sovereign bond yields, because robustness test based instrumental variables and alternative dependent variables could not prove a significant relation.

Overall fiscal processes in the European region are also influencing individual countries borrowing costs. An increasing average level of public debts amplifies risk aversion among financial markets' participants and rise sovereign for all EU member states, regardless

of the current fiscal policy. Hence, it would be beneficial to implement coordinated decisions and reduce the existing spill-over effects. Again, results are consistent with other research papers in this field. Policy makers in EU have already recognized the potential threats of these processes and seek for possible solutions, which could protect from the similar sovereign crisis in the future. This study strengthens the argument for further financial, fiscal, and political integration in EU, which could diminish negative effects of irresponsible fiscal processes. As a result, fiscal processes tend to be significant determinants of long-term sovereign bonds' yields based on the cross-country analysis of 26 EU member states.

References

Aisen, A., &Hauner, D. (2008).*Budget Deficits and Interest Rates: A Fresh Perspective.* Washington, DC: IMF Working Papers. Retrieved from http://www.imf.org/external/pubs/ft/wp/2008/wp0842.pdf.

Akitoby, B., & Stratmann, T. (2008).Fiscal Policy and Financial Markets. *The Economic Journal, 118(533)* , 1971–1985.

Alesina, A. F., &Ardagna, S. (2010). Large Changes in Fiscal Policy: Taxes Versus Spending. In J. R. Brown, *Tax Policy and the Economy, 24* (pp. 35-68). Cambridge, MA: National Bureau of Economic Research, Inc.

Ardagna, S., Caselli, F., & Lane, T. (2007).*Fiscal Discipline and the Cost of Public Debt Service: Some Estimates for OECD Countries.* The B.E. Journal of Macroeconomics, 7(1).

Arghyrou, M. G., &Kontonikas, A. (2011).*The EMU Sovereign Debt Crisis: Fundamentals, Expectations, and Contagion.* Brussels: European Commission Economic Papers. Retrieved from http://ec.europa.eu/economy_finance/publications/economic_paper/2011/pdf/ecp436_en.pdf.

Auerbach, A. J., & Feenberg, D. (2000). The Significance of Federal Taxes as Automatic Stabilizers. *Journal of Economic Perspectives, 14(3)* , 37-56.

Baldacci, E., & Kumar, M. S. (2010). *Fiscal Deficits, Public Debt, and Sovereign Bond Yields.* Washington, DC: IMF Working Papers. Retrieved from http://www.imf.org/external/pubs/ft/wp/2010/wp10184.pdf

Baltagi, B. H. (2005). *Econometric Analysis of Panel Data (3rd ed.).* West Sussex: John Wiley & Sons Ltd.

Barro, R. J. (1989). The Ricardian Approach to Budget Deficits. *Journal of Economic Perspectives, 3(2)* , 37-54.

Benigno, P., Giavazzi, F., & Missale, A. (1997). *Managing the Public Debt in Fiscal Stabilizations: The Evidence.* Cambridge, MA: NBER Working Papers. Retrieved from http://www.nber.org/papers/w6311.

Bernheim, D. B. (1987).Ricardian Equivalence: An Evaluation of Theory and Evidence. In S. Fischer, *NBER Macroeconomics Annual, 2* (pp. 263-316). The MIT Press.

Blanchard, O. J. (1991). International Volatility and Economic Growth: The First Ten Years of The International Seminar on Macroeconomics. In R. J. Gordon, *Current and Anticipated Deficits, Interest Rates and Economic Activity* (pp. 361-390). Elsevier Science Publishers.

Bootle, R. (2012, July 21). *Euro exit and depreciation would bring economic gains.* Retrieved April 8, 2013, from The Telegraph Comment: http://www.telegraph.co.uk/finance/comment/rogerbootle/9417612/Euro-exit-and-depreciation-would-bring-economic-gains.html

Boussard, J., de Castro, F., & Salto, M. (2012). *Fiscal Multipliers and Public Debt Dynamics in Consolidations.* Brussels: European Commission Economic Papers. Retrieved from http://ec.europa.eu/economy_finance/publications/economic_paper/2012/pdf/ecp460_en.pdf.

Breidthardt, A., & Strupczewski, J. (2012, November 27). *Euro zone, IMF secure deal on cutting Greek debt.* Retrieved April 8, 2013, from Reuters article: http://www.reuters.com/article/2012/11/27/us-eurogroup-greece-idUSBRE8AP05820121127

Brook, A. M. (2003). *Recent and Prospective Trends in Real Long-Term Interest Rates: Fiscal Policy and other Drivers.* Paris: OECD Economics Department Working Papers. Retrieved from http://www.oecd-ilibrary.org/economics/recent-and-prospective-trends-in-real-long-term-interest-rates_514820262776.

Buti, M., &Pench, L. R. (2012). *Fiscal Austerity and Policy Credibility*. Retrieved November 25, 2012, from VOX Columns: http://www.voxeu.org/article/fiscal-austerity-and-policy-credibility

Caceres, C., Guzzo, V., &Segoviano, M. (2010).*Sovereign Spreads: Global Risk Aversion, Contagion or Fundamentals?* Washington, DC: IMF Working Papers. Retrieved from http://www.imf.org/external/pubs/ft/wp/2010/wp10120.pdf.

Caggiano, G., & Greco, L. (2011).*Sovereign Risk in the Euro Area: Is it Mostly Fiscal or Financial?* Rimini: The Rimini Centre for Economic Analysis Working Papers. Retrieved from http://rcea-canada.org/pages/may_2012_rimini/papers/Caggiano%20and%20Greco.pdf.

Canzoneri, M. B., Cumby, R. E., & Diba, B. T. (2002). Should the European Central Bank and the Federal Reserve Be Concerned about Fiscal Policy? *Federal Reserve Bank of Kansas City Proceedings* , 333-389.

Cizkowicz, P., & Rzonca, A. (2005).*Non-Keynesian Effects of Fiscal Contraction in New Member States.* Frankfurt: ECB Working Papers. Retrieved from http://www.ecb.int/pub/pdf/scpwps/ecbwp519.pdf.

Clayes, P. (2005). *Crowding Out in Europe: Does Spill-Over Matters?* Bologna: Bologna University. Retrieved from http://www2.dse.unibo.it/soegw/paper/Clayes.pdf

De Grauwe, P., &Ji, Y. (2013, March 6). *Panic-driven austerity in the Eurozone and its implications.* Retrieved March 30, 2013, from VOX Columns: http://www.voxeu.org/article/panic-driven-austerity-eurozone-and-its-implications

Edey, M., Kennedy, M., & Orr, A. (1995). Real Long-Term Interest Rates: the Evidence from Pooled-Time-Series. *OECD Economic Studies, 25* , 75-107.

Eglitis, A. (2013, January 3). *Latvian Austerity Fervor Outstrips IMF After Loan Payback*. Retrieved April 5, 2013, from Bloomberg News: http://www.bloomberg.com/news/2013-01-02/latvian-austerity-fervor-outstrips-imf-after-early-loan-payback.html

Elmendorf, D. W. (1996). *The Effect of Debt-Reduction Laws on Real Interest Rates.* Washington, DC: Board of Governors of the Federal Reserve System. Retrieved from http://www.federalreserve.gov/pubs/feds/1996/199644/199644pap.pdf.

European Central Bank. (2012). *Long-term interest rates statistics for EU Member States*. Retrieved December 17, 2012, from Statistics: http://www.ecb.int/stats/money/long/html/index.en.html

European Commission. (2012). *A Blueprint for a Deep and Genuine Economic and Monetary Union: Launching a European Debate.* Brussels: European Commission. Retrieved from http://ec.europa.eu/commission_2010-2014/president/news/archives/2012/11/pdf/blueprint_en.pdf.

European Union. (2013). *Further expansion.* Retrieved April 8, 2013, from How the EU works: http://europa.eu/about-eu/eu-history/2000-2009/index_en.htm

Eurostat. (2012). *Browse / Search Database*. Retrieved December 17, 2012, from Statistics: http://epp.eurostat.ec.europa.eu/portal/page/portal/statistics/search_database

Eurozone Portal. (2013). *Euro area member states*. Retrieved April 3, 2013, from Euro area: http://www.eurozone.europa.eu/euro-area/euro-area-member-states/

Faini, R. (2004). Fiscal Policy and Interest Rates in Europe. *Economic Policy Forty-First Panel Meeting* (pp. 443-489). Social Science Research Network. Retrieved from http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2040815.

Feldstein, M. (1986). *Budget Deficits, Tax Rules, and Real Interest Rates.* Cambridge, MA: NBER Working Papers. Retrieved from http://www.nber.org/papers/w1970.

Gale, W. G., & Orszag, P. R. (2003).*The Economic Effects of Long-Term Fiscal Discipline.* Washington, DC: The Urban Institute. Retrieved from http://www.urban.org/UploadedPDF/310669_TPC-DP8.pdf

Grennes, T., & Strazds, A. (2013, February 28). *Another look at Ricardian equivalence: The case of the European Union* . Retrieved April 2, 2013, from VOX Columns: http://www.voxeu.org/article/another-look-ricardian-equivalence-case-european-union

Gujarati, D. N. (1995).*Basic Econometrics (3rd ed.).*Istanbul: McGraw-Hill, Inc.

Hauner, D., & Kumar, M. S. (2006). *Fiscal Policy and Interest Rates: How Sustainable Is The "New Economy"?* Washington, DC: IMF Working Papers. Retrieved from http://www.imf.org/external/pubs/ft/wp/2006/wp06112.pdf.

Howe, H., & Pigott, C. (1991). Determinants of the Long-Term Interest Rates: An Empirical Study of Several Industrial Countries. *FRBNY Quarterly Review, 16(4)* , pp. 12-28.

Kinoshita, N. (2006). *Government Debt and Long-Term Interest Rates.* Washington, DC: IMF Working Papers. Retrieved from http://www.imf.org/external/pubs/ft/wp/2006/wp0663.pdf.

Kremer, M., Paesani, P., & Strauch, R. (2006).*Public Debt and Long-Term Interest Rates: The Case of Germany, Italy and the USA.* Frankfurt: ECB Working Papers. Retrieved from http://www.ecb.europa.eu/pub/pdf/scpwps/ecbwp656.pdf.

Kumar, M. S., & Woo, J. (2010). *Public Debt and Growth.* Washington, DC: IMF Working Papers. Retrieved from http://www.imf.org/external/pubs/ft/wp/2010/wp10174.pdf.

Lander, M. (2008, September 30). *The U.S. Financial Crisis Is Spreading to Europe*. Retrieved April 8, 2013, from The New York Times World Business: http://www.nytimes.com/2008/10/01/business/worldbusiness/01global.html

Laubach, T. (2009). New Evidence on the Interest Rate Effects of Budget Deficits and Debt. *Journal of the European Economic Association, 7(4)* , 858–885.

Mongelli, F. P. (2010, March 11). *Some benefits and costs from participating in a monetary union*. Retrieved April 8, 2013, from VOX Columns: http://www.voxeu.org/article/underappreciated-benefits-eurozone-0

Moutot, P., Rother, P., Schuknecht, L., & Stark, J. (2011). *The Stability and Growth Pact Crisis and Reform.* Frankfurt: ECB Occasional Paper Series.

Nickel, C., Rother, P. C., &Rulke, J. C. (2009).*Fiscal Variables and Bond Spread: Evidence from Eastern European Countries and Turkey.* Frankfurt: ECB Working Papers. Retrieved from http://www.ecb.int/pub/pdf/scpwps/ecbwp1101.pdf.

Schaltegger, C. A., &Weder, M. (2010).*Fiscal Adjustment and the Costs of Public Debt Service: Evidence from OECD Countries.* CESifo Working Paper Series. Retrieved from http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1739569.

Schuknecht, L., von Hagen, J., &Wolswijk, G. (2010).*Government Bond Risk Premiums in the EU Revisited: The Impact of the Financial Crisis.* Frankfurt: ECB Working Papers. Retrieved from http://www.ecb.int/pub/pdf/scpwps/ecbwp1152.pdf.

Suoninen, S. (2012, July 5). *ECB cuts rates to new low, no move on bolder measures.* Retrieved April 8, 2013, from Reuters article: http://www.reuters.com/article/2012/07/05/us-ecb-rates-idUSBRE86405K20120705

Swedbank. (2011). *Hazy inflation trends in the Baltic countries:.* Stockholm: Swedbank Economic Research Department.

The Wall Street Journal. (2012). *Comparing Debt Ratios* . Retrieved 11 26, 2012, from Interactive Graphics: http://online.wsj.com/article/SB10001424052748703789104576272891515344726.html

United Nations Statistics Division. (2013). *Composition of macro geographical (continental) regions, geographical sub-regions, and selected economic and other groupings* . Retrieved April 4, 2013, from Methods & Classifications: http://unstats.un.org/unsd/methods/m49/m49regin.htm

Van Rompuy, H. (2012). *Towards a Genuine Economic and Monetary Union.* Brussels: European Council. Retrieved from http://ec.europa.eu/economy_finance/focuson/crisis/documents/131201_en.pdf.

Appendix 1.Key studies in the field

Table 1. Key studies in the field

Name of authors and study	Aim of the research	Sample, time period, and methodology	Empirical findings
Ardagna, S., Caselli, F., & Lane, T. (2007). Fiscal Discipline and the Cost of Public Debt Service: Some Estimates for OECD Countries.	Authors analyze fiscal policy (budget-deficit-to-GDP and public-debt-to-GDP ratios) effects on long-term interest rates.	16 OECD countries, for a period from 1960 (Sample A) and 1975 (Sample B) to 2002. Historical data.	• Both fiscal policy indicators, namely budget deficits and public debts, affect long-term interest rates. • Significant spill-over effects and non-linear relation between public debts and borrowing costs. •Financially less developed countries have higher long-term interest rates.
Baldacci, E., & Kumar, M. S. (2010). Fiscal Deficits, Public Debt, and Sovereign Bond Yields.	Authors analyze fiscal policy effects on sovereign bonds' yields, and incorporate a variety of possible determinants, country specific factors.	31 advanced and developing countries for a period from 1980 to 2008. Historical data.	•Budget deficits and public debts determine 10 years' government bonds yields (a non-linear relationship). •Significant spill-over effects. Expected inflation and short-term interest rates influence long-term interest rates, while the economic growth has no impact. •Initial fiscal, institutional and structural conditions matters.
Caggiano, G., & Greco, L. (2011). Sovereign Risk in the Euro Area: Is it Mostly Fiscal or Financial?	Authors analyze the impact of fiscal processes and financial conditions on 10-years' government bonds yields.	12 Eurozone member countries for a period from 2000Q1 to 2009Q4. Historical data.	•The debt-to-GDP ratio determines long-term sovereign bonds' yields. •The expected GDP growth, net lending, real effective exchange rate and financial factors significantly influence long-term interest rates. •Germany bunds' rates affect interest rates in Eurozone.
Akitoby, B., &Stratmann, T. (2008). Fiscal Policy and Financial Markets.	Authors analyze fiscal policy effects on governments' bonds spreads.	32 countries from emerging markets, during a time period from 1994 to 2003. Historical data.	•Lower government spending has stronger impact on bonds' spreads, compared to an increase in revenues. • Government spending from taxes is preferred compared to the debt financed spending. •Financial market's conditions and macroeconomic indicators are important determinants of sovereign bonds' spreads. •A size of foreign reserves an important indicator for financial markets' participants.
Aisen, A., &Hauner, D. (2008). Budget Deficits and Interest Rates: A Fresh Perspective.	Authors analyze the effect of budget deficits on sovereign bonds' yields.	60 advanced and emerging economies for a period from 1970 to 2006. Historical data.	•Budget deficits determine long-term interest rates, but the effect differs across time periods and countries. •Emerging economies tend to encounter higher borrowing costs compared to advanced economies. •Authors detect a significant crowding-out effect.
Elmendorf, D. W. (1996). The Effect of Debt-Reduction Laws on Real Interest Rates.	Author analyzes the effect of budget deficits laws on long-term interest rates.	Two budget deficit reduction laws are observed for USA in 1985 and 1990.The event study.	• Lower expected budget spending decreases real interest rates, and vice versa. • Lower expected government spending and budget deficit decrease the value of dollar. • Expansionary fiscal policy tends to raise real interest rates.
Laubach, T. (2009). New Evidence on the Interest Rate Effects of Budget Deficits and Debt.	Author analyzes the relationship between expected values of fiscal policy indicators, namely budget-deficit-to-GDP and public-debt-to-GDP ratios, and long-term interest rates.	USA has been analyzed for a time period from 1976-2003. Forecasted data.	• Fiscal policy indicators are significant determinants of long-term interest rates. •The budget-deficit-to-GDP ratio is more important for financial markets' participants compared to the public-debt-to-GDP ratio. • GDP growth, inflation and equity premium rates determine long-term bonds' yields.

Source: Created by the author based on Ardagna, Caselli and Lane (2007), Baldacci and Kumar (2010), Caggiano and Greco (2011), Akitoby and Stratmann (2008), Aisen and Hauner (2008), Elmendorf (1996), and Laubach (2009).

Appendix 2. Description of variables

Table 2. Key studies in the field

Variable	Description and source	Hypothesis	Expected sign
LTIR	Yields of sovereign bonds with the residual maturity of approximately 10 years. Source: Eurostat (2012).	Dependent variable. Financial markets' participants determine long-term sovereign bonds' yields based on fiscal processes and macroeconomic conditions.	–
BUDG	Seasonally-adjusted primary-budget-deficit-to-GDP ratio. Primary-budget-deficit-to-GDP ratio has been calculated by adding interest expenses. Seasonal adjustment has been performed by the author with the Eviews6 statistical software. Source: Eurostat (2012).	Independent variable. Decreasing budget deficits / increasing budget surplus signalize about more responsible /conservative fiscal policy, and correspond to lower sovereign bonds' yields.	Minus
PUBL	A total gross debt of the general government, measured as a share of GDP, at the end of each quarter. Source: Eurostat (2012).	Independent variable. The accumulation of public debts increases a threat of possible sovereign default and causes a higher value of long-term interest rates.	Plus
LnSTIR	Interbank interest rates for deposits with a maturity of three months. Ln indicates a natural logarithm to follow normal distribution. Source: Eurostat (2012).	Independent variable. Increasing short-term interest rates indicates stricter monetary policy and more expensive borrowing for economic units.	Plus
LnHICP	Harmonized index of consumer prices. Ln indicates the natural logarithm in order to follow normal distribution. Quarterly observations have been calculated by the author and correspond to an average value of three monthly observations. Source: Eurostat (2012).	Independent variable. Financial markets' participants require higher bonds' yields for increasing inflation in order to compensate for a raising level of prices.	Plus
RGDP	A growth rate of the real gross domestic product compared to the previous period. Source: Eurostat (2012).	Independent variable. The real GDP growth indicates positive changes in debt servicing capacity and leads to a lower value of long-term bonds' yields.	Minus
D_{euro}	Austria, Belgium, Finland, France, Germany, Ireland, Italy, Luxemburg, Netherlands, Portugal, Spain (1999), Greece (2001), Slovenia (2007), Cyprus, Malta (2008), Slovakia (2009), Estonia (2011). Source: Eurozone Portal (2013).	Dummy variable. Financial markets' participants require lower borrowing costs for Eurozone member countries due to the perception of higher reliability.	Minus
D_{crisis}	Indicates the sovereign debt crisis period from 2008Q1 to 2011Q4.	Dummy variable. During the sovereign debt crisis EU member states have encountered higher bonds' yields, due to an increase in risk aversion.	Plus
D_{south}	Southern Europe: Greece, Italy, Malta, Portugal, Slovenia, Spain, Cyprus. Source: United Nations Statistics Division (2013).	Dummy variable. Southern European countries should encounter higher long-term interest rates compared to Western European countries.	Plus
D_{north}	Northern Europe: Denmark, Finland, Ireland, Latvia, Lithuania, Sweden, UK. Source: United Nations Statistics Division (2013).	Dummy variable. Northern European countries should encounter higher long-term interest rates compared to Western European countries.	Plus
D_{east}	Eastern Europe: Bulgaria, Check Republic, Hungary, Poland, Romania, Slovakia. Source: United Nations Statistics Division (2013).	Dummy variable. Eastern European countries should encounter higher long-term interest rates compared to Western European countries.	Plus
D_{west}	Western Europe: Austria, Belgium, France, Germany, Luxemburg, Netherlands. Source: United Nations Statistics Division (2013).	Dummy variable. Western European countries should encounter lower long-term interest rates compared to other European regions.	Minus
LTIR-STIR	A spread between long-term and short-term interest rates. Calculated by the author from LTIR and STIR variables. Source: Eurostat (2012).	Alternative dependent variable. Coefficients of variables should not change significantly in the baseline regression.	–
$LTIR\text{-}LTIR_{bunds}$	A spread between long-term bonds' and Germany bunds' yields. Calculated by the author from LTIR and $LTIR_{bunds}$ variables. Source: Eurostat (2012).	Alternative dependent variable. Coefficients of variables should not change significantly in the baseline regression.	–

Source: Created by the author using information from Eurostat (2012), Eurozone Portal (2013), and United Nations Statistics Division (2013).

Appendix 3. Panel tests

Table 3. Panel tests

Stationarity	LTIR	LnSTIR	LnHICP	RGDP	BUDG	PUBL
Im-Pesaran-Shin	2.93	1.01	4.60	-12.83**	-6.98**	8.37
Fisher's ADF	4.23**	5.71**	-2.06	-16.40**	3.09**	-0.39

	Statistics	Value	P-value
Westerlund's cointegration test	Gt	-2.771	0.002
	Ga	-10.705	0.751
	Pt	-12.399	0.011
	Pa	-9.195	0.228

Hausman's test	$\chi^2 = 187.91$	P-value = 0.000
Time-fixed effects' test	F = 25.68	P-value = 0.000
Pesaran's test	F = 30.48	P-value = 0.000
Wooldridge's test	F = 390.61	P-value = 0.000

Source: Created by the author.

Notes: Im-Pesaran-Shin and Fisher ADF unit root tests for panels diagnose potential non-stationarity in some regression variables (marks statistically significant stationarity in at least one panel at 5% level). Westerlund's test for panels allows rejecting the null hypothesis for no cointegration at the 5% significance level. Hausman's test indicates that fixed effects, instead of random effects, should be included in the analysis. The null hypothesis, which states that a difference in coefficients is not systematic, is rejected at the 5% significance level. Time fixed effects' test allows rejecting the null hypothesis that coefficients for year dummies are jointly equal to 0; therefore, time fixed effects should be included in the analysis. Pesaran's test indicates cross sectional dependence in the panel. The null hypothesis of no cross sectional dependence is rejected at the 5% significance level. Wooldridge's test allows rejecting the null hypothesis of no first-order autocorrelation at the 5% significance level.**

Appendix 4. Baseline regressions

Table 4. Baseline regressions

Variables	(1) OLS	(2) OLS	(3) OLS	(4) OLS	(5) OLS	(6) OLS	(1) GLS	(2) GLS	(3) GLS	(4) GLS	(5) GLS	(6) GLS
BUDG	-0.091** (0.020)	-0.141** (0.020)	-0.125** (0.018)	-0.124** (0.018)	-0.042** (0.015)	-0.018 (0.012)	-0.001 (0.005)	-0.020** (0.005)	-0.017** (0.001)	-0.015** (0.005)	-0.006 (0.005)	-0.005 (0.004)
PUBL	0.002 (0.003)	0.012** (0.003)	0.013** (0.003)	0.008** (0.002)	0.070** (0.007)	0.064** (0.007)	-0.004 (0.004)	0.017** (0.003)	0.017** (0.003)	0.015** (0.003)	0.060** (0.004)	0.049** (0.004)
LnSTIR		1.536** (0.078)	1.593** (0.076)	1.553** (0.072)	1.377** (0.107)	1.980** (0.206)		1.296** (0.074)	1.354** (0.072)	1.330** (0.072)	1.157** (0.076)	1.922** (0.113)
LnHICP			3.028** (0.672)	2.282** (0.604)	-0.790* (0.458)	1.997** (0.822)			1.725** (0.480)	1.560** (0.498)	-1.567** (0.472)	0.653 (0.916)
RGDP				-0.059 (0.053)	-0.199** (0.046)	-0.157** (0.052)				-0.032** (0.011)	-0.050** (0.011)	-0.042** (0.010)
R^2	5.33	34.31	37.18	40.94	64.00	74.59	–	–	–	–	–	–
Country effects	No	No	No	No	Yes	Yes	No	No	No	No	Yes	Yes
Time effects	No	No	No	No	No	Yes	No	No	No	No	No	Yes
N. Of Obs.	1114	1114	1114	1111	1111	1111	1114	1114	1114	1111	1111	1111

Source: Created by the author.

Notes: ** Marks statistically significant coefficients at the 5% level (* – at the 10% level). Standard errors are presented in parentheses. Ln indicates the natural logarithm of variables. OLS regressions are corrected for heteroscedasticity. GLS regressions control for serial correlation. Country and time fixed effects are included in the analysis. GLS regressions do not provide the R^2 measurement.

Appendix 5. Regressions for non-linear relationships

Table 5. Regressions for non-linear relationships

Variable	(1) OLS	(2) OLS	(3) OLS	(4) OLS	(5) OLS	(6) OLS	(1) GLS	(2) GLS	(3) GLS	(4) GLS	(5) GLS	(6) GLS
BUDG	-0.018 (0.011)	-0.023** (0.011)	-0.025** (0.010)	-0.023 (0.019)	-0.035** (0.010)	-0.046** (0.018)	-0.006 (0.004)	-0.005 (0.004)	-0.005 (0.004)	-0.008 (0.007)	-0.007* (0.004)	-0.008 (0.007)
PUBL	0.065** (0.007)	0.012** (0.012)	0.014 (0.012)	0.066** (0.007)	0.020** (0.007)	0.021** (0.007)	0.049** (0.004)	0.000** (0.010)	0.000 (0.010)	0.050** (0.004)	0.024** (0.007)	0.023** (0.007)
LnSTIR	1.988** (0.206)	1.977** (0.217)	1.985** (0.217)	1.988** (0.206)	1.945** (0.201)	1.946** (0.201)	1.915** (0.113)	1.884** (0.111)	1.876** (0.111)	1.918** (0.113)	1.855** (0.114)	1.858** (0.114)
LnHICP	2.000** (0.820)	2.303** (0.884)	2.306** (0.881)	1.974** (0.818)	1.863** (0.778)	1.804** (0.775)	0.638 (0.906)	-0.453 (0.932)	-0.447 (0.919)	0.608 (0.908)	0.438 (0.928)	0.458 (0.927)
RGDP	-0.158** (0.052)	-0.144** (0.050)	-0.144** (0.050)	-0.157** (0.052)	-0.131** (0.052)	-0.131** (0.052)	-0.042** (0.010)	-0.044** (0.010)	-0.044** (0.010)	-0.042** (0.010)	-0.044** (0.010)	-0.044** (0.010)
$BUDG^2$	-0.000 (0.000)		-0.000 (0.000)				-0.000 (0.000)		-0.000 (0.000)			
$PUBL^2$		0.000** (0.000)	0.000** (0.000)					0.000** (0.000)	0.000** (0.000)			
DB				-0.000 (0.001)		0.000 (0.000)				0.000 (0.000)		0.000 (0.000)
DP					0.001** (0.000)	0.001** (0.000)					0.000** (0.000)	
R^2	74.63	76.21	76.25	74.64	77.84	77.87	–	–	–	–	–	–
Country effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N. Of Obs.	1111	1111	1111	1111	1111	1111	1111	1111	1111	1111	1111	1111

Source: Created by the author.

Notes: ** Marks statistically significant coefficients at the 5% level (* – at the 10% level). Standard errors are presented in parentheses. Ln indicates the natural logarithm of variables. OLS regressions are corrected for heteroscedasticity. GLS regressions control for serial correlation. $BUDG^2$ and $PUBL^2$indicate squared values of BUDG and PUBL ratios. BUDGM is a median value of the BUDG ratio. If BUDG>BUDGM, DB=1, and 0 otherwise. PUBLM – is a median value of the PUBL ratio. If PUBL>PUBLM, DP=1, and 0 otherwise. Country and time fixed effects are included in the analysis. GLS regressions do not provide the R^2 measurement.

Appendix 6. Regressions with EU variables

Table 6. Regressions with EU variables

Variable	(1) OLS	(2) OLS	(3) OLS	(4) OLS	(5) OLS	(1) GLS	(2) GLS	(3) GLS	(4) GLS	(5) GLS
BUDG	-0.017 (0.014)	-0.018 (0.012)	-0.018 (0.012)	-0.017 (0.013)	-0.018** (0.012)	-0.005 (0.005)	-0.005 (0.004)	-0.005 (0.004)	-0.005 (0.004)	-0.005 (0.004)
PUBL	0.064** (0.007)	0.075** (0.007)	0.064** (0.007)	0.064** (0.007)	0.064** (0.007)	0.049** (0.004)	0.057** (0.005)	0.050** (0.002)	0.049** (0.004)	0.049** (0.004)
LnSTIR	1.981** (0.206)	1.880** (0.208)	1.959** (0.263)	1.998** (0.208)	1.976** (0.206)	1.921** (0.113)	1.939** (0.113)	2.149** (0.128)	1.923** (0.113)	1.925** (0.113)
LnHICP	1.993** (0.831)	2.259** (0.795)	2.028** (0.841)	1.727* (0.912)	1.995** (0.822)	0.652 (0.916)	0.534 (0.926)	0.444 (0.911)	0.504 (0.972)	0.588** (0.913)
RGDP	-0.157** (0.052)	-0.161** (0.053)	-0.157** (0.052)	-0.156** (0.052)	-0.163** (0.057)	-0.042** (0.010)	-0.042** (0.010)	-0.044** (0.010)	-0.042** (0.010)	-0.049** (0.011)
EBUDG	0.011 (0.150)					0.005 (0.145)				
EPUBL		0.398** (0.059)					0.298** (0.094)			
LnESTIR			-0.567 (2.443)					11.578** (3.051)		
LnEHICP				-22.956 (25.613)					-13.426 (34.138)	
ERGDP					-0.464 (0.684)					-0.532* (0.314)
R^2	74.59	75.45	74.59	74.61	74.60	–	–	–	–	–
Country effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N. Of Obs.	1111	1111	1111	1111	1111	1111	1111	1111	1111	1111

Source: Created by the author.

Notes: ** Marks statistically significant coefficients at the 5% level (* – at the 10% level). Standard errors are presented in parentheses. Ln indicates the natural logarithm of variables. OLS regressions are corrected for heteroscedasticity. GLS regressions control for serial correlation.EU variables are indicated with the E letter and measure spill-over effects. Country and time fixed effects are included in the analysis. GLS regressions do not provide the R^2 measurement.

Appendix 7. Regressions with dummy variables

Table 7. Regressions with dummy variables

Variables	(1) OLS	(2) OLS	(3) OLS	(4) OLS	(5) OLS	(6) OLS	(1) GLS	(2) GLS	(3) GLS	(4) GLS	(5) GLS	(6) GLS
BUDG	-0.111** (0.091)	-0.082** (0.012)	-0.102** (0.017)	-0.073** (0.012)	-0.120** (0.018)	-0.098** (0.018)	-0.013** (0.005)	-0.008** (0.004)	-0.009* (0.005)	-0.006 (0.004)	-0.013** (0.005)	-0.008* (0.005)
PUBL	0.012** (0.002)	0.010** (0.002)	0.010** (0.002)	0.008** (0.002)	0.008** (0.002)	0.010** (0.002)	0.017** (0.003)	0.004 (0.003)	0.019** (0.003)	0.007** (0.003)	0.016** (0.003)	0.019** (0.003)
LnSTIR	1.369** (0.077)	1.908** (0.117)	1.357** (0.091)	1.952** (0.138)	1.603** (0.079)	1.408** (0.095)	1.140** (0.077)	1.847** (0.093)	1.083** (0.077)	1.834** (0.105)	1.326** (0.073)	1.085** (0.078)
LnHICP	1.886** (0.562)	3.748** (1.116)	1.648** (0.594)	3.729** (1.131)	1.377* (0.810)	0.794 (0.792)	1.101** (0.484)	0.242 (1.026)	0.635 (0.489)	0.923 (1.000)	1.372** (0.571)	0.465 (0.559)
RGDP	-0.101** (0.052)	-0.081 (0.057)	-0.107** (0.054)	-0.085 (0.057)	-0.038 (0.059)	-0.087 (0.060)	-0.038** (0.011)	-0.035** (0.009)	-0.037** (0.010)	-0.033** (0.009)	-0.032** (0.011)	-0.036** (0.010)
D_{euro}	-0.696** (0.083)	-0.423** (0.072)					-1.080** (0.147)	-0.706** (0.140)				
D_{crisis}					0.299* (0.164)	0.287* (0.154)					0.053 (0.104)	0.061 (0.101)
D_{south}			0.611** (0.091)	0.696** (0.078)		0.625** (0.091)			0.938** (0.214)	0.833** (0.154)		0.928** (0.220)
D_{north}			0.742** (0.102)	0.526** (0.089)		0.744** (0.102)			1.626** (0.259)	1.508** (0.284)		1.730** (0.271)
D_{east}			1.116** (0.147)	0.692** (0.129)		1.105** (0.144)			2.141** (0.202)	1.211** (0.212)		2.132** (0.205)
D_{west}			–	–					–	–		
R^2	44.05	59.90	45.10	61.42	41.19	45.33	–	–	–	–	–	–
Time effects	No	Yes	No	Yes	No	No	No	Yes	No	Yes	No	No
N. Of Obs.	1111	1111	1111	1111	1111	1111	1111	1111	1111	1111	1111	1111

Source: Created by the author.

Notes: ** Marks statistically significant coefficients at the 5% level (* – at the 10% level). Standard errors are presented in parentheses. Ln indicates the natural logarithm of variables. OLS regressions are corrected for heteroscedasticity. GLS regressions control for serial correlation. Country fixed effects are not included in the analysis, because of regional dummy variables. GLS regressions do not provide the R^2 measurement. D_{euro} is a dummy variable for countries which have euro as their currency. D_{crisis} indicates a dummy for the sovereign debt crisis period (2008-2012). D_{south}, D_{north}, D_{east}, and D_{west} are dummy variables for four EU regions. D_{west} is used in the analysis as the base dummy variable for comparison with D_{south}, D_{north} and D_{east} dummy variables.

Appendix 8. Regressions with instrumental variables

Table 8. Regressions with instrumental variables

Variables	(1) OLS	(2) OLS	(3) OLS	(4) OLS	(1) GLS	(2) GLS	(3) GLS	(4) GLS
BUDG	-0.009* (0.006)	-0.008 (0.005)	-0.005 (0.006)	-0.004 (0.006)	-0.012** (0.004)	-0.014** (0.004)	-0.011** (0.004)	-0.009** (0.004)
PUBL	0.011** (0.003)	0.013** (0.003)	0.018* (0.010)	0.015 (0.010)	0.017** (0.003)	0.014** (0.002)	0.014** (0.006)	0.012* (0.006)
LnSTIR	0.296** (0.113)	0.254** (0.102)	1.746** (0.345)	1.351** (0.320)	0.561** (0.073)	0.298** (0.052)	1.651** (0.117)	1.434** (0.141)
LnHICP	0.577** (0.509)	0.970** (0.482)	1.110 (2.035)	0.807 (1.932)	0.994** (0.403)	1.240** (0.295)	-0.328 (1.316)	-1.020 (1.343)
RGDP	-0.103* (0.055)	-0.092* (0.047)	-0.094** (0.047)	-0.085* (0.044)	-0.074** (0.011)	-0.081** (0.012)	-0.083** (0.012)	-0.077** (0.012)
L1.LTIR	0.852** (0.047)	1.222** (0.075)	0.885** (0.038)	1.144** (0.072)	0.718** (0.019)	1.191** (0.028)	0.796** (0.018)	1.110** (0.029)
L1.BUDG			-0.004 (0.004)	-0.003 (0.005)			-0.007* (0.004)	-0.003 (0.004)
L1.PUBL			-0.010 (0.010)	-0.004 (0.012)			-0.003 (0.006)	-0.004 (0.008)
L1.LnSTIR			-1.710** (0.344)	-1.405** (0.468)			-1.413** (0.122)	-1.573** (0.238)
L1.LnHICP			-0.341 (2.075)	0.030 (2.189)			1.493 (1.311)	1.640 (1.797)
L1.RGDP			-0.032** (0.015)	-0.023 (0.017)			-0.028** (0.012)	-0.031** (0.012)
L2.LTIR		-0.436** (0.089)		-0.329** (0.080)		-0.442** (0.026)		-0.339** (0.029)
L2.BUDG				-0.002 (0.007)				-0.003 (0.004)
L2.PUBL				-0.000 (0.011)				0.004 (0.006)
L2.LnSTIR				0.148 (0.250)				0.313** (0.147)
L2.LnHICP				-0.110 (1.572)				0.309 (1.352)
L2.RGDP				-0.048** (0.016)				-0.055** (0.012)
R^2	92.40	93.61	93.66	94.19	–	–	–	–
N. Of Obs.	1085	1059	1085	1059	1085	1059	1085	1059

Source: Created by the author.

Notes: ** Marks statistically significant coefficients at the 5% level (* – at the 10% level). Standard errors are presented in parentheses. Ln indicates the natural logarithm of variables. OLS regressions are corrected for heteroscedasticity. GLS regressions control for serial correlation. The first lag of LTIR (1),the first and the second lag of LTIR (2), the first lag of rhs and lhs variables (3), the first and the second lag of rhs and lhs variables (4). Country and time fixed effects are included in the analysis. GLS regressions do not provide the R^2 measurement.

Appendix 9. Regressions with alternative dependent variables

Table 9. Regressions with alternative dependent variables

LTIR–STIR

Variables	(1) OLS	(2) OLS	(3) OLS	(4) OLS	(1) GLS	(2) GLS	(3) GLS	(4) GLS
BUDG	-0.012** (0.017)	0.025 (0.015)	0.024 (0.015)	0.016 (0.013)	-0.007 (0.006)	-0.006 (0.006)	-0.003 (0.005)	-0.001 (0.005)
PUBL		0.090** (0.009)	0.090** (0.009)	0.076** (0.006)		0.058** (0.007)	0.055** (0.006)	0.058** (0.006)
LnHICP			1.565** (1.230)	0.958 (1.194)			-1.732** (0.141)	-1.809** (0.142)
RGDP				-0.029 (0.056)				-0.054* (0.012)
R^2	58.68	71.52	71.63	71.95	–	–	–	–
N. Of Obs.	1114	1114	1114	1111	1114	1114	1114	1111

LTIR-LTIR$_{bunds}$

Variables	(1) OLS	(2) OLS	(3) OLS	(4) OLS	(1) GLS	(2) GLS	(3) GLS	(4) GLS
BUDG	-0.011 (0.015)	-0.012 (0.015)	-0.013 (0.015)	-0.017 (0.012)	-0.003 (0.005)	-0.007* (0.004)	-0.007* (0.004)	-0.005 (0.004)
PUBL	0.068** (0.010)	0.081** (0.009)	0.081** (0.009)	0.064** (0.007)	0.031** (0.006)	0.039** (0.005)	0.043** (0.005)	0.049** (0.004)
LnSTIR		2.330** (0.209)	2.166** (0.206)	1.980** (0.206)		1.948** (0.118)	1.953** (0.118)	1.922** (0.113)
LnHICP			3.075** (0.799)	1.997** (0.821)			1.713* (1.038)	0.653 (0.916)
RGDP				-0.157** (0.052)				-0.042** (0.010)
R^2	61.97	72.93	73.36	76.18	–	–	–	–
N. Of Obs.	1114	1114	1114	1111	1114	1114	1114	1111

Source: Created by the author.

Notes: ** Marks statistically significant coefficients at the 5% level (* – at the 10% level). Standard errors are presented in parentheses. Ln indicates the natural logarithm of variables. OLS regressions are corrected for heteroscedasticity. GLS regressions control for serial correlation. Country and time fixed effects are included in the analysis. GLS regressions do not provide the R^2 measurement.

Appendix 10. Regressions for the two Baltic countries

Table 10. Regressions for the two Baltic countries

Variables	(1) OLS	(2) OLS	(3) OLS	(4) OLS	(5) OLS	(6) OLS	(1) GLS	(2) GLS	(3) GLS	(4) GLS	(5) GLS	(6) GLS
BUDG	-0.661* (0.091)	-0.310** (0.094)	-0.359** (0.093)	-0.298** (0.103)	-0.298** (0.107)	0.009 (0.158)	-0.356** (0.069)	-0.197** (0.052)	-0.220** (0.053)	-0.148** (0.051)	-0.151** (0.051)	0.065 (0.048)
PUBL	-0.002 (0.023)	0.163** (0.023)	0.190** (0.024)	0.199** (0.024)	0.202** (0.025)	0.102 (0.089)	0.052** (0.025)	0.174** (0.025)	0.201** (0.027)	0.209** (0.027)	0.215** (0.027)	0.103* (0.054)
LnSTIR		3.110** (0.305)	3.231 (0.284)	3.106** (0.330)	3.071** (0.327)	-0.549 (0.969)		2.976** (0.359)	3.088** (0.336)	2.985** (0.328)	2.980** (0.319)	-0.442** (0.581)
LnHICP			-2.859** (0.743)	-3.646** (0.903)	-3.838** (0.926)	1.089 (3.459)			-1.971 (1.392)	-2.872* (1.476)	-3.099** (1.405)	-0.512 (4.715)
RGDP				-0.151 (0.136)	-0.156 (0.145)	0.011 (0.214)				-0.161** (0.042)	-0.161** (0.041)	-0.026 (0.050)
R^2	56.29	78.00	79.54	80.61	81.08	92.52	–	–	–	–	–	–
Country effects	No	No	No	No	Yes	Yes	No	No	No	No	Yes	Yes
Time effects	No	No	No	No	No	Yes	No	No	No	No	No	Yes
N. Of Obs.	88	88	88	88	88	88	88	88	88	88	88	88

Source: Created by the author.

Notes: ** Marks statistically significant coefficients at the 5% level (* – at the 10% level). Standard errors are presented in parentheses. Ln indicates the natural logarithm of variables. OLS regressions are corrected for heteroscedasticity. GLS regressions control for serial correlation. Country and time fixed effects are included in the analysis. The two Baltic countries are Lithuania and Latvia. GLS regressions do not provide the R^2 measurement.