Do Fiscal Shocks Explain Bond Yield in High and Low Debt Economies

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Abstract

The goal of this paper is to explore determinants of short-, medium- and long-run bond yields through time series data analysis for 11 developed countries, with five of them being high-debt and remaining as the low-debt economies. By applying variance decomposition using structural vector autoregression (SVAR) model, empirical findings confirm an important role of demand and supply factors that drive the interest rates across their frequency spectrum. Our results also highlight that for interest rates of different maturities, these factors exhibit heterogeneous behavior across high- and low-debt countries during the pre- and post-crisis regimes.

Keywords: Interest rates; demand and supply shocks; SVAR model.

JEL Classification: E43; G12; C23.

1. Introduction

The impact of fiscal policy on the interest rates of developed economies during the global financial crisis of 2008-09 has increased attention of the researchers and policy makers on the nexus between fiscal and monetary policy variables. The European Sovereign Debt Crisis (ESDC) 2010-12 in relevance to certain European Monetary Union (EMU) member countries, i.e. Cyprus, Greece, Ireland, Italy, Portugal and Spain also led to the resurgence of debate on the effects of fiscal policy on economic activity. The convergence in interest rates which existed across the developed economies prior to such crises disappeared with the onset of these crises periods, highlighting that shocks arising from fiscal policy could be strong and significant (Dell'Erba &

Sola, 2013). Fiscal shocks can expose an economy to sudden changes in liquidity and interest rates with implications for many other sectors in the economy. Large fiscal deficits could adversely affect the soundness of domestic policy, economic activity (Afonso, 2010) and reduce national savings, unless offset by an increase in private savings. A fall in national savings, in turn, could lead to a fall in national investment and national income, assuming that other factors remain constant (Gale & Orszag, 2004). Large fiscal deficits can also discourage private sectors economic activity, by crowding out private investments (Fischer & Easterly, 1990) and reduce both households' wealth and their consumption levels (Engen & Hubbard, 2004).

This work is based on highlighting the impact of fiscal shocks on bond yields with different maturities, i.e. short-, medium- and long-run represented by 3-months, 5-years and 10-years, respectively. Furthermore, we investigate the relationship between fiscal shocks and interest rates represented by US bonds with different maturities for two different set of sampling countries representing high- and low-debt economies. Fiscal shocks are explained by using total factor productivity (estimated from Cobb-Douglas production function), tax rates, government expenditures, and interest rates on US government securities. All these four variables are used in the framework proposed Kilian and Park (2009) and used by Caporale et al. (2011) for generating fiscal shocks. Later, these generated fiscal shocks explain the variance in interest rates with varying maturities. Therefore, our work is comprised of two sections, as follows.

- First, it identifies important variables based on theoretical justifications for generating fiscal shocks. This is done using a Structural Vector Autoregression (SVAR) model proposed by Kilian and Park (2009) and following the work by Caporale et al. (2011) for exploring determinants of exchange rates.

- Second, it employs the forecasting variance decomposition methodology to account for the share of variation from endogenous variables and their transmission to all other variables within the system, attributable to the dynamic nature of the VAR model. It further applies forecasting variance decompositions across different forecasting horizons, i.e. 7, 14, 21, 28 and 35 years for both the developed and the developing economies.

Overall, the goal of this paper is to investigate how the uncertainty associated with fiscal policy, i.e. government expenditure and tax revenues, can affect interest rates in a group of eleven countries, comprising of high and low debt countries. These countries include Cyprus, Greece, Ireland, Italy, Portugal, Spain, Australia, Canada, Denmark, New Zealand, Norway, spanning the period 1980-2015. Our study, while strongly associated with the previous literature, differs in the following respect. The previous literature does not capture the financial crisis period of 2008-09, nor does it take a comparative approach – e.g. high debt versus low debt economies - to investigate the effect of fiscal shocks on interest rates. Thus, we aim to address the following questions:

(1) How do fiscal shocks affect interest rates in the sample of selected countries?
(2) How different is the impact of fiscal shocks on interest rates in high and low debt economies?

The second question is of particular importance in light of the significant fiscal shocks faced by Cyprus, Greece, Ireland, Italy, Portugal and Spain in the aftermath of the financial crisis in 2008-09. The empirical analysis makes use of the structural VAR (SVAR) methodological approach, which allows us to decompose the effects of the contribution of shocks generated by each variable, as well as their transmission effects (Blanchard & Perotti, 2002; Mountford & Uhlig, 2005; Galı

et al., 2007). The decomposition tests not only identify significance of each factor across the countries under investigation but also provide useful and insight information about the determinants of interest rates. Our methodology does not run conventional regressions (given that the VAR methodological approach is based on a simultaneous system of equations where the dependent variables just depends on the lagged values of a number of drivers). Therefore, future research that needs to employ a modelling approach with the identification of drivers of interest rates for countries in our sample, will substantially benefit from our findings. In this sense, identification of such factors could assist researchers to detect the future course of credit default risk of a country, as a way to provide a fundamentals-based surveillance tool which can potentially serve as an early warning device.

The rest of this paper is structured as follows. Section 2 discusses the literature, while section 3 presents methodological aspects along with the data used for empirical analysis. Section 4 presents empirical findings. Finally, section 5 concludes our work.

2. Literature review

According to the Keynesian School, an increased demand generated by a fiscal expansion pushes up the interest rates and leads to an increase in income. In the long run, however, the Classical hypothesis holds, with a fiscal expansion not influencing an economic activity (Faini, 2006). According to the Ricardian Equivalence axiom, there is an absence of crowding out under specific assumptions. Private savings completely offsets the effect of higher public consumption for a given level of taxes (Barro, 1974). Alternatively, fiscal deficits need not to be financed only by domestic sources, but also by capital inflows (Balassa, 1988). The effect of a fall in the budget deficit on the trade balance depends on the type of monetary policy adopted by a country, as well

as the effects this policy has on both exchange and interest rates. A fiscal contraction accompanied by a loose monetary policy is expected to lead towards reduced interest rates, causing exchange rate depreciations and thus, leading to increases in the private investments and a fall in the trade deficit (Fischer & Easterly, 1990).

Turning to the empirical literature, some studies show that governments maintaining high fiscal deficits rely substantially on financial markets to finance these deficits (Ford & Laxton, 1999; Reinhart & Sack, 2000; Canzoneri et al., 2002; Gale & Orszag, 2004; Laubach, 2009; Afonso, 2010; Dell'Erba & Sola, 2013). Reinhart and Sack (2000) in a study of the effects of fiscal policy on interest rates in a group of OECD countries, observe that an increase in the budget deficit of the countries under study, lead to higher interest rates. Blanchard and Perotti (2002) employ a SVAR methodology to investigate the effects of fiscal policy on economic activity. Their findings document that government spending shocks have a positive effect on both output and consumption, and a negative effect on investment. Similarly, Canzoneri et al. (2002) use a SVAR methodological approach to illustrate the presence of a strong and statistically significant link between fiscal deficits and medium- and long-term interest rates. They find that positive expenditure shocks lead to an increase in interest rates, while Fatás and Mihov (2001) find, through a similar SVAR methodological approach, a significant positive effect of fiscal expansions on economic activity. Arguing along the same lines, Laubach (2009) observes that government deficits have a statistically significant effect on interest rates. In particular, a unit point increase in the expected budget deficit-to-GDP ratio is projected to raise long-term interest rates by approximately 25 to 30 basis points. Feldstein (1986) argues that it is future and not current budget deficits which affect interest rates. Gale and Orszag (2004), similarly note that expected future budget deficits have a strong positive correlation with real interest rates, while current deficits do not. Wachtel and

Young (1987), however, find that both current and future budget deficits affect interest rates in expectation of higher levels of debt financing. In a study of the effect of debt on interest rates in both the U.S. and the Euro area, Chinn and Frankel (2007) illustrate that the impact of real interest rates on government debt depends on the current as well as expected future levels of public debt in both areas. This finding, however, holds only when foreign interest rates are accounted for. Similar conclusions are reached by Faini (2006) in a study of the association between fiscal policy and interest rates in Europe. He finds that an expansionary fiscal policy in one EMU member country has effects, both on its spread and on the overall level of interest rates for the currency union. Ford and Laxton (1999) note that OECD public debt-to-GDP ratios have a significant impact on real interest rates in nine industrial countries and in a strong market integrated environment. Similarly, Dell'Erba and Sola (2013) use real-time data to investigate the impact of fiscal policy on long-term interest rates for a group of OECD countries. They show that over 60 percent of the variation in long-term interest rates can be explained by both fiscal and monetary policy effects.

Not all empirical studies, however, support this view. Makin (1983) and Dewald (1983) find only weak support for a positive association between budget deficits and interest rates. Evans (1985) similarly argues that large deficits do not necessarily lead to higher interest rates. Similar findings are documented by Barro and Sala-i-Martin (1990) who do not find any significant evidence of debt or deficits influencing world interest rates. Engen and Hubbard (2004) argue that while unsustainable levels of debt can be harmful to an economy, an increase in government debt of around one percent of GDP is likely to have only a small effect of about a 2-3 percent increase in real interest rates.

3. Methodology and data

3.1 Methodology

SVAR models are a multivariate, linear representation of a vector of observables on its own lags and (possibly) other variables, as well as a trend and/or a constant. SVAR modeling makes explicit identifying assumptions to isolate estimates of policy and/or private agents' behavior and its effects on the economy, while keeping the model free of many additional restrictive assumptions needed to give every parameter a behavioral interpretation. Introduced by Sims (1980), SVARs have been used to document the effects of money on output (Sims & Zha, 2005), the relative importance of supply and demand shocks on business cycles (Blanchard & Quah, 1989), the effects of fiscal policy (Blanchard & Perotti, 2002), or the relationship between technology shocks and worked hours (Galí, 1999), among many other applications.

Our work diverges from existing literature on interest rate determinants as it adopts SVAR model by including an array of structural shocks with economic and theoretical interpretation of the sensitivity of interest rates. Though there are few studies investigating the impact of such structural shocks on exchange rate in emerging markets (Caporale et al., 2011), their impact on interest rates in countries with different economic conditions provides an avenue of research. We follow the work of Kilian and Park (2009) in introducing structural shocks to a VAR framework. Existing work documents the impact of factors like productivity, employment, private output, etc. on different macro-economic variables however our work investigates the impact of fiscal shocks employing SVAR model by including number of endogenous variables along with a constant and structural shock ε_t."

We consider wide range of structural shocks with a particular emphasis on fiscal disturbances so that the sensitivity of interest rates with different maturities can be explained. This

process allows us to go one step ahead from merely explaining the dichotomy between supply (permanent) and demand (transitory) shocks. Following the work by Ahmed et al. (1993) and Hoffmaister and Roldos (2001), we rely on quasi-recursive identification criteria which is based on long-run restrictions in retrieving structural shocks that drive the system. Though existing literature documents ample evidence about the role of fiscal shocks on economic outputs (see Mountfort & Uhlig, 2009), the magnitude of such effects remains debatable, mainly because of the identification problems of fiscal disturbances. Though a strand of existing literature (Blanchard & Perotti, 2002; Mountford & Uhlig, 2005) address the identifying assumptions of VAR models, it represents limitation in *i)* anticipating the identified episodes and *ii)* the occurrence of substantial fiscal shocks with different signs and types around the same time. In our work, semi elasticities of fiscal variables to innovations in interest rates at different maturities are set to zero, following the work of De Castro & Fernández (2013) under the assumption that no interest payments are made on government debt.

The SVAR modeling approach has been addressing the criticisms of the standard Vector Autoregression (VAR) modeling approach. This standard VAR methodology has been criticized on the grounds of its unrestricted tendency that permits the model to absorb too many parameters with no theoretical framework to verify the accuracy of the findings. To overcome that, the error term from a SVAR model is guided by restrictions that are adopted from economic theory. The model assumes that the error terms of the variables exhibit a recursive relationship. That is, the error terms in the regression are constructed to be uncorrelated to each other. As presented by Verheyen (2010), the SVAR model includes a number of endogenous variables, a constant and a structural shock ε_t:

$$B\, xy_t = C_0 + C_1\, y_{t-1} + \varepsilon_t \qquad (1)$$

To derive the reduced form of the model, we multiply the above equation by the inverse of B to get:

$$Y_t = \Gamma_0 + \Gamma_1 y_{t-1} + \mu_t \quad (2)$$

where y_t denotes the variables in the system: *(i)* total factor productivity, *(ii)* tax revenues, *(iii)* government expenditures, and *(iv)* interest rates. They are all described further in the data section; Γ_0 is C_0B_{-1}, while Γ_1 stands for $C_1\ B^{-1}$ and μ_t represents $B^{-1}\varepsilon_t$. The model allows certain n(n-1)/2 restrictions to be imposed on the parameter matrix B, which is defined as a function of structural shocks given by:

$$\varepsilon_t = B\mu_t \quad (3)$$

The starting point of our analysis is a SVAR model specified as in (2). Structural innovations are derived by imposing exclusion restrictions on A_0^{-1} in $e_t = A_0^{-1}\ \varepsilon_t$, where ϵ_t is a vector of errors in SVAR framework (Kilian & Park, 2009):

$$y_t = A_0^{-1}A(L)y_{t-1} + A_0^{-1}\varepsilon_t \quad (4)$$

In particular, the four aforementioned structural shocks are classified as follows: ε_{1t} denotes total factor productivity shocks, ε_{2t} represents tax revenue shocks, ε_{3t} captures government expenditure shocks, whereas ε_{4t} denotes interest rate shocks. The identification of A_0^{-1} in Eq. (2) is achieved by imposing the following exclusion restrictions:

$$e_t = \begin{bmatrix} e_{1t}^{tfp} \\ e_{2t}^{tax} \\ e_{3t}^{exp.} \\ e_{4t}^{int.} \end{bmatrix} = \begin{bmatrix} a_{11} & 0 & 0 & 0 \\ a_{21} & a_{22} & 0 & 0 \\ a_{31} & a_{32} & a_{33} & 0 \\ a_{41} & a_{42} & a_{43} & a_{44} \end{bmatrix} \begin{bmatrix} \varepsilon_{1t}^{tfpshock} \\ \varepsilon_{2t}^{taxshock} \\ \varepsilon_{3t}^{exp.shock} \\ \varepsilon_{3t}^{int.shock} \end{bmatrix} \quad (5)$$

The identifying restrictions in the model presented above work on the assumption that total factor productivity does not respond to changes in taxes, government expenditure and interest rate shocks in the comparative short span of time i.e., within months (Blanchard & Quah 1989). The effects of the fiscal shock on taxes, spending, and interest rates will differ depending on the path, the government decides to take (Favero & Giavazzi 2007). Therefore, we assume that government taxes respond to shocks in total factor productivity and taxes shocks only, while they are not sensitive to expenditures and interest rate shocks (Easterly & Rebelo, 1993; Folster & Henrekson, 2001). Following that in the third case, government expenditures are sensitive to total factor productivity, taxes and government expenditure shocks, but they are insensitive to interest rate shocks. Finally, interest rates are sensitive to all four shocks discussed above, recommending that any exogenous shocks in either of the four indicators i.e., total factor productivity, tax, government expenditures and interest rates shocks, are reflected onto interest rates (Dell'Erba & Sola 2013, Canzoneri et al. 2002).

3.2 Data

The analysis makes use of annual data[1], spanning the period 1980 to 2015. Total factor productivity is calculated using a Cobb-Douglas production function. However, to calculate total factor production, data of gross domestic product for each sample country is used. Tax rates represent the amount of taxes along mandatory contributions payable by businesses after allowable deductions and exemptions, as a share of commercial profit. However, taxes withheld or remitted to various tax authorities are not included. Government expenditures consist of cash payments

[1] GDP for all the sampling countries is measured in terms of local currency. Government expenditures represent general government final consumption expenditures also measured in local currency. Taxes variable include taxes along mandatory contributions payable by businesses after allowable deductions and exemptions, as a share of commercial profit. Finally, interest rates represent rates on government securities.

made in providing goods and services. It also includes employee's compensation, grants, rents and dividends, subsidies and interests and social benefits. Finally, interest rates represent rates on government securities. We select interest rates based on three different maturities for each country comprising of 3-months, 5-years and 10-years maturity corresponding to short-, medium- and long-term yields. Data for all the variables is sourced from World Bank Development (WDI) indicators.

Table 1 provides descriptive statistics not only for the overall sample of countries under study, but also for both low-debt and high-debt countries. High-debt countries are characterized not only by their higher mean vis-à-vis the low-debt countries, but also by higher standard deviation.

[Insert Table 1 about here]

4. Empirical Results

4.1 *Preliminary Results*

Table 2 reports unit root tests results. In general, unit root tests cannot distinguish highly persistent stationary processes from non-stationary processes. Also, the power of unit root tests diminishes as deterministic terms are added to the test regressions. That is, tests that include a constant and trend in the test regression have less power than tests that only include a constant in the test regression. For maximum power against very persistent alternatives, we use the test proposed by Elliot et al. (1996). In particular, they introduce a potentially more powerful unit root test, that is, the generalized least squares version of the Augmented Dickey-Fuller (ADF) test and find that the power of the ADF test is lower than those of the limiting power functions when

deterministic components (mean or trend) are included in the data generating process. The null hypothesis is that there is a unit root in the series. We reject the null hypothesis of the presence of a unit root when the test statistic is less than the corresponding critical value. Based on the findings reported in Table 2, we cannot reject the null hypothesis of a unit root for all four variables and across all sampled countries. These findings suggest that our variables are non-stationary in levels, while the results in first differences illustrate that a unit root is rejected. The results remain robust across all countries under study. Thus, for these countries, cointegration tests can be used to check the presence of linear combination since variables in a model for each country are non-stationary and integrated of order one.

[Insert Table 2 about here]

Table 3 reports Johansen's (1995) maximum likelihood cointegration tests. Following Hoffman et al. (1995), we allow for linear deterministic time trends in vector moving-average (in level form) representation of the model, which in turn implies an unrestricted constant and no deterministic time trends in the Vector Error Correction Modeling (VECM) specification. Chao and Phillips (1999) have drawn attention to a potential problem with Johansen's method of performing sequential tests to determine the cointegration rank. Johansen's (1992) Theorem 2 shows that the probability of overestimating the rank remains positive in the limit and, therefore, the cointegration rank is not estimated consistently with the sequential procedure. Furthermore, the VECM of Johansen requires in general to choose an appropriate lag order and results can be sensitive to lag misspecification. Chao and Phillips have proposed to apply the Posterior Information Criterion (*PIC*) of Phillips and Ploberger (1996) to VECMs as an alternative to Johansen's method. This criterion allows the determination of the VECM lag order and the cointegration rank jointly and leads to consistent estimations. The empirical findings in Table 3 also illustrate the optimal lag

length obtained for each country based on the Akaike Informational Criterion (*AIC*). The findings document that in the cases of Greece, Portugal and Spain the null hypothesis of no cointegration cannot be rejected at the 5% significance level. By contrast, in the remaining cases the null hypothesis of no cointegration can be strongly rejected at the 5% significance level.

[Insert Table 3 about here]

Variance decompositions account for the share of variations resulting from the endogenous variables and the transmission to all other variables in the system, because of the dynamic nature of the VAR. Variance decompositions, also known as innovation accounting, offer a workable option for describing the dynamic relationship between variables that either share long-run relationships (Refalo, 2009) or not long-run relationships. Table 4 explains the variations of extracted shocks on original variables across certain forecasting horizons, i.e. 7, 14, 21, 28 and 35 years, when the 3-month interest rates on public debt are used. Original variables not only include dependent variable of interest (i.e. interest rate) but the complete set of all the variables. The findings of Table 4 show that in the case of the high-debt countries, the following results can be highlighted:

i) In the cases of Cyprus and Spain, the interest rates can be substantially explained by the forecasting variance of tax revenues. In both cases, supply shocks tend to drive interest rates as opposed to demand shocks.

ii) In the cases of Greece and Ireland, the interest rates can be significantly explained by the forecasting variance of government expenses. In both countries, demand shocks are the main determinants of interest rates.

iii) In the case of Italy, it is the forecasting variance of productivity that seems to highly explain interest rates. Supply and demand shocks seem to equally drive interest rates, though supply shocks lightly dominate the influence.

iv) Finally, in the case of Portugal, only the own forecasting variable seems to be the main driver for interest rates. Demand shocks are the exclusive driver of interest rates.

Table 4 also displays the forecasting variance decompositions for the low-debt countries. In particular:

i) In Australia, forecasting productivity variance is the main determinants of interest rates. Both demand and supply shock equally drive interest rates.

ii) In the case of Canada, the forecasting variance of government expenses seems to be the primary driver of interest rates, followed by total factor productivity shocks. In this country, the demand shocks highly dominate the supply shocks in driving interest rates.

iii) In Denmark, tax revenues forecasting variance seems to drive interest rates. In this case demand shocks again substantially explain interest rates.

iv) Finally, in the cases of New Zealand and Norway, supply shocks, i.e. total factor productivity, seem to be a very significant factor in explaining interest rates forecasting variance.

[Insert Table 4 about here]

Tables 5 and 6 also report variance decompositions, but this time with respect to the 5-year and 10-year yields, respectively. In particular, in terms of the 5-year yields, the findings highlight a very close picture: in terms of the high-debt countries, total factor productivity shocks seem to play an important role in the cases of Cyprus, Greece and Ireland, while in Portugal this role is

shared with that of government expenses. In Spain, it is government expenditures that continue to drive the course of those yields. In other words, the majority of high-debt countries indicate that the course of the yields on their government bonds is driven by supply factors and not by demand (i.e., government expenses or taxes) factors, indicating the inability of the competitiveness of their economy to support high deficits, which is reflected on higher yields, while supporting that the deficits themselves are not the driving force for those yields. These results are also supported in the two cases (i.e., Portugal and Spain) where demand factors play their role in driving government bond yields and therefore, we are inclined to argue that changes in fiscal performances seem to affect these yields through their effect on perceived default risk, as these high-debt countries are considered low credit worthy. In the case of low-debt countries, the picture is similar to that reported in Table 4 and shows that it is fiscal measures (i.e., government expenses and taxes) that are the primary driver of government bonds yields. Only if these countries disturb their fiscal environment, then they will experience changes in those yields. Finally, in terms of the 10-year (long-term) bonds, though the results for the high-debt countries remain close to those presented in Table 5, in the majority of the cases (except in the cases of Greece and Ireland), the explanation comes from the interest rates themselves. A similar picture emerges for the case of low-debt countries.

[Insert Tables 5-6 about here]

4.2 The role of the 2008 financial crisis

According to Reinhart and Rogoff (2011), the 2008 financial crisis contributed massively to the sovereign debt crisis experienced by a number of Eurozone countries, such as Cyprus, Greece, Ireland, Italy, Portugal and Spain (the first three underwent a very strict austerity/bailout program,

given that they were unable to finance their large government deficits and came close to default). At the same time, Bordo (2015) claims that the Eurozone sovereign debt (fiscal) crisis) was the culmination of the participating countries' significant financial interconnections which evolved along with both the strong forces of financial globalization and their ideology for backing up the necessity for public policymakers to socialize any income losses because of the financial crises occurred earlier. Therefore, this part of the empirical analysis repeats the above variance decomposition procedure by splitting the time sample over the periods prior to and after the 2008 financial crisis. The new results for the 3-month, 5-year and 10-year government bond yields are reported in Tables 7, 8 and 9, respectively.

Across all three cases, these findings highlight the presence of a different picture across the two regimes. For instance, in the case of Greece, the driving force for the 3-month interest rates prior to the crisis event was a demand factor (taxes), while over the post-crisis regime the driving force was a supply driver (total factor productivity). For both the 5- and 10-year yields, however, it was this supply factor that determined the course of both yields. Again, in the case of Ireland for 3-month yields, the supply driver over the pre-crisis period turned into a demand driver over the post-crisis regime, while for the remaining yields, supply factors remained as the dominant drivers.

Finally, for the case of the low debt countries the most characteristics findings are in relevance to the case of Canada where for 3-month and 5-year yields, it is government expenses (a demand factor) that dominates yields variance forecasting, while for the 10-year bond yields it is the self-forecasting variance that seems to dominate the results. Another characteristic example is that of Denmark where for the 5-year interest rates while no factor seemed to primarily explain variance decompositions for bond yields over the pre-crisis period, it was both supply and demand factors that substantially explain such movements over the post-crisis regime. In the case of 10-

year interest rates over both regimes, it is the self-explanatory power of those yields that was driving those decomposition changes.

Values of forecast error variance decompositions (FEVD's) of interest rates are presented with different forecasting horizons. We present these FEVD's for different maturities of yields i.e. short medium and long term. We report complete sample from 1980-2015 with the forecasting horizons of 7, 14, 21, 28 and 35 with equal slab of 7 years to measure short- to long-run variations (see Tables 4-6). As we also aim to check the pre- and post-financial crisis period, and then divide the complete period into pre- and post-crisis with the spacing of 5, 10, 15, 20, 25 pre-crisis period and 1, 2, 4, 6, 7 post crisis period to again check the short- and long-run variation in yield (see Tables 7-9).

[Insert Tables 7-9 about here]

In order to provide a comparison of the empirical findings reported in Tables 7 to 9, we first estimate the individual covariances ratios for each country, calculated as: 2Cov (residuals of country *i* with residuals of country *j*)/Variance of residuals of country *i*) and then we get the sum of those ratios. The results are reported in Table 10 and clearly document that the ratio with respect to high debt vs the low debt countries is positive, indicating that positive (negative) news coming from the proxies of interest rate determinants decrease (increase) interest rates for the case of high debt countries. Next, in terms of the low debt countries and with respect to the period before and after the crisis, the ratio turns out to be negative, indicating that news coming from these proxies decrease interest rates. In other words, low debt countries seem not to experience a severe adverse effect to interest rates from shocks originated in the real economy due to the presence of the financial crisis. By contrast, in terms of the high debt countries and with respect to the period

before and after the crisis, the ratio turns out to be positive, indicating that news coming from these proxies increase interest rates, implying that low debt countries seem to experience a severe adverse effect to interest rates from shocks originated in the real economy due to the presence of the financial crisis. The findings remain consistently similar across all interest rates maturities.

[Insert Table 10 about here]

5. Conclusion

This study examines how fiscal policy shocks can affect interest rates in a group of high and low debt countries over the period 1980-2015 using an SVAR methodology. We investigate the impact of fiscal shocks on interest rates in high and low debt countries, and the role of the 2008 financial crisis in the link between fiscal shocks and interest rates. Although the paper focused on interest rates across both short- and in the long-run, the findings concerning the long-run government interest rates are highly significant for monetary policy makers, since it is the use of these rates that really matters for monetary policy (Seyfried, 2009; Roskelley, 2016).

The empirical findings suggest that both demand and supply factors influence interest rates across their frequency spectrum. For majority of the high-debt countries, the yields on their government bonds is driven mainly by the supply side factors and not by the demand side (i.e., government expenses or taxes) factors. In the case of Portugal and Spain, demand factors play a role in driving government bond yields. Here, changes in fiscal performance appears to influence yields through their effect on perceived default risk, as these high-debt countries are considered to be low credit worthy countries. In the case of low-debt countries, fiscal factors (i.e., government

expenses and taxes) appear as the main driver of government bonds yields. The results also indicate that for interest rates of certain maturities, these factors could be different across high- and low-debt countries and across the pre- and post-crisis regimes.

Future research venues could be the extension of those results for other country groups, especially from the emerging and developing countries territories, while we could also explore the likelihood of non-linear relationships between fiscal measures, i.e. government debt, and interest rates, in a sense that as government debt continues to increase, the credibility of fiscal sustainability decreases, leading to rapid increases in interest rates. Furthermore, any future empirical attempt could account for some factors that can likely contribute to the temporary deviation of sovereign borrowing costs from their long-run equilibrium level in the aftermath of the crisis. For instance, uncertainties related to the feedback effects between banks and sovereigns and the contingent liabilities of the public sector. Finally, given that the economies of certain (mostly small) countries are affected by economic conditions in large countries, especially when they have large capital flows or trading with these countries, the future empirical analysis could also consider both domestic and international (control) macroeconomic variables to explain the course of interest rates due to fiscal changes.

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Table 1: Descriptive statistics

Statistic	Total Factor Productivity	Tax Revenues	Govt. Expenditures	Interest rates Short Term	Interest rates Medium Term	Interest rates Long Term
High Debt Country Sample						
Cyprus						
Minimum	-3.4961	23.2707	0.1205	1.7383	3.9317	3.3208
Maximum	5.8078	69.2357	0.1904	52.5600	20.3200	19.5600
Mean	1.0770	46.8694	0.1610	25.1359	11.0643	9.6453
Std. dev.	2.0278	14.7488	0.0171	19.6273	5.8543	5.2736
Skewness	-0.0385	-0.3633	-0.3127	0.1863	0.1480	0.5231
Kurtosis	0.1364	-1.0781	-0.4795	-1.6754	-1.5648	-1.1177
Greece						
Minimum	-9.4683	17.9315	0.1563	-0.0194	3.5850	3.5850
Maximum	2.6218	22.7616	0.2331	26.3200	22.4975	22.4975
Mean	-0.9054	19.9729	0.1870	12.1974	8.8931	8.7005
Std. dev.	2.5458	1.3360	0.0188	9.7379	3.8711	3.8096
Skewness	-1.0582	0.4940	0.4858	0.1163	1.1992	1.3612
Kurtosis	1.8442	-0.4484	-0.3712	-1.5584	2.4630	3.0198
Ireland						
Minimum	-4.9401	20.0571	0.1471	-0.0191	2.1201	1.1131
Maximum	5.7672	33.2772	0.2222	14.9502	17.2682	17.2682
Mean	1.3253	24.7703	0.1803	6.5653	7.8473	7.8193
Std. dev.	2.3554	4.0624	0.0214	4.9384	4.1524	4.1954
Skewness	-0.4475	1.1225	0.5145	0.3485	0.7606	0.7115
Kurtosis	0.2262	0.1632	-0.7402	-1.2812	-0.3603	-0.3552
Italy						
Minimum	-3.9535	20.3400	0.1659	-0.0194	3.5554	1.7140
Maximum	2.8683	24.2523	0.2062	19.9053	19.6500	21.5900
Mean	-0.1012	22.1027	0.1880	7.8108	9.8269	8.2696
Std. dev.	1.4725	0.9610	0.0090	6.2295	5.9671	4.5090
Skewness	-0.0753	0.3496	-0.2331	0.4251	0.4230	0.7157
Kurtosis	0.5857	-0.0460	-0.4777	-1.1195	-1.5160	0.0782
Portugal						
Minimum	-3.2878	18.7820	0.1272	-0.0194	3.1500	0.8100
Maximum	4.8877	20.9076	0.2143	19.9053	12.9500	10.5900
Mean	-0.6202	20.0766	0.1736	7.8108	7.6488	5.0792
Std. dev.	1.6693	0.6050	0.0280	6.2295	3.0962	2.7090
Skewness	0.8535	-0.6794	-0.4335	0.4251	0.0709	0.4504
Kurtosis	1.6312	-0.4969	-1.2227	-1.1195	-1.5041	-0.7728
Spain						
Minimum	-1.8196	7.1619	0.1363	-0.0194	0.0900	1.7351
Maximum	1.9342	15.8890	0.2052	20.0496	16.1200	16.9092
Mean	-0.6094	12.8197	0.1717	7.6713	6.4908	8.5327
Std. dev.	0.8361	2.7303	0.0181	6.0996	5.0942	4.7794
Skewness	1.3504	-0.5312	0.2361	0.3547	0.4722	0.3837
Kurtosis	1.9326	-0.8256	-0.6610	-1.3213	-1.0031	-1.3505
Low Debt Country Sample						
Australia						
Minimum	-1.9813	0.1711	0.1710	2.2558	2.0000	2.7108
Maximum	2.3574	24.8531	0.1890	17.6117	13.9200	15.3750
Mean	0.0182	11.1451	0.1784	8.1390	7.3364	8.3322
Std. dev.	1.2936	11.7976	0.0053	4.6320	3.7680	3.8247
Skewness	0.2316	0.1318	0.6363	0.7434	0.5018	0.4158
Kurtosis	-1.2039	-1.9577	-0.4950	-0.8675	-1.2631	-1.3021
Canada						
Minimum	-2.3650	11.4555	0.1902	0.6938	0.2455	1.5217
Maximum	1.4767	14.9425	0.2437	18.3756	18.9643	14.9892
Mean	-0.3915	13.5356	0.2124	6.0987	5.6507	6.9611
Std. dev.	1.0596	1.1083	0.0142	4.4783	4.3437	3.6703
Skewness	-0.0663	-0.6254	0.2520	0.8021	0.9301	0.4422
Kurtosis	-0.9868	-0.7681	-0.6140	-0.0519	0.6024	-0.7514

Denmark						
Minimum	-4.2656	28.6398	0.2305	-0.1242	-0.2100	0.6908
Maximum	4.7055	34.8764	0.2806	16.5650	13.6900	12.6500
Mean	-0.2623	31.4862	0.2509	6.6832	6.2723	6.7660
Std. dev.	1.8660	1.8048	0.0128	5.0843	4.6021	3.6460
Skewness	0.1760	0.0256	0.7319	0.4719	0.0641	0.1019
Kurtosis	0.5614	-0.8528	-0.7008	-1.1152	-1.4972	-1.3066
New Zealand						
Minimum	-3.7596	27.8469	0.1663	2.6567	2.3400	3.4233
Maximum	3.2911	32.0150	0.1989	23.3050	22.7400	17.6575
Mean	-0.0929	29.6473	0.1810	9.1746	9.0419	8.5519
Std. dev.	1.6645	1.4748	0.0106	5.5369	6.0699	3.8873
Skewness	-0.1055	0.2225	0.2352	0.8548	0.8117	0.7686
Kurtosis	-0.0353	-1.3214	-1.1680	-0.1548	-0.6426	-0.5922
Norway						
Minimum	-4.3803	25.7806	0.1790	1.2907	0.8100	1.5650
Maximum	3.7264	28.9390	0.2197	15.3667	22.9400	13.4800
Mean	0.3650	27.2335	0.2049	7.3702	7.5678	7.4166
Std. dev.	2.0214	0.9334	0.0120	4.5807	5.2974	3.8880
Skewness	-0.2674	0.0586	-0.5860	0.3110	0.7591	0.3189
Kurtosis	-0.7766	-0.8114	-0.8426	-1.3700	0.1988	-1.3169

***Note**:* * represents the rejection of null hypothesis of no correlation at 1 percent, ** at 5 percent and *** at 10 percent.

Table 2: Unit root tests

	Total Factor		Tax revenues				Government expenditures				Interest rates			
	Levels		Levels		1st Differences		Levels		1st Differences		Levels		1st Differences	
	D	DT	D	DT	D	DT	D	DT	D	DT	D	DT	D	DT
Cyprus	-4.916	-5.608	-0.518	-3.564	-6.793	-6.730	-2.153	-2.867	-5.285	-5.717	-1.228	-4.431	-9.316	-7.038
Greece	-4.746	-5.009	-2.101	-2.668	-5.362	-5.326	-1.176	-2.273	-5.236	-6.693	-1.561	-1.522	-3.527	-4.101
Ireland	-3.003	-4.195	-1.921	-2.796	-5.547	-5.735	-1.153	-1.230	-4.645	-5.196	-2.133	-2.681	-6.377	-7.045
Italy	-4.382	-5.439	-2.562	-2.705	-7.697	-7.636	-1.324	-2.203	-3.299	-4.538	-1.641	-1.641	-4.802	-5.004
Portugal	-4.641	-5.079	-1.998	-4.943	-5.631	-7.156	-0.572	-0.989	-4.849	-5.237	-1.420	-3.310	-8.180	-9.805
Spain	-3.860	-3.977	-1.798	-3.033	-6.725	-6.573	-0.393	-2.520	-3.814	-3.860	-2.739	-3.001	-8.588	-8.822
Australia	-1.003	-3.735	-0.603	-1.921	-5.725	-5.756	-2.705	-3.091	-4.035	-3.572	-1.438	-1.941	-0.149	-7.106
Canada	-3.316	-3.937	-1.193	-2.490	-3.894	-3.952	-2.238	-2.398	-4.223	-4.223	-2.265	-4.313	-0.056	-7.069
Denmark	-4.807	-5.251	-2.199	-2.537	-6.954	-7.030	-1.648	-2.005	-4.638	-5.179	-2.856	-3.269	-7.733	-8.703
New Z.	-4.644	-4.875	-4.396	-4.851	-6.016	-6.635	-1.386	-1.631	-4.265	-4.537	1.143	-2.721	-0.780	-1.865
Norway	-1.944	-2.945	-0.585	-0.733	-0.636	-1.191	-2.197	-2.759	-4.942	-5.164	-3.516	-3.958	-7.750	-7.898

Note: DF-GLS test statistics for null hypothesis of unit root process at levels and first differences are reported. D and DT represent unit root tests without and with trend, respectively. Critical values at the 1, 5 and 10 percent significance levels with constant and without time trend are -2.635, -1.915 and -1.611, respectively. Critical values at 1, 5 and 10 percent with constant and a linear time trend are -4.963, -3.770 and -3.190, respectively. Total factor productivity is by definition stationary in levels. Therefore, there is no need for first differences.

Table 3: Johansen cointegration tests

		Rank							
Lags		0		1		2		3	
		Eigen values	Trace Statistics	Eigen values	Trace Statistics	Eigen values	Trace Statistics	Eigen values	Trace Statistics
High debt countries									
Cyprus	1	0.522*	53.005*	0.422*	27.938*	0.230	9.276	0.012	0.417
Greece	1	0.533*	45.929*	0.284	20.071	0.166	8.720	0.072	2.534
Ireland	2	0.628*	65.382*	0.462*	31.799*	0.200	10.709	0.088*	3.144*
Italy	2	0.567*	50.921*	0.345	21.740	0.127	7.392	0.079*	2.805*
Portugal	1	0.500*	45.687*	0.339	22.109	0.174	8.031	0.044	1.523
Spain	1	0.445	43.842	0.307	23.811	0.248	11.346	0.047	1.644
Low debt countries									
Australia	3	0.509*	56.885*	0.434*	32.686*	0.308	13.314	0.024	0.812
Canada	2	0.617*	57.831*	0.416	25.221	0.172	6.927	0.015	0.517
Denmark	2	0.465*	55.493*	0.422*	34.213*	0.273*	15.596*	0.131*	4.755*
New Zealand	1	0.697*	80.543*	0.459*	39.999*	0.343*	19.143*	0.133*	4.866*
Norway	1	0.495*	58.607*	0.452*	35.378*	0.253*	14.912*	0.137*	5.017*

Note: Critical values for the trace test statistics at the 95 percent for rank 0, 1, 2, and 3 are 47.856, 29.797, 15.495 and 3.841 respectively. Lags report the number of lags included in the VAR specification chosen according to the AIC criterion.

Table 4: Variance decompositions: 3-month interest rates

Country	Forecasting Horizon	Individual shocks			
		Total Factor	Tax	Government	Interest rates
Cyprus	7	0.0000	0.0000	0.0000	100.0000
	14	3.0612	10.5230	2.3176	84.0983
	21	2.1988	9.4429	3.6364	84.7219
	28	1.7830	8.4005	5.8534	83.9633
	35	1.6558	7.8853	6.3289	84.1300
Greece	7	0.0000	0.0000	0.0000	100.0000
	14	12.2304	6.8206	1.0856	79.8634
	21	11.9068	15.7780	6.2149	66.1003
	28	15.3961	20.1068	8.9394	55.5578
	35	17.6733	20.0250	11.1015	51.2002
Ireland	7	0.0000	0.0000	0.0000	100.0000
	14	0.9629	4.2131	3.8015	91.0226
	21	4.6897	5.6546	4.1745	85.4815
	28	7.2793	8.3550	3.6141	80.7519
	35	9.8958	10.0587	3.7780	76.2675
Italy	7	0.0000	0.0000	0.0000	100.0000
	14	2.2484	1.3162	6.7551	89.6804
	21	2.7898	12.0846	10.9599	74.1658
	28	2.7115	15.9273	11.6028	69.7585
	35	3.4102	16.3714	14.6748	65.5438
Portugal	7	0.0000	0.0000	0.0000	100.0000
	14	2.3070	0.4108	0.2002	97.0822
	21	5.2026	3.8057	4.9884	86.0034
	28	6.1372	6.7088	7.4462	79.7080
	35	5.5493	8.8706	9.1749	76.4054
Spain	7	0.0000	0.0000	0.0000	100.0000
	14	5.2499	1.0172	6.4464	87.2867
	21	4.7126	1.5068	9.3245	84.4562
	28	3.6003	1.4031	10.2772	84.7196
	35	3.3372	1.6259	9.0577	85.9792
Australia	7	0.0000	0.0000	0.0000	100.0000
	14	5.9751	0.0167	2.4645	91.5438
	21	5.8444	0.4456	2.0586	91.6516
	28	4.7926	0.7407	2.5271	91.9398
	35	4.5078	1.7210	8.7509	85.0204
Canada	7	0.0000	0.0000	0.0000	100.0000
	14	1.3263	4.5380	11.4413	82.6944
	21	3.7885	6.3641	22.6600	67.1877
	28	4.1932	5.6607	25.3064	64.8398
	35	4.2545	5.6441	26.4117	63.6899
Denmark	7	0.0000	0.0000	0.0000	100.0000
	14	1.8278	0.4289	3.8782	93.8653
	21	2.2778	3.7538	3.4034	90.5652
	28	2.6349	5.3313	3.3884	88.6454
	35	3.0650	7.7632	4.1963	84.9758

New Zealand	7	0.0000	0.0000	0.0000	100.0000
	14	0.1946	2.4225	1.8734	95.5097
	21	2.8739	2.1979	2.1153	92.8131
	28	5.2136	2.2718	2.1143	90.4005
	35	5.1526	2.4012	2.2883	90.1581
Norway	7	0.0000	0.0000	0.0000	100.0000
	14	0.0624	0.0866	0.4810	99.3701
	21	0.8590	0.1317	0.6275	98.3820
	28	1.0024	0.1512	0.8627	97.9839
	35	0.9578	0.1956	1.0818	97.7651

Notes: Percentage contribution of each structural shock in explaining the historical variance of the interest rate. Second column indicates interest rate variable whereas last column represents subsequent interest rate shock

Table 5: Variance decompositions: 5-year interest rates

Country	Forecasting Horizon	Individual shocks			
		Total Factor	Tax	Government	Interest rates
Cyprus	7	0.0000	0.0000	0.0000	100.0000
	14	7.6380	0.9229	4.8515	86.5878
	21	13.5740	4.4194	3.6324	78.3744
	28	19.0327	4.3849	3.0500	73.5326
	35	21.8905	4.1069	2.8658	71.1371
Greece	7	0.0000	0.0000	0.0000	100.0000
	14	19.1003	0.9385	1.9442	78.0172
	21	29.7314	3.6668	3.5376	63.0642
	28	28.4391	5.5300	7.4507	58.5804
	35	28.9952	5.7143	8.2400	57.0505
Ireland	7	0.0000	0.0000	0.0000	100.0000
	14	3.7448	0.2141	0.8711	95.1700
	21	5.5439	0.7218	0.6705	93.0640
	28	6.0137	0.7650	1.0602	92.1614
	35	6.4566	0.9065	0.9107	91.7264
Italy	7	0.0000	0.0000	0.0000	100.0000
	14	0.5115	11.6882	5.6775	82.1227
	21	2.3117	11.4300	5.8510	80.4075
	28	3.5106	11.1289	6.9357	78.4250
	35	4.1754	10.9548	7.0137	77.8563
Portugal	7	0.0000	0.0000	0.0000	100.0000
	14	3.5949	0.4725	1.4857	94.4470
	21	9.6961	1.1616	7.2669	81.8755
	28	11.9480	1.2709	11.8608	74.9205
	35	11.7064	1.2181	14.2964	72.7792
Spain	7	0.0000	0.0000	0.0000	100.0000
	14	5.5222	0.3039	1.9619	92.2121
	21	4.6919	1.8386	9.2835	84.1862
	28	6.2519	5.7942	15.3642	72.5898
	35	5.4656	5.6257	19.6762	69.2327
Australia	7	0.0000	0.0000	0.0000	100.0000
	14	0.4388	1.7088	1.3970	96.4554
	21	7.7810	2.4689	5.1626	84.5877
	28	9.5495	2.2769	7.9634	80.2104
	35	8.9464	4.6772	13.1948	73.1818
Canada	7	0.0000	0.0000	0.0000	100.0000
	14	0.0777	5.8366	15.7137	78.3720
	21	0.2243	4.1008	20.4626	75.2124
	28	0.1964	3.3635	21.2442	75.1959
	35	0.1837	3.5770	20.6594	75.5798
Denmark	7	0.0000	0.0000	0.0000	100.0000
	14	3.3296	8.9490	8.4364	79.2851
	21	10.7888	13.7169	6.1829	69.3114
	28	18.5057	13.1896	5.8439	62.4609
	35	20.5024	14.4343	5.8473	59.2161

New Zealand	7	0.0000	0.0000	0.0000	100.0000
	14	4.5884	4.0772	5.4272	85.9072
	21	6.9531	7.7785	5.7415	79.5271
	28	7.0159	7.9265	6.7953	78.2625
	35	7.0099	8.0349	6.9805	77.9748
Norway	7	0.0000	0.0000	0.0000	100.0000
	14	0.1191	0.1579	0.0312	99.6918
	21	0.2832	0.3047	0.0594	99.3528
	28	0.3140	0.2845	0.1432	99.2583
	35	0.3448	0.2968	0.1378	99.2205

Notes: Percentage contribution of each structural shock in explaining the historical variance of the interest rate. Second column indicates interest rate variable whereas last column represents subsequent interest rate shock

Table 6: Variance decompositions: 10-year interest rates

Country	Forecasting Horizon	Individual shocks			
		Total Factor	Tax	Government	Interest rates
Cyprus	7	0.0000	0.0000	0.0000	100.0000
	14	2.0039	2.7759	2.1937	93.0266
	21	1.5468	2.6434	1.7510	94.0589
	28	1.7551	2.5037	1.3671	94.3743
	35	1.4840	2.2225	1.4003	94.8934
Greece	7	0.0000	0.0000	0.0000	100.0000
	14	14.0787	0.5444	1.9198	83.4572
	21	26.1043	1.5821	4.4337	67.8801
	28	29.9623	2.7601	7.8124	59.4654
	35	32.6520	2.8285	8.2855	56.2342
Ireland	7	0.0000	0.0000	0.0000	100.0000
	14	3.4234	1.2950	3.3577	91.9239
	21	7.4135	3.3173	2.5307	86.7387
	28	11.4636	2.9935	2.8731	82.6699
	35	14.3961	3.0619	2.5931	79.9490
Italy	7	0.0000	0.0000	0.0000	100.0000
	14	1.0162	2.4539	0.3564	96.1736
	21	2.8094	5.0637	4.0591	88.0679
	28	3.6453	5.7909	6.5337	84.0303
	35	4.6157	7.1155	9.2864	78.9826
Portugal	7	0.0000	0.0000	0.0000	100.0000
	14	1.9155	0.9627	0.7836	96.3383
	21	1.9996	0.7455	1.3733	95.8817
	28	1.5835	0.5872	3.6094	94.2199
	35	1.2522	1.0143	5.7312	92.0024
Spain	7	0.0000	0.0000	0.0000	100.0000
	14	0.2149	5.1404	2.3203	92.3245
	21	5.0099	9.0339	1.6656	84.2907
	28	6.1484	8.8626	1.3774	83.6117
	35	6.6365	10.0337	1.4556	81.8744
Australia	7	0.0000	0.0000	0.0000	100.0000
	14	0.1569	0.5944	0.1734	99.0755
	21	0.5815	0.5507	0.2256	98.6423
	28	0.5500	0.6411	0.2553	98.5537
	35	0.6524	0.9598	1.1747	97.2134
Canada	7	0.0000	0.0000	0.0000	100.0000
	14	1.6315	2.9788	1.4436	93.9463
	21	1.3039	5.1266	1.2896	92.2799
	28	1.2791	5.1824	1.2372	92.3014
	35	1.1371	4.9952	2.0383	91.8296
Denmark	7	0.0000	0.0000	0.0000	100.0000
	14	3.4828	7.4972	2.5501	86.4700
	21	3.6523	6.6954	3.1172	86.5351
	28	3.1204	6.2688	3.5033	87.1076
	35	2.7718	5.5970	4.2620	87.3694

New Zealand	7	0.0000	0.0000	0.0000	100.0000
	14	0.1906	1.7402	1.2323	96.8370
	21	3.2130	5.1373	0.9297	90.7201
	28	5.1330	6.6731	1.0990	87.0950
	35	4.9159	7.4392	1.0352	86.6098
Norway	7	0.0000	0.0000	0.0000	100.0000
	14	0.2274	5.7287	1.7219	92.3221
	21	5.5642	4.8956	1.2852	88.2551
	28	5.5529	5.3130	1.9060	87.2282
	35	4.6498	6.0409	2.3070	87.0026

Notes: Percentage contribution of each structural shock in explaining the historical variance of the interest rate. Second column indicates interest rate variable whereas last column represents subsequent interest rate shock

Table 7: Variance decompositions before and after the financial crisis: 3-month interest rates

Country	Forecasting Horizon	Individual shocks			
		Total Factor	Tax revenues	Government	Interest rates
High debt countries					
Cyprus					
Before financial crisis	7	0.0000	0.0000	0.0000	100.0000
	14	5.0071	9.9107	0.4060	84.6762
	21	3.4923	7.7673	3.2652	85.4752
	28	2.5120	6.4627	6.9262	84.0991
	35	2.0146	5.6488	8.0100	84.3265
After financial crisis	7	0.0000	0.0000	0.0000	100.0000
	14	1.1152	11.1353	4.2292	83.5203
	21	0.9053	11.1185	4.0076	83.9686
	28	1.0540	10.3382	4.7805	83.8273
	35	1.2969	10.1218	4.6478	83.9335
Greece					
Before financial crisis	7	0.0000	0.0000	0.0000	100.0000
	14	0.8306	9.3932	0.8650	88.9111
	21	5.0660	13.5292	0.4605	80.9443
	28	11.1129	15.1004	0.3418	73.4449
	35	14.8749	13.9433	0.3174	70.8643
After financial crisis	7	0.0000	0.0000	0.0000	100.0000
	14	23.6302	4.2480	1.3061	70.8156
	21	18.7476	18.0268	11.9693	51.2563
	28	19.6793	25.1132	17.5370	37.6706
	35	20.4716	26.1067	21.8856	31.5360
Ireland					
Before financial crisis	7	0.0000	0.0000	0.0000	100.0000
	14	1.8965	4.6643	7.2339	86.2053
	21	6.6069	6.5353	6.4228	80.4351
	28	10.7451	9.7920	5.1819	74.2810
	35	15.3246	12.4681	5.3439	66.8633
After financial crisis	7	0.0000	0.0000	0.0000	100.0000
	14	0.0292	3.7619	0.3690	95.8399
	21	2.7724	4.7738	1.9261	90.5277
	28	3.8134	6.9179	2.0462	87.2227
	35	4.4669	7.6493	2.2121	85.6717
Italy					0.0000
Before financial crisis	7	0.0000	0.0000	0.0000	100.0000
	14	1.0810	2.1010	11.7861	85.0319
	21	0.7397	15.4784	17.2393	66.5427
	28	1.4017	20.3377	17.4600	60.8007
	35	3.5081	20.3566	22.0757	54.0596
After financial crisis	7	0.0000	0.0000	0.0000	100.0000
	14	3.4157	0.5314	1.7241	94.3288
	21	4.8399	8.6908	4.6805	81.7888
	28	4.0213	11.5169	5.7455	78.7163
	35	3.3122	12.3861	7.2738	77.0280

Portugal					
Before financial crisis	7	0.0000	0.0000	0.0000	100.0000
	14	3.6750	0.4904	0.0633	95.7712
	21	3.3898	6.0392	8.6839	81.8872
	28	3.5685	11.9913	13.0834	71.3568
	35	2.6652	15.6044	16.7949	64.9355
After financial crisis	7	0.0000	0.0000	0.0000	100.0000
	14	0.9389	0.3311	0.3370	98.3930
	21	7.0154	1.5722	1.2928	90.1195
	28	8.7059	1.4262	1.8089	88.0591
	35	8.4333	2.1368	1.5548	87.8752
Spain					
Before financial crisis	7	0.0000	0.0000	0.0000	100.0000
	14	4.0116	0.0012	5.3732	90.6140
	21	4.5872	1.7238	7.4344	86.2546
	28	3.2632	1.2086	7.5347	87.9935
	35	3.4048	1.9052	6.1612	88.5288
After financial crisis	7	0.0000	0.0000	0.0000	100.0000
	14	6.4881	2.0331	7.5196	83.9593
	21	4.8379	1.2898	11.2146	82.6578
	28	3.9373	1.5975	13.0196	81.4456
	35	3.2696	1.3466	11.9542	83.4296
Low debt countries					
Australia					
Before financial crisis	7	0.0000	0.0000	0.0000	100.0000
	14	9.4174	0.0031	0.2236	90.3560
	21	8.5392	0.1858	0.2984	90.9766
	28	6.9205	0.3851	1.2978	91.3967
	35	6.7219	2.4904	9.5070	81.2806
After financial crisis	7	0.0000	0.0000	0.0000	100.0000
	14	2.5328	0.0303	4.7054	92.7315
	21	3.1495	0.7053	3.8188	92.3264
	28	2.6647	1.0962	3.7564	92.4828
	35	2.2937	0.9516	7.9947	88.7600
Canada					
Before financial crisis	7	0.0000	0.0000	0.0000	100.0000
	14	0.0493	2.4521	13.3862	84.1123
	21	5.2523	3.4639	25.7991	65.4848
	28	5.4533	2.8712	29.1224	62.5532
	35	4.7832	2.5179	32.0576	60.6413
After financial crisis	7	0.0000	0.0000	0.0000	100.0000
	14	2.6033	6.6238	9.4964	81.2765
	21	2.3246	9.2642	19.5208	68.8905
	28	2.9330	8.4502	21.4904	67.1263
	35	3.7257	8.7703	20.7658	66.7383
Denmark					
Before financial crisis	7	0.0000	0.0000	0.0000	100.0000
	14	0.9038	0.8087	4.6478	93.6398

	21	2.4304	2.4473	3.9049	91.2174
	28	2.4612	3.0872	3.7932	90.6584
	35	2.2051	7.7856	4.8159	85.1935
After financial crisis	7	0.0000	0.0000	0.0000	100.0000
	14	2.7518	0.0490	3.1086	94.0907
	21	2.1252	5.0602	2.9018	89.9129
	28	2.8086	7.5754	2.9836	86.6323
	35	3.9248	7.7407	3.5766	84.7579
New Zealand					
Before financial crisis	7	0.0000	0.0000	0.0000	100.0000
	14	0.2356	1.3025	0.3067	98.1553
	21	1.3046	1.7616	0.2259	96.7080
	28	1.4587	2.2602	0.6147	95.6664
	35	1.3371	2.8230	0.5378	95.3021
After financial crisis	7	0.0000	0.0000	0.0000	100.0000
	14	0.1536	3.5424	3.4400	92.8639
	21	4.4431	2.6342	4.0046	88.9181
	28	8.9684	2.2833	3.6139	85.1345
	35	8.9680	1.9793	4.0388	85.0140
Norway					
Before financial crisis	7	0.0000	0.0000	0.0000	100.0000
	14	0.0923	0.0862	0.5588	99.2627
	21	1.6931	0.0867	0.8689	97.3513
	28	1.9758	0.1125	1.4266	96.4851
	35	1.7072	0.1118	1.6668	96.5142
After financial crisis	7	0.0000	0.0000	0.0000	100.0000
	14	0.0324	0.0869	0.4031	99.4775
	21	0.0248	0.1767	0.3860	99.4126
	28	0.0289	0.1898	0.2987	99.4826
	35	0.2083	0.2793	0.4967	99.0158

Notes: Percentage contribution of each structural shock in explaining the historical variance of the interest rate. Second column indicates interest rate variable whereas last column represents subsequent interest rate shock

Table 8: Variance decompositions before and after the financial crisis: 5-year interest rates

Country	Forecasting Horizon	Individual shocks			
		Total Factor	Tax revenues	Government	Interest rates
High debt countries					
Cyprus					
Before financial crisis	7	0.0000	0.0000	0.0000	100.0000
	14	15.0724	0.7371	7.1193	77.0712
	21	27.0260	0.7703	4.8323	67.3714
	28	37.7689	0.5610	3.5884	58.0818
	35	43.6231	0.4698	3.0158	52.8913
After financial crisis	7	0.0000	0.0000	0.0000	100.0000
	14	0.2035	1.1086	2.5837	96.1042
	21	0.1219	8.0684	2.4325	89.3773
	28	0.2964	8.2088	2.5115	88.9833
	35	0.1578	7.7439	2.7157	89.3827
Greece					
Before financial crisis	7	0.0000	0.0000	0.0000	100.0000
	14	11.6042	0.5776	1.2204	86.5979
	21	20.2534	4.0358	2.1580	73.5527
	28	21.1741	6.6376	2.4818	69.7065
	35	22.5389	6.8392	2.7353	67.8865
After financial crisis	7	0.0000	0.0000	0.0000	100.0000
	14	26.5964	1.2994	2.6679	69.4363
	21	39.2094	3.2978	4.9172	52.5756
	28	35.7040	4.4223	12.4195	47.4543
	35	35.4515	4.5894	13.7447	46.2144
Ireland					
Before financial crisis	7	0.0000	0.0000	0.0000	100.0000
	14	0.1491	0.0006	1.6632	98.1871
	21	2.2327	0.8122	1.2190	95.7362
	28	3.9361	0.8271	1.7203	93.5166
	35	5.0737	1.1224	1.4453	92.3586
After financial crisis	7	0.0000	0.0000	0.0000	100.0000
	14	7.3404	0.4276	0.0790	92.1529
	21	8.8550	0.6314	0.1220	90.3917
	28	8.0913	0.7028	0.4000	90.8060
	35	7.8394	0.6906	0.3760	91.0940
Italy					
Before financial crisis	7	0.0000	0.0000	0.0000	100.0000
	14	0.2119	1.1016	1.5616	97.1248
	21	3.0435	1.1235	2.5372	93.2958
	28	5.3116	0.8877	3.2126	90.5881
	35	6.6716	0.8012	3.5439	88.9834
After financial crisis	7	0.0000	0.0000	0.0000	100.0000
	14	0.8111	22.2748	9.7934	67.1206
	21	1.5798	21.7364	9.1648	67.5191
	28	1.7096	21.3701	10.6587	66.2617
	35	1.6791	21.1084	10.4834	66.7291

Portugal					
Before financial crisis	7	0.0000	0.0000	0.0000	100.0000
	14	3.6809	0.9411	2.1173	93.2607
	21	3.0405	1.8286	11.6088	83.5222
	28	2.4584	1.8946	20.5797	75.0674
	35	2.2316	1.8067	25.5704	70.3912
After financial crisis	7	0.0000	0.0000	0.0000	100.0000
	14	3.5089	0.0038	0.8541	95.6332
	21	16.3517	0.4946	2.9249	80.2288
	28	21.4376	0.6471	3.1418	74.7735
	35	21.1812	0.6294	3.0223	75.1671
Spain					
Before financial crisis	7	0.0000	0.0000	0.0000	100.0000
	14	7.4333	0.5764	0.9258	91.0645
	21	4.6092	0.4075	4.7285	90.2549
	28	4.8253	0.7042	7.2242	87.2462
	35	4.0889	1.1880	10.1418	84.5813
After financial crisis	7	0.0000	0.0000	0.0000	100.0000
	14	3.6111	0.0314	2.9979	93.3596
	21	4.7746	3.2696	13.8385	78.1174
	28	7.6785	10.8841	23.5041	57.9333
	35	6.8422	10.0634	29.2105	53.8840
Low debt countries					
Australia					
Before financial crisis	7	0.0000	0.0000	0.0000	100.0000
	14	0.8105	2.7177	2.3050	94.1667
	21	0.9188	2.0378	6.2829	90.7605
	28	0.9300	1.7695	9.8629	87.4377
	35	1.0367	1.6918	13.3559	83.9157
After financial crisis	7	0.0000	0.0000	0.0000	100.0000
	14	0.0671	0.6999	0.4890	98.7441
	21	14.6431	2.9000	4.0422	78.4148
	28	18.1690	2.7842	6.0638	72.9831
	35	16.8560	7.6626	13.0336	62.4478
Canada					
Before financial crisis	7	0.0000	0.0000	0.0000	100.0000
	14	0.0777	5.8366	15.7137	78.3720
	21	0.2243	4.1008	20.4626	75.2124
	28	0.1964	3.3635	21.2442	75.1959
	35	0.1837	3.5770	20.6594	75.5798
After financial crisis	7	0.0000	0.0000	0.0000	100.0000
	14	0.0777	5.8366	15.7137	78.3720
	21	0.2243	4.1008	20.4626	75.2124
	28	0.1964	3.3635	21.2442	75.1959
	35	0.1837	3.5770	20.6594	75.5798
Denmark					
Before financial crisis	7	0.0000	0.0000	0.0000	100.0000
	14	0.7712	0.1155	0.1265	98.9869

	21	1.3136	0.0987	0.4903	98.0973
	28	1.4626	0.0928	0.8992	97.5453
	35	1.6293	0.2194	1.1663	96.9850
After financial crisis	7	0.0000	0.0000	0.0000	100.0000
	14	5.8880	17.7825	16.7463	59.5832
	21	20.2640	27.3351	11.8754	40.5255
	28	35.5487	26.2864	10.7885	27.3764
	35	39.3755	28.6491	10.5283	21.4471
New Zealand					
Before financial crisis	7	0.0000	0.0000	0.0000	100.0000
	14	3.8810	5.3776	10.0617	80.6796
	21	6.4431	6.4593	10.7178	76.3799
	28	6.6458	5.4351	12.9003	75.0189
	35	6.8100	4.7452	13.3042	75.1406
After financial crisis	7	0.0000	0.0000	0.0000	100.0000
	14	5.2958	2.7767	0.7927	91.1348
	21	7.4630	9.0976	0.7651	82.6742
	28	7.3859	10.4178	0.6902	81.5060
	35	7.2098	11.3245	0.6567	80.8090
Norway					
Before financial crisis	7	0.0000	0.0000	0.0000	100.0000
	14	0.1191	0.1579	0.0312	99.6918
	21	0.2832	0.3047	0.0594	99.3528
	28	0.3140	0.2845	0.1432	99.2583
	35	0.3448	0.2968	0.1378	99.2205
After financial crisis	7	0.0000	0.0000	0.0000	100.0000
	14	0.1191	0.1579	0.0312	99.6918
	21	0.2832	0.3047	0.0594	99.3528
	28	0.3140	0.2845	0.1432	99.2583
	35	0.3448	0.2968	0.1378	99.2205

Notes: Percentage contribution of each structural shock in explaining the historical variance of the interest rate. Second column indicates interest rate variable whereas last column represents subsequent interest rate shock

Table 9: Variance decompositions before and after the financial crisis: 10-year interest rates

Country	Forecasting Horizon	Individual shocks			
		Total Factor	Tax revenues	Government	Interest rates
High debt countries					
Cyprus					
Before financial crisis	7	0.0000	0.0000	0.0000	100.0000
	14	0.5275	0.0067	0.6538	98.8120
	21	0.5628	1.2541	0.5233	97.6598
	28	0.9465	1.3233	0.4285	97.3017
	35	0.8471	1.3875	0.3815	97.3839
After financial crisis	7	0.0000	0.0000	0.0000	100.0000
	14	3.4803	5.5451	3.7336	87.2410
	21	2.5307	4.0326	2.9787	90.4579
	28	2.5637	3.6840	2.3056	91.4467
	35	2.1208	3.0575	2.4190	92.4028
Greece					
Before financial crisis	7	0.0000	0.0000	0.0000	100.0000
	14	1.0807	0.0041	1.1302	97.7850
	21	12.4451	0.1300	3.9316	83.4934
	28	23.4102	1.4723	3.3890	71.7286
	35	28.9840	1.4204	2.9334	66.6623
After financial crisis	7	0.0000	0.0000	0.0000	100.0000
	14	27.0766	1.0847	2.7094	69.1293
	21	39.7634	3.0342	4.9357	52.2667
	28	36.5143	4.0479	12.2357	47.2021
	35	36.3199	4.2365	13.6376	45.8060
Ireland					
Before financial crisis	7	0.0000	0.0000	0.0000	100.0000
	14	6.8468	2.5848	4.5503	86.0181
	21	12.5789	5.4686	3.5414	78.4111
	28	18.8148	4.7233	3.8556	72.6063
	35	23.4004	4.4643	3.6284	68.5069
After financial crisis	7	0.0000	0.0000	0.0000	100.0000
	14	0.0000	0.0052	2.1651	97.8297
	21	2.2481	1.1659	1.5199	95.0661
	28	4.1124	1.2636	1.8906	92.7334
	35	5.3918	1.6594	1.5578	91.3911
Italy					
Before financial crisis	7	0.0000	0.0000	0.0000	100.0000
	14	0.8943	4.8960	0.6491	93.5605
	21	3.0612	10.0026	7.9733	78.9629
	28	4.0995	11.4236	12.9302	71.5467
	35	7.1105	11.1735	16.1538	65.5623
After financial crisis	7	0.0000	0.0000	0.0000	100.0000
	14	1.1380	0.0118	0.0636	98.7867
	21	2.5576	0.1248	0.1448	97.1728
	28	3.1910	0.1582	0.1371	96.5137
	35	2.1208	3.0575	2.4190	92.4028

Portugal					
Before financial crisis	7	0.0000	0.0000	0.0000	100.0000
	14	3.7544	0.3333	0.8974	95.0149
	21	2.8294	0.3277	0.7571	96.0858
	28	1.9430	0.2286	4.2109	93.6174
	35	1.2840	1.1976	7.0611	90.4573
After financial crisis	7	0.0000	0.0000	0.0000	100.0000
	14	0.0766	1.5920	0.6697	97.6617
	21	1.1698	1.1632	1.9895	95.6774
	28	1.2239	0.9458	3.0079	94.8223
	35	1.2203	0.8310	4.4012	93.5474
Spain					
Before financial crisis	7	0.0000	0.0000	0.0000	100.0000
	14	0.2046	8.0802	3.8734	87.8418
	21	8.0632	13.6302	2.5291	75.7775
	28	8.9257	13.5694	1.9809	75.5240
	35	9.5223	14.8085	1.6456	74.0237
After financial crisis	7	0.0000	0.0000	0.0000	100.0000
	14	0.2252	2.2006	0.7671	96.8071
	21	1.9566	4.4376	0.8021	92.8038
	28	3.3711	4.1558	0.7739	91.6992
	35	3.7506	5.2588	1.2655	89.7250
Low debt countries					
Australia					
Before financial crisis	7	0.0000	0.0000	0.0000	100.0000
	14	0.2585	0.4506	0.0284	99.2625
	21	1.0153	0.4033	0.1298	98.4515
	28	0.9444	0.4928	0.2477	98.3151
	35	1.1509	0.7353	1.6704	96.4435
After financial crisis	7	0.0000	0.0000	0.0000	100.0000
	14	0.0552	0.7381	0.3183	98.8884
	21	0.1477	0.6981	0.3214	98.8329
	28	0.1556	0.7894	0.2628	98.7922
	35	0.1538	1.1843	0.6789	97.9831
Canada					
Before financial crisis	7	0.0000	0.0000	0.0000	100.0000
	14	1.6727	4.6928	1.0369	92.5976
	21	1.3217	9.0297	1.1182	88.5304
	28	1.1417	9.3914	1.0653	88.4016
	35	1.0221	9.1057	0.9731	88.8991
After financial crisis	7	0.0000	0.0000	0.0000	100.0000
	14	1.5903	1.2647	1.8502	95.2948
	21	1.2861	1.2235	1.4609	96.0294
	28	1.4165	0.9734	1.4091	96.2011
	35	1.2521	0.8846	3.1034	94.7599
Denmark					
Before financial crisis	7	0.0000	0.0000	0.0000	100.0000
	14	4.1710	14.4116	5.0478	76.3696

	21	4.5828	12.8570	6.1783	76.3819
	28	4.0962	11.9689	6.9317	77.0032
	35	3.7252	10.7195	8.3953	77.1601
After financial crisis	7	0.0000	0.0000	0.0000	100.0000
	14	2.7946	0.5828	0.0523	96.5703
	21	2.7218	0.5338	0.0561	96.6883
	28	2.1446	0.5687	0.0749	97.2118
	35	1.8183	0.4744	0.1286	97.5787
New Zealand					
Before financial crisis	7	0.0000	0.0000	0.0000	100.0000
	14	0.3800	2.2067	0.0842	97.3291
	21	2.6193	4.9456	0.2682	92.1669
	28	3.2844	6.7278	0.9271	89.0607
	35	2.9047	8.1798	0.8928	88.0227
After financial crisis	7	0.0000	0.0000	0.0000	100.0000
	14	0.0012	1.2736	2.3804	96.3449
	21	3.8067	5.3290	1.5911	89.2732
	28	6.9816	6.6183	1.2709	85.1292
	35	6.9270	6.6985	1.1776	85.1969
Norway					
Before financial crisis	7	0.0000	0.0000	0.0000	100.0000
	14	0.4541	8.2083	1.8455	89.4921
	21	6.5984	7.8197	1.0727	84.5092
	28	6.9614	8.2187	1.5961	83.2239
	35	5.8471	10.0566	2.7254	81.3710
After financial crisis	7	0.0000	0.0000	0.0000	100.0000
	14	0.0006	3.2491	1.5982	95.1520
	21	4.5300	1.9715	1.4977	92.0008
	28	4.1444	2.4073	2.2159	91.2324
	35	3.4524	2.0251	1.8885	92.6341

Notes: Percentage contribution of each structural shock in explaining the historical variance of the interest rate. Second column indicates interest rate variable whereas last column represents subsequent interest rate shock

Table 10: Variance decompositions - A comparison through covariance metrics

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Panel 1: 3-month interest rates

High debt vs low debt countries: ΣCov(high debt)/ΣCov(low debt) = 13.894

Before and after the financial crisis and low debt countries:

ΣCov(before the crisis)/ΣCov(after the crisis) = -10.426

Before and after the financial crisis and high debt countries:

ΣCov(before the crisis)/ΣCov(after the crisis) = 17.731

Panel 2: 5-year interest rates

High debt vs low debt countries: ΣCov(high debt)/ΣCov(low debt) = 18.509

Before and after the financial crisis and low debt countries:

ΣCov(before the crisis)/ΣCov(after the crisis) = -13.614

Before and after the financial crisis and high debt countries:

ΣCov(before the crisis)/ΣCov(after the crisis) = 19.246

Panel 3: 10-year interest rates

High debt vs low debt countries: ΣCov(high debt)/ΣCov(low debt) = 22.935

Before and after the financial crisis and low debt countries:

ΣCov(before the crisis)/ΣCov(after the crisis) = -16.338

Before and after the financial crisis and high debt countries:

$\sum$Cov(before the crisis)/$\sum$Cov(after the crisis) = 24.705

Notes: The numbers denote the sum of covariance terms, where each term is normalized by the variance of interest rates innovation.