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DOMESTIC AND CROSS-BORDER FISCAL MULTIPLIERS: EVIDENCE FROM EUROPE

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In this paper a two-country static model is developed in order to analyze short-run fiscal multipliers and fiscal spillovers in a monetary union. Both countries are large open economies representing core and periphery countries in the Euro zone. This paper implements a structural VECM framework recognizing short-run and long-run cross-economy relationships in order to empirically investigate the signs and magnitudes of the multipliers. Empirical analysis covers the period of 1979–2011 quarterly. The results demonstrate that domestic fiscal multipliers are positive but small suggesting that private consumption and investments might be crowded out. In addition, the domestic tax shocks have less impact on the output than the government spending shock. Effect on inflation is more significant. Cross border multipliers are also positive. Moreover, a spending spillover effect is larger than the spillover effect from a tax shock.

Keywords: Large Open Economy Model, Fiscal shocks, fiscal spillovers, structural Vector Error Correction Model, Euro Area.

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Foreword

This work constitutes the Master Thesis for the Department of Economic of the Erasmus University Rotterdam and Master Thesis for the Department of Economics of National Research University Higher School of Economics. The final report has been written for the Master program Economics of Markets, Organizations and Policy as part of the double degree program with the National Research University – Higher School of Economics. I want to thank Dr. Bas Jacobs for his support, assistance and patience during the months of the thesis research.

The last year living abroad has been an extraordinary experience in multiple ways. Rotterdam has been extremely kind and the Erasmus University an ideal scenario to learn not only from the curricula but also by meeting people with such different cultural backgrounds. I also would like to thank my supervisor in Russia, Sergey Pekarski, for giving me an opportunity to do a double degree program. My special thanks go to Atie and Wout Siddre who supported and helped me during my Master time in the Netherlands.

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Contents

1 Introduction

Many countries all around the world have suffered from the global financial crisis. As a result the governments and central banks introduced measures to deal with the liquidity problems in financial market. One of the chosen remedies was a fiscal stimulus package. Moreover, many countries agreed to act together to synchronize the implementation of these packages. They believed that such coordinated effort would benefit more than if the packages were introduced separately. One of the questions to the policy makers was whether the provisions of the packages should be via tax cuts or spending increases.

However, the actions resulted in high rates of debt to GDP and deficit to GDP ratios in most of the countries. As a result, the next question that policy makers faced was how to stop the accumulation of debt and deficit growth. In order to do this some countries, mainly in Europe, have chosen to withdraw the fiscal stimulus packages (fiscal austerity or consolidation). Not only heavily indebted counties like Greece, Spain, and Portugal have done this, but also the countries with relatively healthy financial and economic conditions like Germany and the Netherlands have introduced budget cuts. Yet to what extent these policies have had a significant spillover growth effects is still to be determined.

To answer this, a closer look must be taken at how much tax cuts or spending increases boost the economic activity. Proponents of the fiscal stimulus packages emphasize the Keynesian multiplier effect. The same argument can be applied to the fiscal austerity measures. The Keynesian multiplier effect can be summarized as follows. A country's gross domestic product is equal to the sum of private consumption, investment, net export and government expenditure in a country. An increase (a decrease) in government spending will lead to an increase (decrease) in total spending (consumption, investment, net export and government expenditures). The increase (decrease) in total spending thus leads to higher (lower) total GDP. Therefore the fiscal expansion stimulates domestic activity resulting in higher domestic import and higher export of other countries which boosts foreign income while contractionary fiscal policy leads to the opposite effect.

Since the fiscal policy in one country may impact the key economic variables in another country, a domestic fiscal expansion may benefit trading partners through a demand cross-border effect. Increasing domestic demand results in rising imports (which lowers the domestic net export) and the export of a foreign country (trade channel). Higher domestic activity tends to lead to a higher price of domestic products

which lowers their competitiveness and affects the trade (relative price channel). In case of a monetary union fiscal expansion also increases the domestic price level resulting in lower real interest rate than in the foreign country because the nominal interest rate is set to be the same in the union (interest rate channel). A lower real interest rate attracts more capital inflows to the foreign country but dampens (foreign) investments and therefore the economic activity. A large number of countries undertaking fiscal austerity measures are in the Eurozone where the nominal exchange rate is set to unity and the real exchange rate adjusts slower[1].

The magnitude of the net spillover effect is important to understand whether the synchronized or coordinated fiscal policy could be conducted. Moreover, during crises the domestic fiscal policy change might have rather significant impact on other countries' activity because the decreases in domestic demand cannot be offset by the increases in net export.

In addition to that, the countries in the Euro are highly interconnected (capital and labour markets are highly integrated, most of the trade is conducted among European countries), therefore fiscal policy changes in one country may result in substantial cross-border effects within the Euro Area. Thus, the aim of this paper is to examine the effectiveness of fiscal policy in the Euro Area with the focus on assessing the magnitude of the fiscal programs announced by the governments of the Euro Area Members and quantifying the impact of them on domestic and foreign economic activity.

This paper intends to analyse the sign of fiscal effects in the Euro Area (a monetary union) depending on the way fiscal policy is implemented (expenditures versus taxes). The modelling of the international linkages between the Euro area members requires an open economy specification. Usually, a small open-economy assumption is imposed. A small open-economy setting might be useful for describing certain situations, for example the international economic relations between Norway and the U.S. But it should not be applied to a framework which characterizes trade between countries of roughly equal economic size, for example between France and Germany. The major proportion of international trade in any European country is conducted with other European countries, so (at least for a variety of examples in the Euro area) the small open economy assumption is inappropriate[2]. Therefore, we use a large open-economy specification.

[1] This refers to the argument of Milton Friedman (1953) that under the flexible nominal exchange rate there will be an efficient adjustment in terms of trade even when nominal goods prices are sticky.

[2] Another way to incorporate in the model the international linkages is to use an

This paper is based on a simple, two-country model inspired by Benassy-Quere (2006). Two large open countries constitute a monetary union. The present framework may be taken as being applicable to two economies of roughly equal economic size that conduct most of their trade with one another. The emphasis is on interdependencies that exist in such a setting. Monetary policy is delegated to the common central bank, while fiscal policy remains a national issue. The model relies on two IS curves which set the dependence of the domestic output on the foreign output among other variables. The prices adjust according to the Phillips curves. Since the main objective of the European Central Bank is to maintain price stability, the monetary policy rule is set in relation to the domestic conditions captured in inflation, its target and interest rate target. Fiscal policy is implemented via government spending or taxes influencing demand and prices. The spillovers between the two countries may transmit through the trade (as in Benassy-Quere, 2006), common monetary policy, through the real exchange rate.

The empirical analysis of fiscal multipliers is based on the implementation of Structural Vector Error Correction model (SVECM) that recognizes the links between two major economic entities. The vector auto regression (VAR) is one of the most frequently used tools to empirically analyse the effect of monetary and fiscal policy on output. However, this method is not taking into account the nonstationary nature of majority of the macroeconomic time series data (Granger, 2004). Since the unit roots are present in the data, the VAR technique fails to recognise the existence of any long run linkage for cross country output levels. In this paper we propose a more general framework which allows studying long-run relations and transitory (short run) dynamics in data.

The two entities are represented by two groups of the Euro Area countries. The methodology is applied to the sample of 11 European countries which are divided into two groups of core and periphery countries. This allows us calibrating the model for the two economies constituting a monetary union. The modelling approach implemented here captures the fact that fiscal shocks may transmit from one country to the other. Moreover, cointegration links the output of the two regions in the long run giving rise to an additional feedback mechanism between the two countries via the error correction parameters. Since the empirical model takes into account the nonstationary nature of macroeconomic series, the open economy relationships between the two groups of the Euro Area countries are captured more consistently with the observed data.

approach where individual countries interact with a rest of world component like in the global VAR (GVAR) model associated with Dees et al. (2007). However, this setting treats the Euro Area as a single economy.

The methodology is applied to the Euro Area and covers the period from the beginning of 1979 when the European Monetary System was introduced through the end of 2011 (quarterly data). In order to investigate the fiscal spillovers in the Euro Area, firstly, the impact of a fiscal shock on the domestic activity in the closed economy setting is estimated to understand the relative strength of the effect among countries. Secondly, we measure the impact on growth, interest rate and inflation due to a foreign fiscal shock.

This paper contributes to the research of fiscal policy effectiveness in the following directions. Firstly, a model of two large open economies constituting a monetary union is constructed. It received much less attention in the theoretical and empirical papers surrounding the European fiscal framework. The empirical methodology for studying the short run effect of fiscal policy with long run relations is unique because the nonstationary nature of series with the existence of cointegration is taken into account[3].

Our estimates demonstrate that domestic fiscal multipliers are found to be positive but small suggesting that private consumption and investments might be crowded out. In addition, the domestic tax shocks have less impact on the output than the government spending shock. Effect on inflation is more significant. Cross border multipliers are found to be positive. A spending spillover effect is larger than the spillover effect from a tax shock. The results imply that the domestic fiscal policy might have a positive effect on foreign activity on average in the short run.

The remainder of the paper is organized as follows. Section 2 gives an overview of the findings of the related literature on the size and the magnitude of fiscal multipliers and fiscal spillovers. In section 3 we present the analytical framework of the model of interactions between two countries forming a monetary union. The application of the model to the Eurozone is presented in sections 4 and 5 where the former describes the data and the latter presents the empirical results. Section 6 summarizes the main results and gives some further extensions of the study.

[3]The paper by Dangey and Osborn (2009) also includes potential nonstationarity and cointegration in the analysis but studies the impact of monetary policy shocks.

2 Related literature

In this section we review the related literature that discusses the sign and the magnitude of the short run fiscal multipliers.

The IS-LM theory predicts that an increase in government purchases raises the income leading to higher consumption which causes the income in the economy to rise further. The same refers to a decrease in taxes. Therefore, the fiscal multiplier in this setting is larger than unity. In the open economy IS-LM model (Mundell-Fleming model) an increase in government spending results in higher domestic interest rate attracting more capital inflows. This leads to the appreciation of exchange rate resulting in deterioration of the external current account which may offset the output rise due to higher government spending thus reducing the magnitude of the fiscal multiplier. The larger the crowding out effect, the lower is the multiplier. The appreciation of the exchange rate results in higher import and export of foreign countries boosting foreign income. Therefore, the larger the crowding out effect, most likely the larger the spillover effect is.

However, the empirical estimations of fiscal multipliers largely differ across studies in a single country context. Empirical methodologies to analyze and quantify the fiscal policy multipliers include simulations based on the IS-LM and New-Keynesian macroeconomic models; case studies; estimations based on the vector auto-regressions (VAR); econometric studies of consumer behavior in response to fiscal shocks (Schindler and Spilimbergo, 2009). Many empirical studies focus on the estimation of the fiscal policy shocks in the US and Germany while there are few analyses of cross-border fiscal multipliers. For example, Blanchard and Perotti (2002) estimates the impact of fiscal policy shock on the US economy while Baum and Koester (2011), Perotti (2005) use the same technique of vector auto regression quantifying the multiplier effect for Germany, the US, and few other countries.

Investigating the fiscal multipliers in the US during the period of 1960 and 1997, Blanchard and Perotti (2002) find that the spending and tax multipliers are close to unity using the structural VAR technique. The spending multiplier is larger than the tax multiplier. Evidence for the OECD countries such as the US, West Germany, the UK, Canada, and Australia discussed in Perotti (2005) points out that the government spending multiplier is smaller than unity although the same approach introduced in Blanchard and Perotti (2002) is used.

More recent study, Baum and Koester (2011) also apply the approach of Blanchard and Perotti (2002) to the analysis of the effects of fiscal

shocks on domestic output in Germany. The authors extend the Blanchard and Perotti study by capturing potential non-linearity in the fiscal policy influence largely depending on the phase of business cycle. They use a threshold structural VAR approach. The output gap is used as a threshold measure splitting the time period on positive and negative. As a result an increase in government spending or decrease in government revenue leads to much higher change in the domestic output during the period of a negative output gap than during the period of a positive output gap. Their findings suggest that an increase in government spending by 1 per cent is associated with an increase in domestic GDP by 0.7 per cent which is consistent with the findings of Blanchard and Perotti (2002). A reduction in government revenues by 1 per cent leads to a higher domestic GDP by 0.66 per cent.

In a related study Nakamura and Steinsson (2011) identify the fiscal policy multipliers, in particular the impact of government spending shocks on the output of the regions in the US. The military spending is used as a measure of government spending. Based on the yearly data in per capita terms for the period from 1966 to 2006 by state, they find that government spending and output are positively correlated. These findings imply that an increase of 1 percent in military spending per capita contributes to the rise of the GDP per capita by 1.4-1.9 percent. Moreover, they find that the government spending multiplier is substantially larger in the period of high unemployment. The multiplier ranges between 2 to 3.5 in the period of high unemployment.

Cwik and Wieland (2010) examine whether the macroeconomic models predict the result of conventional Keynesian model that an increase in government spending results in higher domestic GDP by more than one for one for the announced fiscal stimulus packages of European governments in 2008 and 2009. They provide an overview of the simulation results of four macroeconomic models presented in Smets and Wouters (2003), Laxton and Pesenti (2003), Ratto et al. (2009), Fagan et al. (2005). All the models predict that the fiscal multipliers are sufficiently less than one during the time of global financial crisis. All the models except for the Fagan et al. (2005) model are dynamic stochastic general equilibrium models with New Keynesian features such as monopolistic competition, staggered price setting. The model introduced in Fagan et al. (2005) uses backward-looking individuals representing a traditional Keynesian model.

A number of empirical studies look at different episodes of fiscal expansion and contraction in order to identify the magnitude of the fiscal multipliers and factors that determine them. Evidence presented in Alesina and Ardagna (2010) suggests that after the period of large de-

creases in government spending or increases in taxes the GDP tended to rise. The authors analyze the budget data for OECD countries over the period of 1970-2007 focusing on the fiscal adjustment periods. As a fiscal adjustment the periods of fiscal stimulus packages and fiscal consolidation plans were examined. A large fiscal consolidation is considered to be when the cyclically-adjusted budget deficit falls sharply (by at least 1.5 percent of GDP). The findings demonstrate that after large fiscal consolidations the output was increasing on average implying that spending cuts programs were expansionary in the past.

Hemming et al. (2002) investigates the impact of fiscal policy on economic activity during and after the recession periods in advanced economies. The paper demonstrates that the initial fiscal balance and the size of government might influence the magnitude of the fiscal multipliers. Moreover, in the closed economy setting the multiplier demonstrates the Keynesian features but it is less than unity. In the open economy the multiplier is smaller than in the closed economy setting (it might even be zero when there is a floating exchange rate). The magnitude of the fiscal multiplier depends partly on how interest rates and the exchange rates respond to fiscal policy changes. The empirical studies find a small positive impact of fiscal policy change on interest rate. A positive fiscal shock leads to appreciation of the real exchange rate. However, the impact is not always significant making the appreciation less important.

Many studies focus on the estimation of the fiscal policy shocks on domestic economic activity but there are only few analysis of the cross-border fiscal multipliers.

Benassy-Quere (2006) uses a two-country framework to analyze the sign of fiscal spillovers in a monetary union. The findings suggest that an increase in government spending (tax cut) positively affects the foreign economic activity when the central bank accommodates the shock. If the central bank does not accommodate the shock, the spillovers are found to be negative. The interest rate of the union increases due to the fiscal expansion resulting in lower foreign output.

Various articles use the VAR approach to quantify the cross-border spillovers due to fiscal policy change. Beetsma et al. (2006) investigate the cross-border spillover effects of fiscal policy in the European Union. The main channel of influence is assumed to be trade. The other potential channels of influence are not taken into account since the trade among EU countries is much larger than the trade with the rest of the world resulting in the higher spillovers through trade inside the EU. As indicated in Giuliodori and Beetsma (2004) fiscal shocks in EU countries result in substantial spillovers through trade channel. Beetsma et

al. (2006) apply a standard VAR technique for 11 EU countries for the period from 1965 to 2002. The analysis is divided in two stages. On the first stage the response of domestic output on the change in fiscal stance is estimated. And the impact of domestic output change on bilateral exports of the neighbouring countries is quantified on the second stage. The idea behind this division is that a positive fiscal shock spurs the domestic activity resulting in higher domestic import and hence higher foreign export stimulating the income of neighbouring countries. The findings suggest that a 1 per cent rise of GDP in government spending rises causes the foreign export to be higher by 7.8 per cent representing the cumulative effect after 2 years. The net tax cut of 1 per cent of GDP is associated with an increase by 1.4 per cent in foreign export. A positive shock in government spending in Germany mostly affects the small neighbouring countries such as Austria, Belgium and Luxemburg,

In a related study, Benassy-Quere and Cimadomo (2006) investigate the effects of fiscal policy within the Germany, the UK and the US and the effects of fiscal policy change in Germany on the neighboring EU countries including France, Italy, the Netherlands, Belgium and Austria. They use quarterly data from 1971 to 2004 to estimate a factor augmented VAR model. Based on these data period they find that tax multipliers are larger than the spending ones. Moreover, the tax multipliers are found to be positive and declining over the period of investigation while the spending multipliers are less but still positive and stable over time. The findings suggest that an increase in the government spending in Germany positively impacts the output in Italy in the short period but worsens the output of France. An increase in taxes in Germany generates a positive influence (however, it is positive only in the short period and only for France, the Netherlands and the UK). The countries that are closer to Germany are most influenced by the changes in the fiscal stance in Germany. The changes in taxes of Germany explain around 10 percent of changes in GDP of the UK (during the period of 1970 and 1980), Italy, Belgium and Austria (during the period of 1970 and 1990). While shocks in Germany government spending contribute to around 25 percent GDP variance of the Netherlands and Italy, to around 12 percent GDP variance of Austria, Belgium and the UK, and 2.5 and 4 percent GDP variance of France and Spain respectively. The contributions of GDP change due to tax and government spending are descending over the period of analysis.

The investigation of fiscal policy spillovers attracted more attention during the global crisis. Potentially fiscal spillovers are found to be larger during the crisis (Blanchard et. al. (2009), Auerbach and Gorodnichenko (2010)). Nakamura and Steinsson (2011) find that the gov-

ernment spending multiplier is substantially larger in the period of high unemployment. The multiplier is almost two times higher ranging from 2 to 3.5 in the period of high unemployment.

Cwik and Wieland (2010) use a multi-country model of Taylor (1993) to measure the potential cross-country spillover effects of fiscal policy when fiscal plans of increasing government spending are introduced in the European countries. A higher government spending in Germany by 1 per cent cause domestic real GDP to rise by 0.3 per cent on average, by 0.015 and -0.02 per cent on average in France and Italy respectively during the 2009 and 2012. The simulated effect is much lower than predicted by Beetsma et. al. (2006).

Moreover, the authors employed a multi-country model to simulate the spillovers when German government introduces the spending cut plan. It is assumed that spending cut plan will be implemented after two years. The impact on domestic output turns to be positive in the first two years, however the multiplier does not exceed 0.1 and negative when the consolidation is implemented. Therefore, the spending stimulus boosts the domestic activity in the short run and only when the information that plan will be implemented after two years is credible. However, the paper does not analyze the effect of introduction of fiscal consolidation policy after the implementation of fiscal stimulus packages on economic activity.

However, many studies investigate the cross-border spillover multipliers assuming that the policy in other countries in fixed. This does not allow fully capturing the effect of coordinated policy. When countries together introduce the fiscal stimulus packages as it happened in 2009, the influence of the domestic fiscal policy change might be rather significant on the global economy since the changes in domestic demand cannot be offset by the changes in net export. The IMF (2011) report demonstrates that the output spillover effect from Euro Area which is represented by 8 European countries is around 20 percent. The magnitude depends on the model of estimation and on the country under consideration[4]. The neighboring country is influenced the most (the spillover contributes to 25 percent change in the GDP of the UK). The spillover impact from the US accounts for 15 percent change in the Euro Area GDP. The planned fiscal consolidation plans will result in the reduction of GDP by 2.3 percent during 2011-2016 on average within the Euro Area. The rest of the world will be affected by less than half percent.

[4]The report of IMF (2011) presents two models to simulate the spillover effects: global auto regression (GVAR) with 26 countries under consideration where Euro Area as one economy is represented by 8 countries and a macroeconometric model of G-20 where the Euro Area is represented by France, Germany, Italy and Spain.

The related study by Ivanova and Weber (2011) simulate the effect of fiscal policy change on domestic and foreign economies focusing on the impact of synchronized consolidation plans. The authors use a two step procedure. In the first step, the uniform shock of 1 percent change in government spending as a share of GDP is evaluated. In the second step, the spillover short term effect on growth is estimated based on the projection in the countries for 2011 and 2012. Three different approaches are used to measure the fiscal stance that captures different aspects of fiscal policy: cyclically-adjusted revenues and expenditures as a percentage of GDP, headline revenue and expenditures as a percentage of GDP and in real terms. The results show that in 2011 and 2012 1 percent reduction in fiscal stance in all the countries of investigation leads to a lower GDP growth by 1.25 percentage points. After two years the expected reduction in the pace of GDP growth is 0.9 percent due to a 1 percent of GDP coordinated fiscal consolidation. The change in GDP growth largely is due to a domestic change in fiscal policy stance – the contribution is on average 80 percent while the cross border spillover effect accounts for 20 percent change in GDP growth. However, the estimates vary substantially across the countries. The most affected countries are small and open economies such as Austria, Belgium, Ireland and the Netherlands while for the other countries the spillover effect does not exceed half percentage point. In particular in Ireland the total growth impact will be -1.4 percentage points due to synchronized change in fiscal stance with a spillover effect contributing 40 percent to growth reduction. In Belgium the spillover effect contributes to 80 percent change in GDP growth.

The recent literature considerably debates on how effective fiscal policy is. The studies conclude that in the very short run fiscal policies have some Keynesian effects. Fiscal expansion leads to a rise in output, although multipliers are generally found to be small. The results substantially vary across countries. The magnitude of the fiscal multipliers depends on how sensitive the interest rates and exchange rate are to the changes in fiscal policy (since this determines the crowding out effect). During the turmoil periods the fiscal multiplier is found to be larger. With higher government spending or lower taxes the positive impact on output is higher when monetary policy is accommodating, government debt is low, prices are sticky as highlighted in Hemming et al. (2002) and Briotti (2005). The spillover effects are found considerably small. They are larger when the countries are more open to the trade. In addition, it is found that the impact depends on whether the fiscal policy is carried out through government expenditures or taxes. In the next section we build a model of two large open countries constituting a monetary union that takes into account the channels through which the cross

border effect might transmit (common monetary policy, trade and the real exchange rate).

3 The Model

In this section the model of the world consisting of two countries interaction is presented. The model is based on Benassy-Quere (2006). The difference from the study is that two large open economies are considered. Foreign activity influencing the domestic activity through the common monetary policy and the real exchange rate and through trade as in Benassy-Quere (2006).

The countries are both large open economies and have roughly equal economic size (together two countries work as a closed economy). The two countries constitute a monetary union. As an example of this framework two blocks of Eurozone can be considered: the periphery and the core countries. Domestic residents in any country have the option of buying the domestic products or the international ones or investing in domestic or international assets. Therefore the countries conduct their trade with each other. Since countries consitute a monetary union, the nominal exchange rate is set to be 1 (resindents use the same currency). The IS curves represent the goods market, the monetary policy rule sets the interest rate and the Phillips curve captures the supply in each country.

The goods market is represented by the IS curve in each country based on the national accounts. The demand for goods consists of private consumption, investments, government expenditures, exports and imports and is given by

$$Y_t = C_t + I_t + G_t + NX_t \tag{1a}$$
$$Y_t^f = C_t^f + I_t^f + G_t^f + NX_t^f \tag{1b}$$

where C_t is consumption, I_t is investment, G_t is the government spending, NX_t is the net export measured as the difference between the export and the import at time t (the same refers to the foreign economy). Variables with mark f refer to a foreign country. The single element of the demand are respectively given by

$C_t = C(\overline{C}, Y_t, T_t)$,
$I_t = I_t(\overline{I}, r_t)$,
$NX_t = NX_t(\overline{NX}, \varepsilon_t, Y_t, Y_t^f)$.

The first function is consumer spending as an increasing function of disposable income (income without lump sum taxes, T_t). The second function represents investment as a decreasing function of the real interest rate. The net export depends positively on the foreign income and negatively on the domestic income, and it increases when the real exchange rate depreciates. The same applies to the foreign economy. A bar denotes the autonomous components in the elements of the demand function [5]. Substituting the components into the aggregate demand in log linear form, the aggregate demand in each country is expressed as

$$y = u + c(y - t) + g - \beta e - \eta r + \alpha^f y^f \tag{2a}$$
$$y^f = u^f + c^f(y^f - t^f) + g^f + \beta^f e - \eta^f r^f + \alpha y \tag{2b}$$

where c is the marginal propensity to consume, α is a share of domestic output spent on foreign goods and α^f is that of the foreign country, u, u^f are the autonomous components for domestic and foreign countries respectively[6]. The following notations are employed: i - domestic nominal interest rate, r - domestic real interest rate, y - domestic real income level (aggregate demand) in logarithm, $\overline{y}$ - domestic real natural income level in logarithm, g - domestic real government expenditures of the domestically produced goods in logarithm, t - domestic real lump sum taxes in logarithms, c - domestic real consumption in logarithm, p - domestic price level in logarithm, p^{EZ}- monetary union price level in logarithm, e- real exchange rate in logarithm (the real exchange rate is the number of foreign goods that can be obtained in exchange for one unit of the domestic good). A dot denotes a time derivative, overbars denote equilibrium or steady state levels

The equations (2) can be simplified as

$$y = \frac{1}{1-c}(u - ct + g - \beta e - \eta r + \alpha^f y^f) \tag{3a}$$
$$y^f = \frac{1}{1-c^f}(u^f - c^f t^f + g^f + \beta^f e - \eta^f r^f + \alpha y). \tag{3b}$$

Substituting equations (3) in each other, the aggregate demand can be expressed as

[5] Later in this section the time subscript is not used assuming that all the variables are measured at the period of time t.

[6] This specification of IS curve is similar to the one proposed in the model of Benassy-Quere (2006), however, an additional component of autonomous expenditures is included.

$$y = a_1(u - ct + g - \eta r) + a_2(u^f - c^f t^f + g^f - \eta^f r^f) + a_3 e, \quad (4a)$$
$$y^f = b_1(u - ct + g - \eta r) + b_2(u^f - c^f t^f + g^f - \eta^f r^f) + b_3 e. \quad (4b)$$

The coefficients are given by

$$a_1 \equiv \frac{1 - c^f}{(1-c)(1-c^f) - \alpha^f \alpha}; a_2 \equiv \frac{\alpha^f (1 - c^f)}{(1-c)(1-c^f) - \alpha^f \alpha};$$
$$b_1 \equiv \frac{\alpha(1-c)}{(1-c)(1-c^f) - \alpha^f \alpha}; b_2 \equiv \frac{(1-c)}{(1-c)(1-c^f) - \alpha^f \alpha};$$
$$a_3 \equiv -\frac{1 - c^f}{(1-c)(1-c^f) - \alpha^f \alpha}\beta + \frac{\alpha^f (1 - c^f)}{(1-c)(1-c^f) - \alpha^f \alpha}\beta^f;$$
$$b_3 \equiv -\frac{(1-c)}{(1-c)(1-c^f) - \alpha^f \alpha}\beta + \frac{\alpha(1-c)}{(1-c)(1-c^f) - \alpha^f \alpha}\beta^f.$$

The equation (4a) points out the international effects of monetary and fiscal policies conducted in any country. An increase in government spending in home or foreign country causes home aggregate demand to increase. The effect of increased foreign spending operates via increased foreign import. An increase in the price level of domestic goods diverts the home demand towards home goods. This results in higher domestic demand leading to an increase in import stimulating foreign demand (y^f). At the same time, the increase in relative price of domestic goods implies that foreign demand is also switched towards home goods. Therefore, home export is followed by an increase in domestic output (y) and foreign output (y^f). (It is assumed that an increase in terms of trade stimulates home demand depressing foreign demand.)

The domestic and foreign assets are viewed by residents of each country as being substitutes on an uncovered basis (the uncovered interest parity), thus the yields on the two assets must be equal

$$r = r^f + \dot{e}^E. \quad (5)$$

The expected rate of depreciation ($\dot{e}^E$) of home currency is given by

$$\dot{e}^E = \lambda(e - \overline{e}). \quad (6)$$

In this equation we distinguish between the exchange rate to which the economy will converge in the long-run ($\overline{e}$), and the current exchange

rate (e). As in Dornbush (1976) we assume that the expected rate of depreciation of the real exchange rate is proportional to the difference between the long-run rate and the current rate. Therefore, the equation (5) states that if the domestic currency is expected to depreciate, domestic interest rate well exceed the foreign rate by the expected rate of depreciation.

The real exchange rate is determined as $\varepsilon = \frac{P}{P^f}$ (or in logarithms $e = p - p^f$). The equation can be rewritten as $\varepsilon P^f = P$, therefore

$$\frac{\dot{P}}{P} = \frac{\dot{\varepsilon}}{\varepsilon} + \frac{\dot{P^f}}{P^f}. \tag{7}$$

In logarithms it takes the form of

$$\dot{p} = \dot{e} + \dot{p^f}. \tag{8}$$

Since there is a monetary union, the inflation index is assumed to be a weighted average of the inflation in the domestic and foreign countries:

$$\dot{p}^{EZ} = w\dot{p} + (1-w)\dot{p}^f. \tag{9}$$

Substituting equation (8) in (9) yields

$$\dot{p}^{EZ} = \dot{p} - (1-w)\dot{e}. \tag{10}$$

Inflation in the economies is determined by a conventional Phillips curve. The Phillips curve equations are symmetric for the two economies, with the prices of the domestic market in each country adjusting according to a measure of excess demand in the home goods markets

$$\dot{p} = \phi(y - \overline{y}) + v_t, \tag{11a}$$

$$\dot{p^f} = \phi^f(y^f - \overline{y}^f) + v_t^f. \tag{11b}$$

According to this equation, inflation depends on the deviation of output from its natural level and an exogenous supply shock (v_t, v_t^f).

Since we consider a monetary union, the monetary policy is set the same for the two countries in relation to the domestic conditions, captured by the inflation and output using the standard interest rate rule as proposed in Taylor (1993)[7]

[7] Another difference from the model of Benassy-Quere (2006) is that the behavior of the central bank is determined by the loss function while in the paper the Talor rule is used.

$$i = \dot{p}^{EZ} + \bar{i} + \theta(\dot{p}^{EZ} - \pi^t) + \theta_y(y - \overline{y}). \tag{12}$$

We assume that the central bank adjusts the nominal interest rate in response to deviation in inflation in the monetary union from its target (π^t is the target for the inflation rate set by the monetary authority)[8], thus θ_y is set to be equal to zero. Since both countries are in a monetary union, the nominal interest rate is the same. Therefore, the monetary policy rule is a Taylor interest rule of the following type.

$$i = i^f = \dot{p}^{EZ} + \bar{i} + \theta(\dot{p}^{EZ} - \pi^t). \tag{13}$$

The policy parameter θ is assumed to be greater than zero. This parameter indicate how much the monetary authority allows the interest rate target responding to fluctuations in inflation, $\bar{i}$ is the natural rate of interest (the real interest rate at which, in the absence of any shock, the demand for goods and services equals the natural level of output).

The relationship between the real and nominal interest rates is determined by Fisher equation. Since in a monetary union the central bank sets the nominal interest rate to be the same in both countries and the inflation rate is calculated for the union, the real interest rates are equal to each other, therefore Fisher equation takes the form

$$r = r^f = i - (\dot{p}^{EZ})^E. \tag{14}$$

The expected rates of inflation of the prices of domestically produced goods in each economy are defined in the same manner as the exchange rate expectations (equilibrium price levels $\overline{p}, \overline{p}^f$ are known to the market)

$$\dot{p}^E = \mu(p - \overline{p}), \tag{15a}$$
$$\dot{p}^{fE} = \mu^f(p^f - \overline{p}^f). \tag{15b}$$

Therefore, the expected rate of inflation in the monetary union is given by

$$(\dot{p}^{EZ})^E = w\dot{p^E} + (1-w)\dot{p}^{fE} = w\mu(p - \overline{p}) + (1-w)\mu^f(p^f - \overline{p}^f) \tag{16}$$

The short-run equilibrium is determined by the system of equations (4), (11) and (13) together with (14). There are several channels through

[8] An example of such rule might be the one implemented by the monetary authority of the Eurozone. The main objective of the Eurosystem which consists of the European Central Bank and the national central banks is maintaining the price stability (www.ecb.int).

which the foreign economic activity is affected by domestic fiscal policy shocks: the income channel ($\alpha y, \alpha^f y^f$), the competitiveness channel ($a_3 e = a_3(p - p^f)$), and the interest-rate channel ($-(a_1\eta + a_2\eta^f)r$). A domestic positive shock on public expenditures positively influences the output of the other country through the first two channels but negatively through the last channel.

The multiplier of the government expenditures in the home country is equal to $\frac{1-c^f}{(1-c)(1-c^f)-\alpha^f\alpha} > 0$ which leads to a positive spillover effect to the foreign country of $\frac{\alpha(1-c)}{(1-c)(1-c^f)-\alpha^f\alpha}$ other things equal in the short run [9]. Analogously, the 1 per cent change in the government expenditures of the foreign country leads to a change in its output equal to $\frac{(1-c)}{(1-c)(1-c^f)-\alpha^f\alpha}$ leading to a change in the output of the home country $\frac{\alpha^f(1-c^f)}{(1-c)(1-c^f)-\alpha^f\alpha}$ ceteris paribus. The multiplier of the taxes of the home (foreign) country is equal to $\frac{-c(1-m^{pcf})}{(1-c)(1-c^f)-\alpha^f\alpha}$ ($\frac{-c^f(1-c)}{(1-c)(1-c^f)-\alpha^f\alpha}$) other things equal. A 1 per cent change in the tax of the home (foreign) country results in change of $\frac{-c*\alpha(1-c)}{(1-c)(1-c^f)-\alpha^f\alpha}$ ($\frac{-c^f\alpha^f(1-c^f)}{(1-c)(1-c^f)-\alpha^f\alpha}$) in the foreign (home) output other things equal. The next sections empirically investigate the signs of the domestic and spillover effects.

The adjustment mechanism to the equilibrium levels in the short run is described as follows. The prices do not adjust instantaneously to shocks. Therefore, the short run equilibrium is determined by the goods market and by the policy responses. Consider a demand shock in one of the countries. A positive demand shock causes the output in the country to rise. Increased demand boosts the imports weakening the net trade. In addition the inflation rises in the country (the adjustment is through the Phillips curve). This leads to the rise in the interest rate since the monetary authority sets the interest rate rule depending on the deviation of the inflation from its target level. This puts downward pressure on the domestic output since the investment is weakened due to the higher interest rate. Moreover, the change in the price level of the domestic country also leads to a change in the real exchange rate and to the lower trade. Because domestic goods become more expensive relative to foreign ones, the net exports fall putting downward pressure on the demand. Initially increased demand boosts the imports resulting in a further weakening the net trade. The adjustment process is happening until the output, the inflation return to their steady state levels.

[9] It is positive if $(1-c)(1-c^f) > \alpha^f\alpha$. The same applies to the other multipliers.

4 Data and Methodology

This section discusses the data used for the empirical investigation of the (dynamic) fiscal multipliers and cross-border effects. Empirical methodology is also briefly described based on Engle, Granger (1987).

The empirical analysis is based on implementation of the Structural Vector Error Correction model (SVECM) that recognizes the links between the two economies. One of the standard approaches to empirically analyse the effect of monetary and fiscal policy on output is the vector autoregression analysis (VAR). However, the limitation of this approach is that it does not take into account the nonstationary nature of most of the macroeconomic time series data (Granger, 2004). Since the unit roots are present in the time series, this method fails to recognise the existence of any long run linkages for cross country output levels. In this paper we propose a more general framework which allows studying long-run relations and short run dynamics in data, structural VECM. The VECM representation is obtained as a simple rearrangement of the VAR once the variables in the VAR are cointegrated (Jacobs, Wallis, 2010).

We employ the SVECM specification which allows taking into account the influences and interdependences between the two constructed large open economies when the series of variables are found to be cointegrated of the same order. The SVECM approach seeks to explain the observed cross-country co-movement amongst economic variables. The impulse responses in our VECM specification to shocks that originate within one economy are influenced by the short term and long term interactions. In order to provide information on the role of these interactions, separate closed economy models are also estimated for comparison purposes. The closed economy specification in each case contains domestic output, inflation, interest rates and fiscal stance measure (government expenditures, taxes). However, as closed economy models, foreign output is excluded from the domestic output equation, foreign inflation is excluded from the Phillips curve relation, and the monetary union price level is not valid in this case.

Since the variables are found to be cointegrated (this will be discussed in detail later in this section), there exists an error-correction representation. This means that changes in the dependent variables are functions of the level of disequilibrium in the cointegrating relationship, captured by the error-correction term, and changes in other explanatory variables (Engle, Granger, 1987). The structural vector error-correction model analysed in this case is

$$B(L)\Delta Y_{it} = \alpha + \gamma Y_{t-1} + \Sigma_{-i,j}\delta_j \Delta Y_{-i,t-j} + \Sigma_{i=1}^{r}\xi_i E_{r,t-1} + \epsilon_t$$

where $Y_{it} = \{y_t^c, y_t^p, r_t^c, r_t^p, \pi_t^c, \pi_t^p, g_t^c, g_t^p, t_t^c, t_t^p\}$ in which $y_t^i, r_t^i, \pi_t^i, g_t^i, t_t^i$ represent the output, inflation, the short run interest rate for core and periphery economies ($i = c, p$), Y_t is the vector of n (nonstationary) endogenous variables in the system, L is the lag operator, E refers to the error-correction terms and ϵ_t is serially uncorrelated random error term with mean zero. Our choice of variables is determined by the theoretical analysis in the previous section (the output equations, the Phillips curves, the interest rate rule). The vector Y_t contains the variables cointegrated of order 1, therefore the differenced terms are used.

We focus on the European countries constituting the Eurozone. In our setting we employ data for 11 countries. The following countries are considered: Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, the Netherlands, Portugal and Spain. We use quarterly data for the period from 1979 to 2011. We start from 1979 because this represents the beginning of the move towards a common currency in the Europe when the European Monetary System was established introducing the exchange rate mechanism linking the currencies of the member countries[10].

The data is collected from the Economic Outlook of the OECD Statistical Compendium and the International Financial Statistics of the International Monetary Fund. In the estimations we use the real data. All variables except for the interest rate have been seasonally adjusted by the original sources. We define the government spending as the government consumption. Inflation is calculated as growth rates from country specific CPI indexes. The real interest rate is constructed as the difference between the short term interest rate and the inflation rate. Real GDP is derived by taking the nominal GDP for every country and dividing it by the GDP deflator of the respective country. Real government expenditure and real taxes are derived in the similar way. The data for the taxes which are measured as the taxes on production and import is available for all the countries under consideration only since 1991.

[10]The European Monetary System was launched in March 1979 in order to reduce exchange-rate instability. The members were Belgium, Denmark, France, Ireland, Italy, Luxembourg, the Netherlands, and West Germany, Portugal, Greece, though British pound joined only in 1990 and stayed for two years, Spain joined in 1989. The European Currency Unit, a weighted average of the member states currencies, was introduced establishing the linkage with adjustable exchange rates of the member states currencies.

Therefore we divide our analysis in two parts. In the first part we analyze the government spending multipliers for the period of time from 1979 to 2011 using quarterly data. In the second part we analyze the government spending and tax multipliers from 1991[11].

The sample of countries is divided in two groups: core and periphery countries. Core countries include Austria, Belgium, Finland, France, Germany, the Netherlands, while the periphery countries include Greece, Ireland, Italy, Portugal and Spain. The group series are constructed as weighted averages of the country-specific variables. The weights are based on the GDP shares of each country in the Eurozone region. Specifically, weights are constructed by averaging over the period 1979-2011 the GDP series for each given country. Then they are divided by the total GDP of the region in order to sum up to the unity. Since the shares might change over time, we use the weights calculated in Fagan et al. (2001) which are constructed for an area-wide model for the euro area (AWM model). These weights are constructed by the European Central Bank (ECB). This method of aggregation has been widely used in the studies of the Euro Area and of the Europe. For example, Gali et al. (2001) applied it for the New Keynesian model of the Euro Area for estimation of monetary policy functions in order to compare its features and dynamics with those observed in the US while Smets and Wouters (2003) did it for Dynamic Stochastic General Equilibrium (DSGE) models study of Europe. Moreover, it has been employed in studies dedicated to the development of the leading indicators for Europe (Giannone and Reichlin, 2004, Banerjee et al., 2005) and in studies of money demand and inflation and monetary policy functions (e. g. Gerlach and Svensson, 2003). In more details the construction of the AWM weights are presented in Fagan et al. (2001)[12].

[11] The (small) sample size in the second part might lead to the biased estimation of the results. Therefore we also investigate the sample from 1979. In addition, the comparison of the results obtained from different samples may be used as a robustness check.

[12] In this study the aggregation is over twelve countries of the Euro Area including Luxembourg. However, we exclude it from the analysis since its weight is less than 0.01 and its data is not available for the whole period of time.

country	AWM weight	weight in the group
Core		
Germany	0.283	0.451
France	0.201	0.321
Netherlands	0.06	0.096
Belgium	0.036	0.057
Austria	0.03	0.048
Finland	0.017	0.027
country	AWM weight	weight in the group
Periphery		
Italy	0.195	0.527
Spain	0.111	0.300
Greece	0.025	0.068
Portugal	0.024	0.065
Ireland	0.015	0.041

Table 1. Aggregation weights for Euro Area countries

Before turning to the results of the estimations we discuss the extent of the possible international interactions between the groups of countries (Table 2 and 3). The simple correlation between the levels of output in the two groups is high (70 percent). The short run interest rates and the inflation rates are more correlated (79 and 92 percent respectively). This is a consequence of similar monetary policy operated across these economies. The correlation between the taxes of the two groups of countries is also moderate (26 percent), probably due to the fact that the fiscal policy is conducted by the countries separately with absence of the fiscal union.

	$Inlf_c$	$Inlf_p$	Y_p	Y_c	G_c	G_p	r_c	r_p
$Inlf_c$	1							
$Inlf_p$	0.92	1						
Y_p	-0.71	-0.88	1					
Y_c	-0.69	-0.88	0.70	1				
G_c	0.19	0.27	-0.28	-0.31	1			
G_p	-0.52	-0.67	0.73	0.70	0.01	1		
r_c	0.22	0.34	-0.46	-0.56	-0.24	-0.21	1	
r_p	-0.16	-0.04	-0.21	-0.32	-0.12	0.05	0.79	1

Table 2. Correlation among the variables under consideration for the period 1979-2011

	T_c	T_p	$Inlf_c$	$Inlf_p$	Y_p	Y_c	G_c	G_p	r_c	r_p
T_c	1									
T_p	0.26	1								
$Inlf_c$	0.19	0.59	1							
$Inlf_p$	0.18	0.63	0.98	1						
Y_p	0.15	-0.24	0.1	0.02	1					
Y_c	0.14	-0.10	0.45	0.40	0.53	1				
G_c	-0.13	-0.40	-0.38	-0.39	-0.39	0.11	1			
G_p	-0.21	-0.54	-0.69	-0.69	-0.37	-0.15	0.84	1		
r_c	-0.19	-0.45	-0.77	-0.75	-0.45	-0.27	0.55	0.75	1	
r_p	-0.21	-0.67	-0.87	-0.87	-0.17	-0.27	0.49	0.71	0.88	1

Table 3. Correlation among the variables under consideration for the period 1991-2011 including taxes

Inspection of the visual representation of the variables suggests that each variable is nonstationary. The augmented Dickey-Fuller tests are reported in the Tables in the Appendix. Since the data is quarterly, we use the four lag lengths for testing for stationarity. Since the absolute values of all the t-statistics are well below the critical values, we cannot reject the null hypothesis of a unit root in any of the series. The tests for the presence of the unit root in first differenced data for each of the variables suggest that all the variables contain a single unit root. The test for the cointegration among the variables implies that we cannot reject the null hypothesis of no cointegration. Further analysis allows us concluding that the data series are all integrated of order one indicating the existence of long-run relationships. Therefore we proceed with the analysis of the SVECM. This model allows calculating the impact of fiscal policy changes on the key economic variables by estimating the impulse response function. A shock to the fiscal policy variable directly affects the variable of interest and it is also transmitted to all of the other endogenous variables through the dynamic structure of the SVECM. An impulse response function traces the effect of a one-time shock to one of the innovations on current and future values of the endogenous variables. However, all the shocks are set equal to one standard error in this specification of the model which does not allow us comparing the results[13]. Therefore, we construct the fiscal multipliers as the percentage

[13]Since the shocks might have a permanent effect on the time series containing unit root, not all the impulse responses function approach to zero as the horizon increases. Moreover, there are no confidence intervals in this specification; therefore it is difficult to conclude whether the impulse responses are showing significant effects.

changes in the government spending and taxes as follows[14]. The original impulse response of the responding variable at period k is divided by product of the impact response of government spending at period 0 and average ratio of spending to responding variable over sample. Therefore the rescaled impulse response of the output can be interpreted as the percentage change of real GDP to the spending shock. The reaction of inflation and interest rate can be interpreted as percentage point changes. The tax multiplier is constructed in the same manner.

In this section the impulse response analysis will be presented based on open versus closed economy comparison implied by the empirical Structural VECM specification. First, we will analyze the impact of the fiscal shock in the countries under investigation to understand the relative strength of the impact on the economic growth among the countries. Second, we investigate the impact of the changes in the domestic fiscal policy on the economic growth of other countries (spillover effects). Fiscal shocks are normalized to be equal to one percent of domestic GDP. The reaction of inflation and interest rate can be interpreted as percentage point changes while the reaction of taxes and government expenditures and output can be interpreted as percentage change.

4.1 Domestic effects of fiscal policy

Impulse response functions for the single country models for the period from 1979 till 2011 and 1991 till 2011 are reported in Figures 1-6.

Figure 1 and 2 summarize how key domestic variables adjust to the spending impulse for the period 1979-2011. In core countries (Figure 1), an exogenous government spending shock has a negative impact within one year, steadily increasing afterwards[15]. Inflation and interest rate have similar reaction but the magnitude differs. In the short run, within two years, the impact on the interest and inflation rates is negative increasing in absolute value. After that, both of the variables still react negatively to the government spending shock though the reaction is decreasing in absolute value. As for the periphery countries (Figure 2), the impact of the change in the domestic fiscal policy on the output

[14]This approach for constructing fiscal multipliers was introduced in Blanchard, Perotti (2002) and was also used in Kirchner et al. (2010).

[15]If we consider the negative government spending shock, the picture will be reversed and this can be a confirmation of the expansionary fiscal consolidation hypothesis. The typical examples that confirm this hypothesis are Denmark in 1983-86 and Ireland in 1987-89. This topic is discussed in Perotti (2011).

is reversed. Within first year, the multiplier is positive and changing slightly. Afterwards, the sign of the impulse response is negative gradually decreasing over time. In the short run (within year) an exogenous positive shock in government spending has a negative impact on the interest rate in the periphery countries. But after a year the interest rate reacts upwards, steadily increasing and slightly fluctuating. Inflation steadily rises in the periphery countries as a result of the government spending shock. The GDP multiplier for both groups of countries is much less than predicted by the Keynesian model. It ranges between -0.01 and 0.03 for the core countries and -0.03 and 0.01 for the periphery countries. The impact multiplier of the inflation rate is much more than the GDP multiplier reaching 0.9 after two years.

Figure 3-4 display the Impulse responses of the variables that capture changes in domestic spending and tax policy for the period 1991-2011 for the two single economy models. Inclusion of the taxes in the analysis results in significant changes in the impulse responses of the variables under consideration. Figure 3 indicates that the government spending shock causes the output to decrease, and the multiplier is close to -0.5 within the first three years in the core countries. After that the impact response starts to increase reaching 0.5. The impact on the interest rate is weaker. Interest rate drops slightly. While the impact on the inflation is much stronger, the multiplier is close to one in the end of the second year.

The influence of the change in tax policy has much weaker effect on the output and inflation but stronger on the interest rate as Figure 4 and 6 show. An exogenous tax shock results in the positive response of the output of the core countries within the first year (Figure 4). The response changes to negative in the second and third years. Inflation rises by almost 0.2 percentage points after half a year, drops significantly to almost -0.2 percentage points after a year. After that the impact response is negative. Like the spending shock, tax change has a negative impact on the interest rate. Within the first half a year the multiplier is -0.4, becoming almost negligible at the end of the year and fluctuating around -0.3 afterwards.

With the inclusion of the taxes in the analysis, an exogenous spending rise has a positive impact on output within half a year in the periphery countries as shown on the Figure 5. During the third and fourth quarters the multiplier is negative reaching almost -0.5. Within the second and third years the multiplier of the output reaches almost 1. Inthe following quarters, GDP reacts downwards. The behavior of the response of the inflation rate to the government spending shock is similar in the magnitude and the direction. However, the exogenous change in government

spending results in negative response of the interest rate resulting in the most sizable impact during the third year.

The exogenous tax cut has a positive impact on output, though the impact is much less than due to the change in the government spending in the periphery countries (Figure 4). A positive tax shock stimulates the inflation to decrease in the first year, and the multiplier reaches its peak at the level of -0.6 in the first half a year. During the second year this shock boosts the inflation rate with the multiplier reaching 0.9 in the end of the second year. Then inflation impact response is gradually decreasing. Tax shock spurs the interest rate though with the decreasing multiplier in the first year and a half. Albeit the multiplier is small: it ranges between 0.015 and 0.02.

On the whole, we find that the spending shocks have different effects on the output of the core and periphery groups of countries. Inclusion of the taxes in the estimation does not change significantly the magnitude of the impact on the output. The fiscal policy change has much stronger impact on the inflation rate.

4.2 Cross-border effects

Figures 7 and 8 illustrate the nature and importance of the cross-border relationships by showing the estimated impulse responses of output, inflation and interest rates in the core group of countries to shocks originating in the periphery group. A shock to spending in the periphery countries leads to an increase in the output of the core countries in the very short run albeit small which is followed by a sharp decrease to almost -0.01% (Figure 7). The government spending shock in the periphery countries push the interest rate of the core countries. Compared to the influence on output the interest rate and inflation are much more affected by the changes in the foreign fiscal policy. Interest rate impact response rises soaring from 0 to 0.06 percentage points, then drops to almost 0.02 percentage points. During the second year there are further fluctuations between 0.02 and 0.05. After that the impact response gradually decreases. The impact response of inflation in core countries is negative during the first year sliding to -0.03 percentage points before then soaring back to 0. During the second year there are further fluctuations in the impact response between -0.01 and 0. After that the interest rate response declines gradually. The effect on the interest rate is similar to the impact on the output during the first three years but of different magnitude.

The periphery countries output impact responses to the core countries' shocks, shown in Figures 9 and 10, are stronger than those on Figures 7 and 8. The impact on the output ranges between -0.03 and 0.2% while the interest rate response is slower and of similar magnitude to that of the core countries soaring within the two years to 0.02 percentage points. The impact on the domestic output due to changes in foreign fiscal policy in the periphery countries differs from the impact on the core countries domestic output. After half a year the output response is positive and grows till 0.02%, slightly fluctuating between 0.01 and 0.02 within the next year. Over the next years, the impact response is decreasing, even becoming negative. The higher government spending in the periphery countries leads to a positive impact response of the inflation rate. Within the first year the multiplier reaches the level of 0.015, and then the impact response is gradually falling.

The inclusion of the taxes changes the impact responses of the variables of interest to the government spending shock substantially (Figure 9). As in the case when taxes are excluded the impact on the output of the core countries is small (the magnitude is less than 0.02%) but positive most of the time. The interest rate effect of spending shock originated in the periphery countries is substantially larger fluctuating between -0.01 and 0.02 percentage points for the core countries. An exogenous government spending shock has a positive impact on inflation as opposed to the case when taxes are excluded from the analysis. Over time impact response is gradually increasing.

Figure 11 presents the effects of spending shock on the key variables of the periphery countries. The output and inflation in the periphery countries are more significantly affected than when taxes are not included in the analysis. The output responses positively to the spending shock in the core countries. However, the impact is delayed over time (it is slightly fluctuates around zero during the first two years), then rising gradually reaching 0.1%. The impact on the interest rate is of similar magnitude to its impact when taxes are not included in the analysis albeit differs in the direction. Starting from the positive response to the shock in spending, the response becomes negative in the second half of the year, gradually soaring and reaching the level of 0.05 at the end of the third year. The influence on the inflation is more substantial. Within the first year its impact response starts from 0.5 percentage points climbing to 1 percentage point within the second quarter. The multiplier drops to -1 within the next two years, and then gradually increasing.

Figures 10 and 12 also depict the impulse response functions in the open economy model following an exogenous tax shock. In the core countries the output and inflation rate are positively affected by the changes

in foreign tax policy. An exogenous shock in taxes in the periphery countries pushes the output of the core countries up, and the impact response is increasing over time. In contrast, in case of periphery countries the output is positively affected but the impact is changing over time. The changes in foreign tax policy cause the output to rise in the first two quarters after the shock, and then the impact is almost zero. After two years the multiplier is gradually increasing. The impact response of the core countries interest rate is also gradually increasing over time. In contrast, the interest rate in periphery countries is negatively affected. The impact response of the interest rate to the foreign tax shock follows a cyclical pattern decreasing within the first year, increasing in the second and then again decreasing. The multiplier fluctuates between 0 and -0.04 percentage. The tax spillovers effect on the inflation is positive in the core countries, though fluctuates over time. Starting from 0.2 the impact response of inflation to change in foreign tax policy is decreasing and reaching zero in the fourth and sixth quarters. Afterwards there is a sharp increase in the response which is followed by a gradual decrease. The influence on the inflation in periphery countries is much stronger. During the first two years, the foreign tax change negatively affects the inflation.

On the whole, the results of the open economy model which allows the effects of shocks flowing in both directions between these economies reveal the economic relationships. The strongest international effects flow through interest rates and inflation influencing the changes in the real exchange rate.

4.3 GDP variance decomposition

In this section we assess how much the fiscal shocks contribute to the dynamics of GDP using a forecast error variance decomposition over the different time samples. Thus we investigate the relative importance of fiscal policy innovation in affecting the GDP. The results are presented in Figures 13-18. In the closed economy case, Figures 13 and 14 show that in core countries innovation in government spending contributes to around 30 percent for the time period spanning from 1979 to 2011 and less than 2 percent of output volatility over the whole period of observation when taxes are included in the estimation. The innovation in tax policy explains also around 2 percent of GDP in the core countries. For the periphery countries, explaining power of the innovation in government spending is growing over time, reaching up to 55 percent of output volatility (Figure 14). However, when the taxes are included in the analysis the government spending shock accounts for less than 2

percent of GDP forecast error as indicated on the Figure 13. In contrast, the innovation in tax policy explains up to 30 percent of GDP (Figure 14).

Forecast error variance decompositions for each group of country's GDP are reported in Figures 14 and 17, displaying the contribution of fiscal shocks to variability in foreign economic activity. For the sample of 1979-2011, the government spending shock (domestic shock) contribute to less than 2 percent for the core countries and around 5 percent in the beginning achieving the level of up to 30 percent in the periphery countries. For the core countries the change in government spending in the other country is much more important explaining up to 20 percent (Figure 16). Conversely, for the periphery countries the contribution of the change in fiscal policy in the core countries is less than 5 percent (Figure 17). The same situation applies when the taxes are included in the analysis. Domestic tax shock accounts for at most 5% of GDP forecast error variance, while the foreign tax shock explains up to 20% for the core and periphery countries (Figure 18).

These findings suggest that for the core countries the domestic fiscal policy is relatively ineffective in the open economy case comparing to the monetary policy innovations. For the periphery countries the changes in the domestic tax policy is more effective than the changes in the domestic government spending shock. When the taxes are not included in the analysis, the innovations in the fiscal policy in the periphery countries contribute much more to the change in GDPs of both core and periphery countries than the policy in the core countries.

5 Conclusions

In this study we built a simple two-country static model and explored the empirical importance of impact of fiscal shocks on the domestic and foreign activity. The magnitude of the multipliers and spillover effects might be important for assessing whether fiscal coordination is necessary. A stronger effect on foreign economic activity means that a larger share of domestic fiscal shock spills over on the neighboring countries. Therefore the synchronized policy might be more attractive. Moreover, the switch from fiscal expansion to fiscal consolidation is likely to influence the magnitude of the impact.

A simple two-country static model has been developed in order to analyze fiscal multipliers and spillovers in a monetary union. The analysis relies on two IS curves, two Phillips curves and an interest rate policy rule of the central bank. The impact on the key economic variables depends on the way fiscal policy is implemented. Fiscal policy consists

of either a spending shock, which impacts on demand, or a tax shock, which impacts on both demand and prices.

To calibrate the model for two economies we use the sample of 11 European countries which are divided into two groups of core and periphery countries. Two types of samples are analyzed: quarterly data covering the period ranging between 1979 and 2011 and data covering the period from 1991. The empirical analysis is based on structural VECM. The impact of a fiscal shock is estimated in a closed-economy case to measure the relative strength. Afterwards, the potential cross-border effects are quantified.

Our estimates suggest that domestic tax multipliers have less impact on the output in a single economy case. The effect on inflation is more significant. Most cross-border multipliers are found to be positive (impact on output). However, this means that when there is a negative fiscal shock there might be a counter-productive impact on neighboring countries. A domestic fiscal impulse equal to 1 percent of GDP leads to a gain of average 0.053 percent of GDP for a sample when tax are included in the analysis and 0.029 when taxes are not included (a cumulative effect after 2 years) for a government spending shock. A tax shock leads to a gain of 0.027 percent of GDP.

Further research should address the technicalities related to the enlargement of the countries in a monetary union in the model. The current model includes only two large open economies, therefore further inclusion of small open economies is on the future research agenda. In addition, another potential channel through which the spillover effects might transmit is financial markets as in Dees et al. (2009). Also, potentially one of the countries might be more powerful, therefore influence of the spending change might be more dominant than from other countries.This also could be on the future research agenda.

6 References

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7 Appendix A

The steady state (long-run equilibrium) of the model is described by a constant level of inflation and exchange rate, output and interest rate are on their natural levels, $p^{EZ} = \pi^t, e = \overline{e}, i = \overline{i} = i^f = r = r^f = \overline{r}, y = \overline{y}$.

In the steady state $\dot{p} = \phi(y - \overline{y}) = \phi(a_1(u - c*t + g - \eta r^f) + a_2(u^f - c^f * t^f + g^f - \eta^f r^f) + (p - p^f)a_3 - \overline{y}) = 0$. Therefore the long run exchange rate is equal to

$$a_1(u - c*t + g - \eta r^f) + a_2(u^f - c^f * t^f + g^f - \eta^f r^f) + (\overline{p} - \overline{p}^f)a_3 - \overline{y} = 0 \quad (17)$$

Solving for nominal interest rates from monetary policy rule (**??**) and using (5) and (6), obtain

$$e - \overline{e} = \frac{\theta - \theta^f}{\lambda}(\dot{p}^{EZ} - \pi^t) + \frac{1}{\lambda}(\overline{i} - \overline{i}^f). \quad (18)$$

Since θ is equal to θ^f, (18) can be rewritten as

$$e - \overline{e} = \frac{1}{\lambda}(\overline{i} - \overline{i}^f). \quad (19)$$

Since there is a monetary union and nominal exchange rate is equal to unity, the terms of trade effect is equal to the real exchange rate ($e = p - p^f$). Therefore, (19) can be solved for the terms of trade as

$$e = \overline{e} + \frac{1}{\lambda}(\overline{i} - \overline{i}^f). \quad (20)$$

The full employment income levels must satisfy where the autonomous parameters have been suppressed

$$\begin{aligned} \overline{y} &= a_1(-c*t + g - \eta\overline{r}) + a_2(-c^f * t^f + g^f - \eta^f\overline{r}) + a_3\overline{e}, \\ \overline{y}^f &= b_1(-c*t + g - \eta\overline{r}) + b_2(-c^f * t^f + g^f - \eta^f\overline{r}) + b_3\overline{e}. \end{aligned}$$

which can be rewritten as

$$\begin{aligned} M - (a_1\eta + a_2\eta^f)\overline{r} + a_3\overline{e} = 0, M = a_1(-c*t + g) + a_2(-c^f * t^f + g^f), \\ M^f - (b_1\eta + b_2\eta^f)\overline{r} + b_3\overline{e} = 0, M^f = b_1(-c*t + g) + b_2(-c^f * t^f + g^f) \end{aligned}$$

where M and M^f are purely exogenous. These equations may be solved as

$$\overline{i} = \overline{r} = \frac{a_3M - b_3M^f}{(b_1\eta + b_2\eta^f)a_3 - (a_1\eta + a_2\eta^f)b_3} \quad (21)$$

$$\bar{e} = \frac{(b_1\eta + b_2\eta^f)M + (a_1\eta + a_2\eta^f)M^f}{(b_1\eta + b_2\eta^f)a_3 - (a_1\eta + a_2\eta^f)b_3}. \tag{22}$$

The equations (21) and (22) show that the steady-state interest rate and terms of trade levels are determined by fiscal policy and are independent of monetary factors. Therefore, the equilibrium of the model reflects monetary neutrality as opposed to the results of the model in Dornbush (1976).

Now, consider the response of the interest rate and terms of trade to an increase in domestic government spending (g and g^f). The impact on the equilibrium terms of trade and the interest rates is ambiguous. Recalling the definitions of M and M^f, the effect of the change of the home government spending (g) on the equilibrium interest rate is

$$\frac{d\bar{r}}{dg} = \frac{d\bar{i}}{dg} = \frac{a_3a_1 - b_3b_1}{(b_1\eta + b_2\eta^f)a_3 - (a_1\eta + a_2\eta^f)b_3}.$$

The effect of the change of the foreign government spending (g^f) on the equilibrium interest rate is

$$\frac{d\bar{r}}{dg^f} = \frac{d\bar{i}}{dg^f} = \frac{a_3a_2 - b_3b_2}{(b_1\eta + b_2\eta^f)a_3 - (a_1\eta + a_2\eta^f)b_3}.$$

The effect of the change of the home and foreign government spending on the equilibrium terms of trade respectively is

$$\frac{d\bar{e}}{dg} = \frac{(a_1\eta + a_2\eta^f)a_1 - (b_1\eta + b_2\eta^f)b_1}{(b_1\eta + b_2\eta^f)a_3 - (a_1\eta + a_2\eta^f)b_3},$$

$$\frac{d\bar{e}}{dg^f} = \frac{(a_1\eta + a_2\eta^f)a_2 - (b_1\eta + b_2\eta^f)b_2}{(b_1\eta + b_2\eta^f)a_3 - (a_1\eta + a_2\eta^f)b_3}.$$

Analogously, the change in taxes in the home country will lead to the change in the interest rate and terms of trade

$$\frac{d\bar{r}}{dg} = \frac{d\bar{i}}{dg} = \frac{-c(a_3a_1 - b_3b_1)}{(b_1\eta + b_2\eta^f)a_3 - (a_1\eta + a_2\eta^f)b_3},$$

$$\frac{d\bar{e}}{dg} = -c\frac{(a_1\eta + a_2\eta^f)a_1 - (b_1\eta + b_2\eta^f)b_1}{(b_1\eta + b_2\eta^f)a_3 - (a_1\eta + a_2\eta^f)b_3}$$

while the change in taxes in the foreign country leads to a change in the interest rate and terms of trade

$$\frac{d\bar{r}}{dg^f} = \frac{d\bar{i}}{dg^f} = \frac{-c^f(a_3a_2 - b_3b_2)}{(b_1\eta + b_2\eta^f)a_3 - (a_1\eta + a_2\eta^f)b_3},$$

$$\frac{d\bar{e}}{dg^f} = -c^f \frac{(a_1\eta + a_2\eta^f)a_2 - (b_1\eta + b_2\eta^f)b_2}{(b_1\eta + b_2\eta^f)a_3 - (a_1\eta + a_2\eta^f)b_3}.$$

8 Appendix B

	t-statistics	
Variable	Core countries	Periphery countries
GDP	-2.19181	-2.08751
	(0.4851)	(0.2501)
Gov. Spending	-2.97749	-2.46178
	(0.1426)	(0.3465)
Inflation	-2.46376	-1.96159
	(0.1268)	(0.6161)
Interest rate	-1.43215	-1.41136
	(0.5647)	(0.5749)

Table 1a. Augmented Dickey-Fuller (ADF) unit root tests for the series in levels. Sample: 1979-2011. (Note: The probability values are reported in brackets)

	t-statistics	
Variable	Core countries	Periphery countries
GDP	-1.67122	-0.32209
	(0.7585)	(0.9888)
Gov. Spending	-2.19117	-2.60699
	(0.4878)	(0.2785)
Taxes	0.775262	-2.17394
	(0.8788)	(0.2173)
Inflation	-2.61199	-2.48109
	(0.2764)	(0.3365)
Interest rate	-2.33852	-2.62078
	(0.4087)	(0.2725)

Table 1b. Augmented Dickey-Fuller (ADF) unit root tests for the series in levels. Sample: 1991-2011. (Note: The probability values are reported in brackets)

	t-statistics	
Variable	Core countries	Periphery countries
GDP	-9.887870	-8.258572
	(0.0000)	(0.0000)
Gov. Spending	-6.138669	-11.92222
	(0.0000)	(0.0000)
Inflation	-7.619518	-4.753526
	(0.0000)	(0.0009)
Interest rate	-9.238484	-9.841878
	(0.0000)	(0.0000)

Table 2a. Augmented Dickey-Fuller (ADF) unit root tests for differenced series. Sample: 1979-2011 (Note: The probability values are reported in brackets)

	t-statistics	
Variable	Core countries	Periphery countries
GDP	-6.12945	-6.833655
	(0.0000)	(0.0000)
Gov. Spending	-7.60024	-3.32618
	(0.0000)	(0.0169)
Taxes	-5.752758	-3.30688
	(0.0000)	(0.0178)
Inflation	-7.67441	-7.36834
	(0.0000)	(0.0009)
Interest rate	-7.78579	-6.48494
	(0.0000)	(0.0000)

Table 2b. Augmented Dickey-Fuller (ADF) unit root tests for differenced series. Sample: 1991-2011 (Note: The probability values are reported in brackets)

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-70.06	NA	3.88e-05	1.194	1.28	1.23
1	733.04	1541	1.19e-10	-11.50	-11.0	-11.3
2	778.47	84.26	7.41e-11*	-11.97*	-11.1*	-11.6*
3	789.53	19.78	8.04e-11	-11.89	-10.7	-11.4
4	797.18	13.19	9.23e-11	-11.76	-10.2	-11.1
5	819.56	37.18*	8.38e-11	-11.86	-9.95	-11.0
6	829.15	15.30	9.38e-11	-11.76	-9.48	-10.8
7	843.41	21.85	9.77e-11	-11.73	-9.09	-10.6
8	855.50	17.74	1.06e-10	-11.66	-8.66	-10.4

* indicates lag order selected by the criterion

LR: sequential modified LR test statistic (each test at 5% level)

FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

Table 3a. Lag length Selection for core countries. Sample: 1979-2011.

We choose the lag of 2 since the residual correlograms for VAR(2) are considerably better than the others.

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-265.97	NA	0.000915	4.35	4.44	4.39
1	625.52	1711	6.74e-10	-9.76	-9.31*	-9.58*
2	649.07	43.68	5.97e-10	-9.88	-9.06	-9.55
3	662.22	23.53	6.27e-10	-9.84	-8.65	-9.36
4	680.42	31.41	6.07e-10	-9.87	-8.33	-9.24
5	701.08	34.32	5.67e-10	-9.95	-8.04	-9.17
6	722.25	33.79*	5.26e-10*	-10.0*	-7.76	-9.11
7	736.52	21.87	5.48e-10	-10.0	-7.37	-8.93
8	745.84	13.66	6.21e-10	-9.90	-6.89	-8.68

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

Table 3b. Lag length Selection for periphery countries. Sample: 1979-2011.

We choose the lag of 6 since the residual correlograms for VAR(2) are considerably better than the others.

Lag	LogL	LR	FPE	AIC	SC	HQ
0	186.69	NA	7.74e-12	-2.88	-2.70	-2.80
1	1451.9	2346	2.99e-20	-22.25	-20.61*	-21.59*
2	1538.6	149.6	2.09e-20	-22.62	-19.53	-21.36
3	1594.0	88.41	2.48e-20	-22.48	-17.93	-20.63
4	1649.9	82.13	3.00e-20	-22.35	-16.35	-19.91
5	1746.3	128.9	1.97e-20	-22.87	-15.41	-19.84
6	1824.7	94.83	1.83e-20	23.10	-14.19	-19.48
7	1899.5	80.88	1.94e-20	-23.28	-12.91	-19.07
8	1997.7	93.46*	1.55e-20*	-23.83*	-12.00	-19.03

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

Table 3c. Lag length Selection for the open economy model. Sample: 1979-2011.

We choose the lag of 8 since the residual correlograms for VAR(8) are considerably better than those for the VAR(1) as suggested by SC and HQ.

Data Trend	None	None	Linear	Linear	Quadratic
Test Type	No Intercept	Intercept			
	No Trend	No Trend	No Trend	Trend	Trend
Trace	2	2	1	2	1
Max-Eig	2	2	1	1	1

*Critical values based on MacKinnon-Haug-Michelis (1999)

Table 4a. Johansen Cointegration Test for core countries. Sample: 1979-2011.

We choose the linear model with intercept and trend since the AIC criteria is minimal, which suggests that there are 2 cointegrating values.

Data Trend	None	None	Linear	Linear	Quadratic
Test Type	No Intercept	Intercept			
	No Trend	No Trend	No Trend	Trend	Trend
Trace	2	2	2	2	2
Max-Eig	2	2	2	3	2

*Critical values based on MacKinnon-Haug-Michelis (1999)

Table 4b. Johansen Cointegration Test for periphery countries. Sample: 1979-2011

We choose the linear model with intercept and trend since the AIC criteria is minimal, which suggests that there are 2 cointegrating values.

Data Trend	None	None	Linear	Linear	Quadratic
Test Type	No Intercept		Intercept		
	No Trend	No Trend	No Trend	Trend	Trend
Trace	5	6	5	6	6

Max-Eig	2	3	3	2	2

*Critical values based on MacKinnon-Haug-Michelis (1999)

Table 4c. Johansen Cointegration Test. Sample: 1979-2011.

We choose the linear model with intercept and trend since the AIC criteria is minimal, which suggests that there are 6 cointegrating values.

Lag	LogL	LR	FPE	AIC	SC	HQ
0	207	NA	4.03e-09	-5.13	-4.83	-5.01
1	591.69	697.8	3.62e-13	-14.46	-13.39	-14.03
2	650.89	99.94	1.51e-13	-15.34	-13.52*	-14.61
3	689.17	59.65	1.09e-13	-15.69	-13.10	-14.65
4	730.49	59.02	7.48e-14	-16.11	-12.76	-14.77*
5	764.84	44.61*	6.31e-14	-16.35	-12.25	-14.71
6	796.44	36.93	5.95e-14	-16.53	-11.66	-14.58
7	831.07	35.97	5.46e-14*	-16.78*	-11.14	-14.52

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

Table 5a. Lag length Selection. Sample: 1991-2011.

We choose the lag of 5 since the residual correlograms for VAR(8) are considerably better than the other.

Lag	LogL	LR	FPE	AIC	SC	HQ
0	357.6	NA	8.24e-11	-9.03	-8.72	-8.90
1	660.4	550.5	6.07e-14	-16.2	-15.1*	-15.8
2	686.9	44.67	5.90e-14	-16.2	-14.4	-15.5
3	728.0	64.03	3.98e-14	-16.7	-14.1	-15.6
4	782.5	77.82	1.94e-14	-17.4	-14.1	-16.1*
5	814.6	41.79*	1.73e-14*	-17.6	-13.5	-16.0
6	833.8	22.36	2.25e-14	-17.5	-12.6	-15.5
7	869.8	37.42	1.99e-14	-17.7*	-12.1	-15.5

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion

SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

Table 5b. Lag length Selection. Sample: 1991-2011.

We choose the lag of 5 since the residual correlograms for VAR(8) are considerably better than the other.

Lag	LogL	LR	FPE	AIC	SC	HQ
0	579.0	NA	4.44e-19	-13.8	-13.5	-13.7
1	1438	1488	4.07e-27	-32.4	-29.1*	-32.1*
2	1573	200.4*	1.94e-27*	-34.2*	-27.0	-30.7
3	1716	201.4	2.55e-28	-33.6	-26.3	-31.8
4	1869	247.5	1.30e-28	-33.9	-24.6	-32.0
5	2050	228.1	1.29e-29	-34.0	-23.7	-32.0

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

Table 5c. Lag length Selection. Sample: 1991-2011.

We choose the lag of 2 since the residual correlograms for VAR(2) are considerably better than those for the VAR(1) as suggested by SC and HQ.

Data Trend	None	None	Linear	Linear	Quadratic
Test Type	No Intercept	Intercept			
	No Trend	No Trend	No Trend	Trend	Trend
Trace	3	2	2	2	2
Max-Eig	0	0	0	0	0

*Critical values based on MacKinnon-Haug-Michelis (1999)

Table 6a. Lag length Selection for core country. Sample: 1991-2011

We choose the linear model with intercept and trend since the AIC criteria is minimal, which suggests that there are 2 cointegrating values.

Data Trend	None	None	Linear	Linear	Quadratic
Test Type	No Intercept	Intercept			
	No Trend	No Trend	No Trend	Trend	Trend
Trace	4	5	5	4	2

Max-Eig	4	1	1	1	0

*Critical values based on MacKinnon-Haug-Michelis (1999)

Table 6b. Lag length Selection for periphery country. Sample: 1991-2011

We choose the linear model with intercept and trend since the AIC criteria is minimal, which suggests that there are 4 cointegrating values.

$_{Data\ Trend}$	None	None	Linear	Linear	Quadratic
$_{Test\ Type}$	No Intercept	Intercept			
	No Trend	No Trend	No Trend	Trend	Trend
Trace	7	8	8	8	6
Max-Eig	4	5	5	4	4

*Critical values based on MacKinnon-Haug-Michelis (1999)

Table 6c. Johansen Cointegration Test. Sample: 1991-2011.

We choose the linear model with intercept and trend since the AIC criteria is minimal, which suggests that there are 4 cointegrating values.

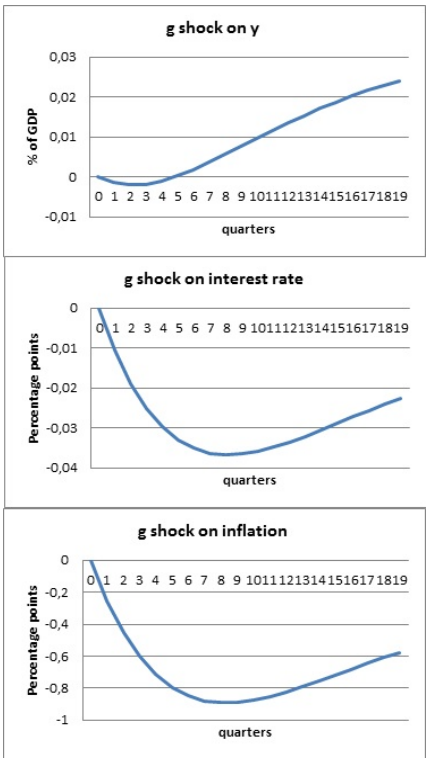

Figure 1: Core countries. Effects of a shock to to government spending (g) equal to one percent of GDP on real GDP (y), inflation and real interest rate. Sample: 1979 - 2011.

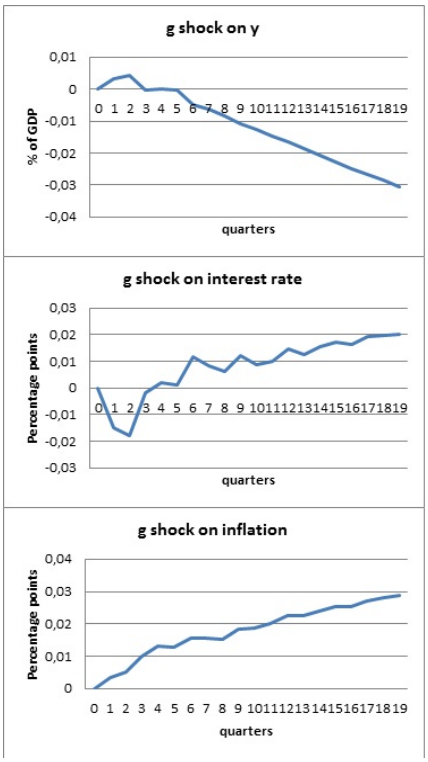

Figure 2: Periphery countries. Effects of a shock to a shock to government spending (g) equal to one percent of GDP on real GDP (y), inflation and real interest rate. Sample: 1979 - 2011.

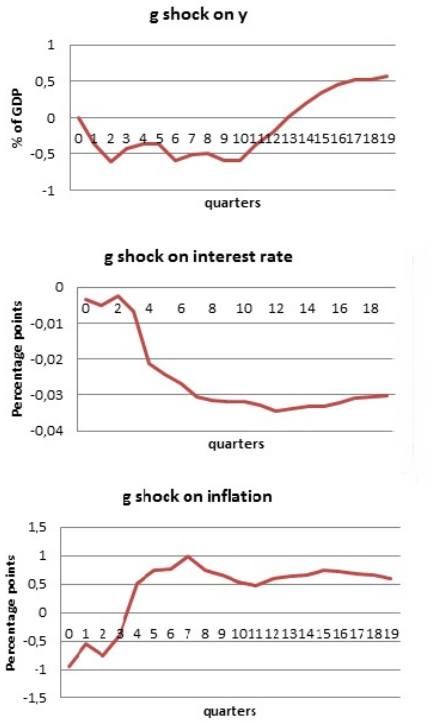

Figure 3: Core countries. Effects of a shock to government spending (g) equal to one percent of GDP on real GDP (y), inflation and real interest rate. Sample: 1991 - 2011.

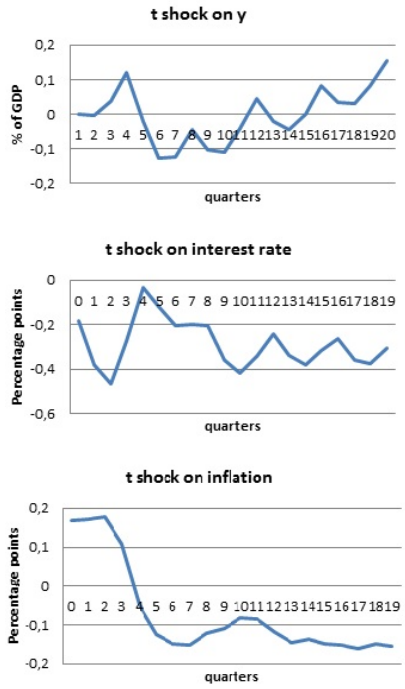

Figure 4: Core countries. Effects of a shock to a shock to taxes (t) equal to one percent of GDP on real GDP (y), inflation and real interest rate. Sample: 1991 - 2011.

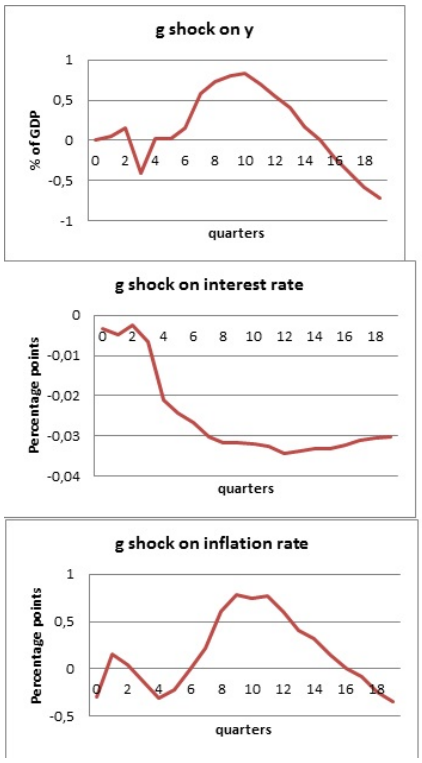

Figure 5: Periphery countries. Effects of a shock to government spending (g) equal to one percent of GDP on real GDP (y), inflation and real interest rate. Sample: 1991 - 2011.

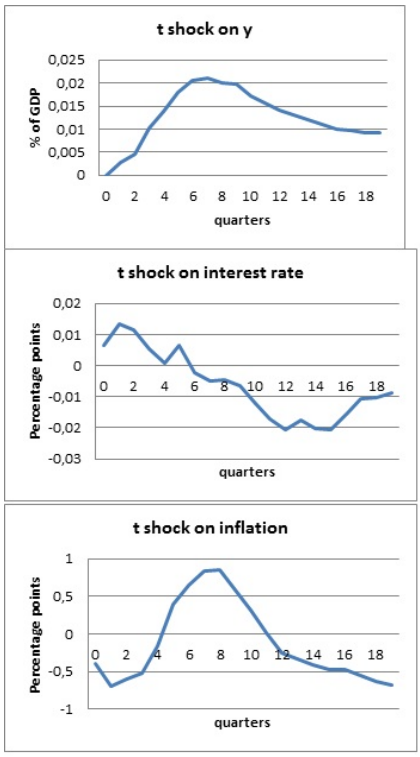

Figure 6: Periphery countries. Effects of a shock to taxes (t) equal to one percent of GDP on real GDP (y), inflation and real interest rate. Sample: 1991 - 2011.

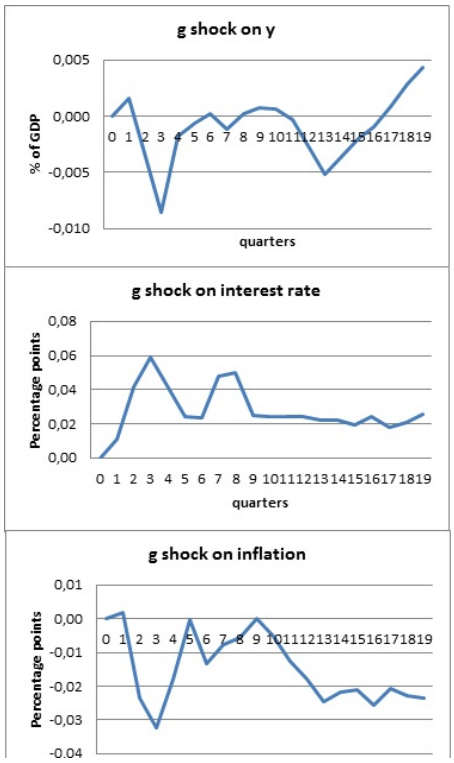

Figure 7: Effects of a core countries government spending shock equal to one percent of GDP on GDP of periphery countries. Sample: 1979 - 2011.

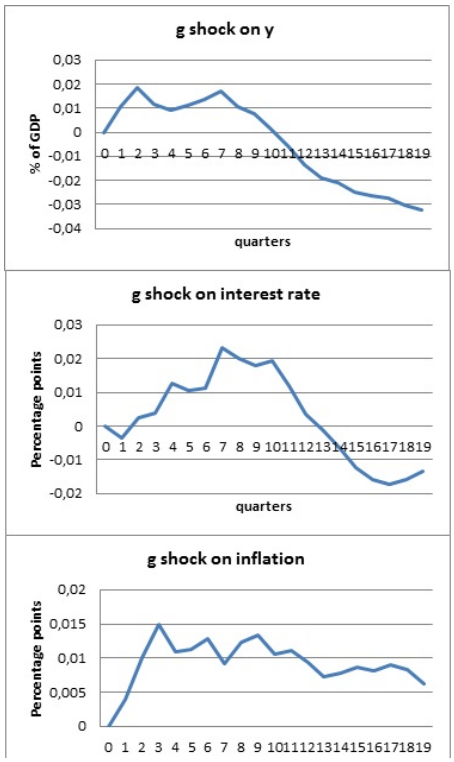

Figure 8: Effects of a periphery countries government spending shock equal to one percent of GDP on GDP of periphery countries. Sample: 1979 - 2011.

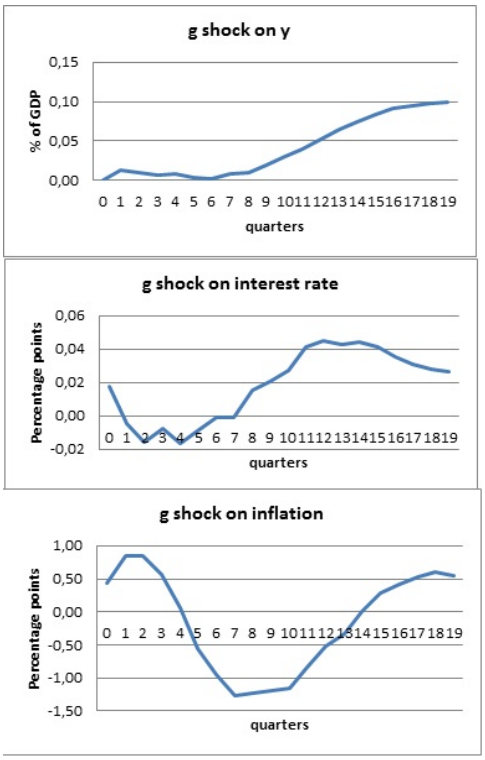

Figure 9: Effects of a periphery countries government spending shock (g) equal to one percent of GDP on GDP of core countries. Sample: 1991 - 2011.

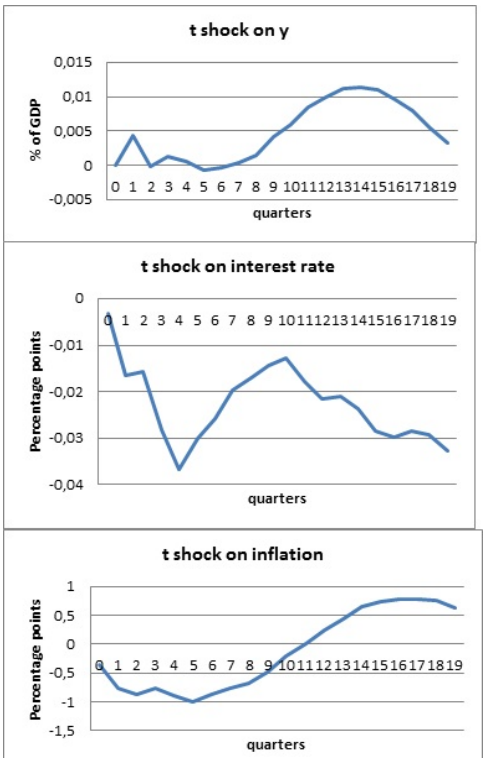

Figure 10: Effects of a periphery countries tax shock (t) equal to one percent of GDP on GDP of core countries. Sample: 1991 - 2011.

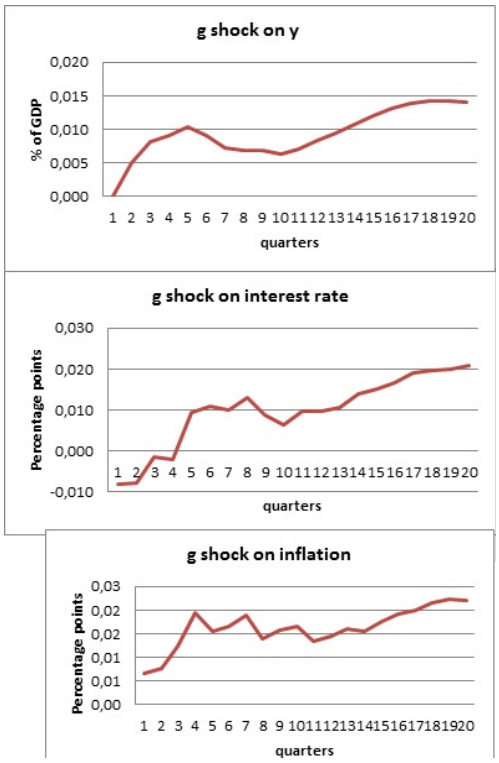

Figure 11: Effects of a core countries government spending shock (g) equal to one percent of GDP on GDP of periphery countries. Sample: 1991 - 2011.

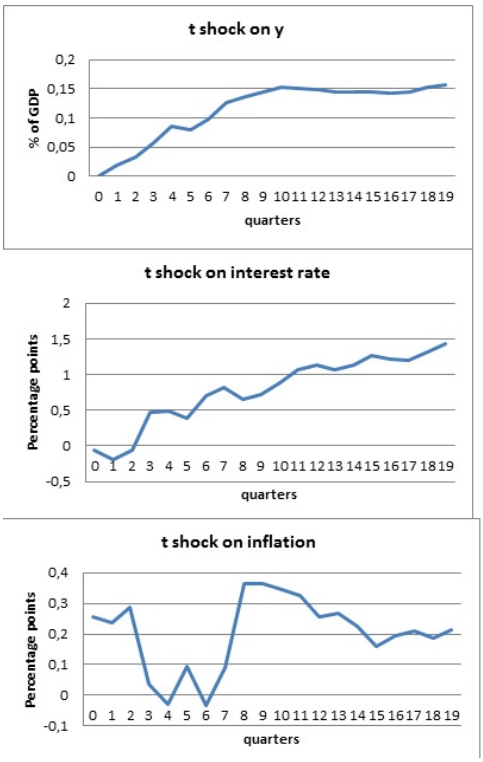

Figure 12: Effects of core countries tax shock (t) equal to one percent of GDP on GDP of periphery countries. Sample: 1991 - 2011.

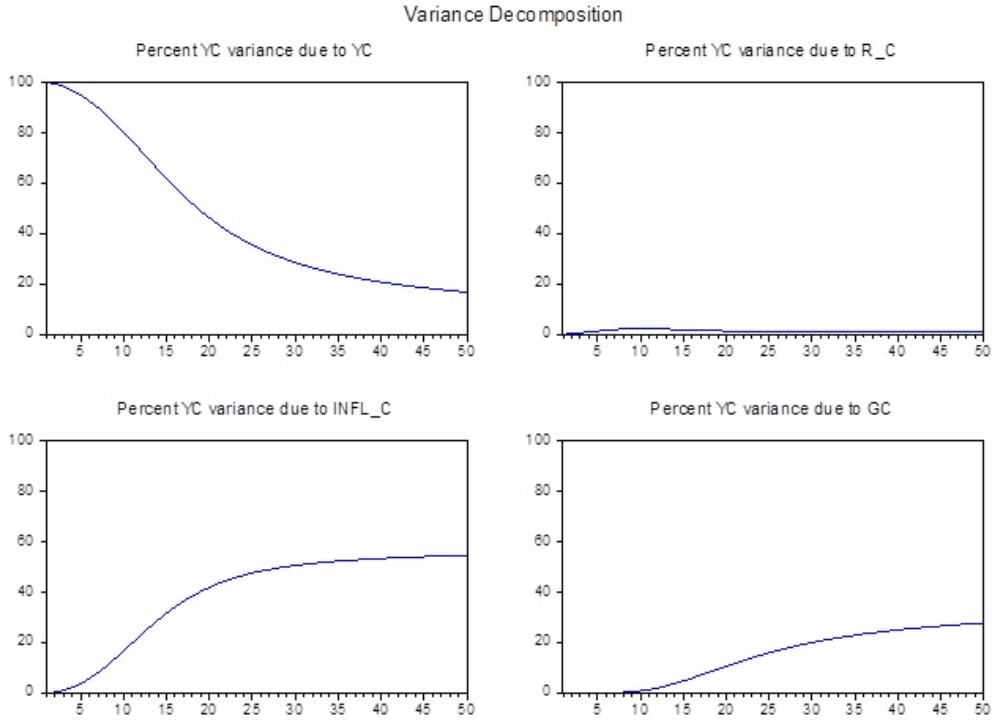

Figure 13: Forecast error variance decomposition. Percentage of GDP variance explained by tax shocks (tc), government spending shocks (gc), interest rate (rc) and inflation (inflc) shocks. Sample: 1979-2011.

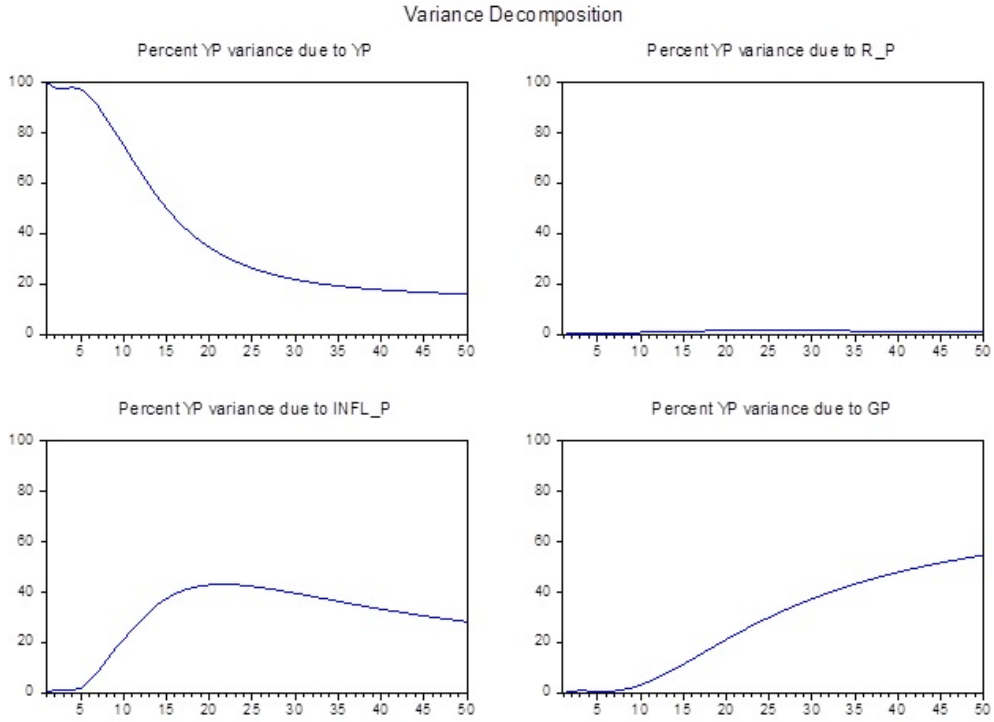

Figure 14: Forecast error variance decomposition. Percentage of GDP variance explained by tax shocks (tp), government spending shocks (gp), interest rate (rp) and inflation (inflp) shocks. Sample: 1979-2011.

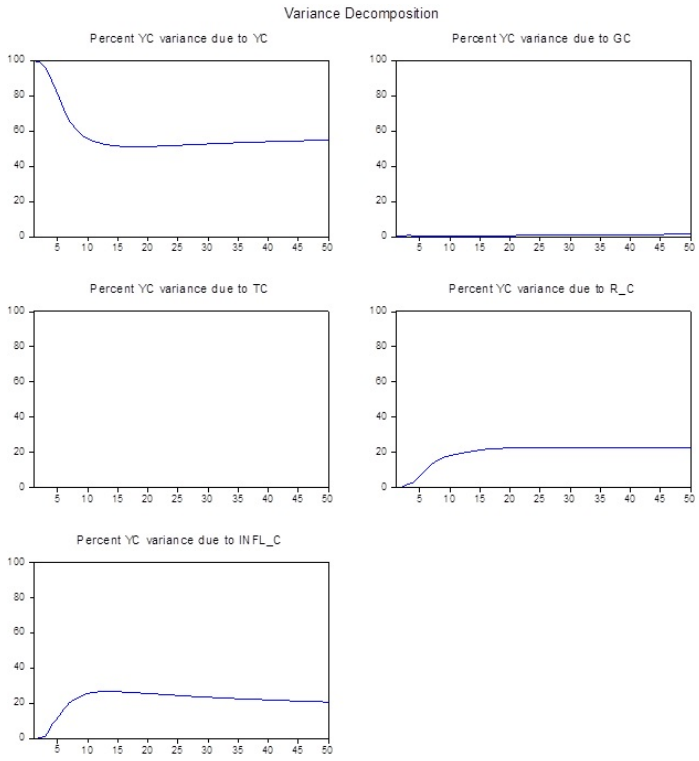

Figure 15: Forecast error variance decomposition. Percentage of GDP variance explained by tax shocks (tc), government spending shocks (gc), interest rate (rc) and inflation (inflc) shocks. Sample: 1991-2011.

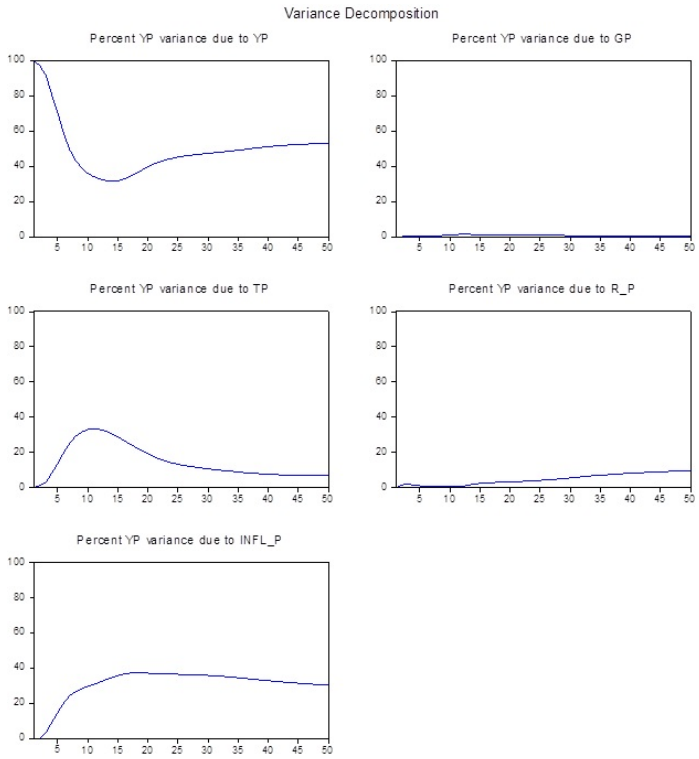

Figure 16: Forecast error variance decomposition. Percentage of GDP variance explained by tax shocks (tp), government spending shocks (gp), interest rate (rp) and inflation (inflp) shocks. Sample: 1991-2011.

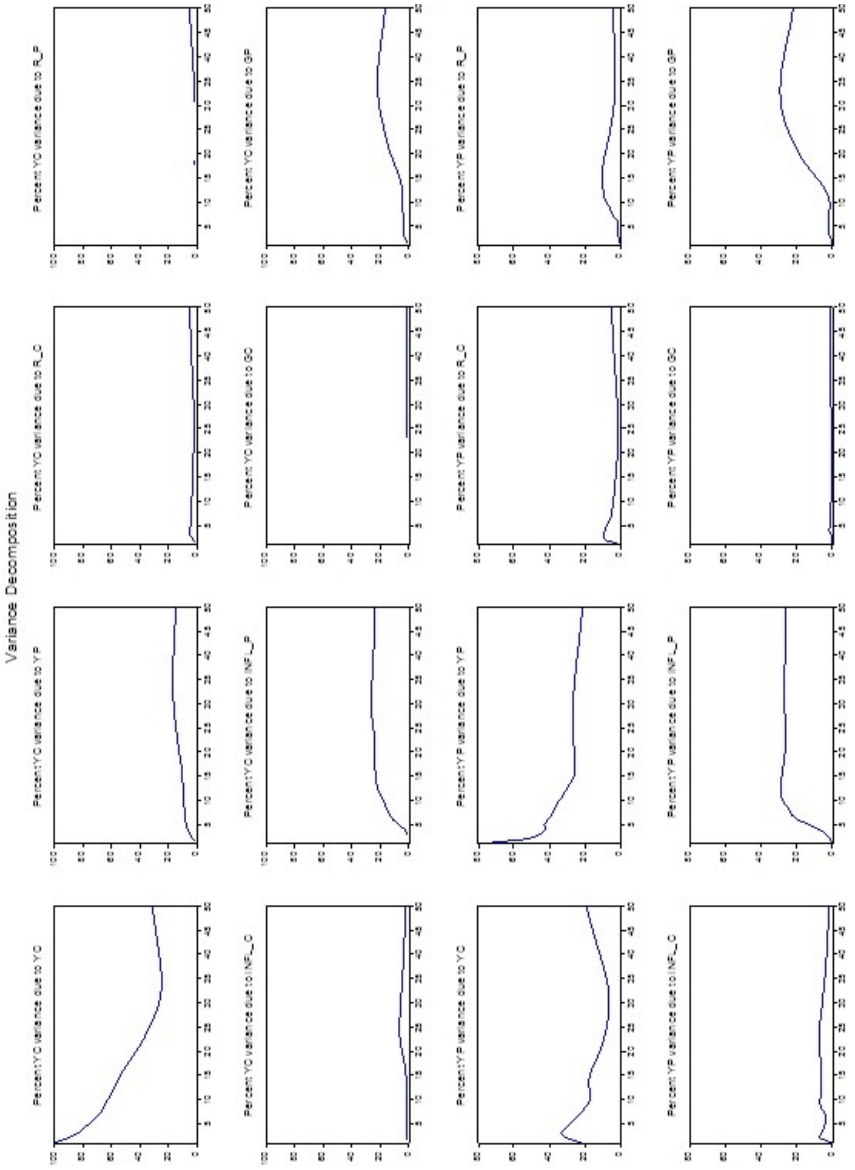

Figure 17: Forecast error variance decomposition. Percentage of GDP variance explained by tax shocks, government spending shocks, shocks in interest and inflation rates. Sample: 1979-2011.

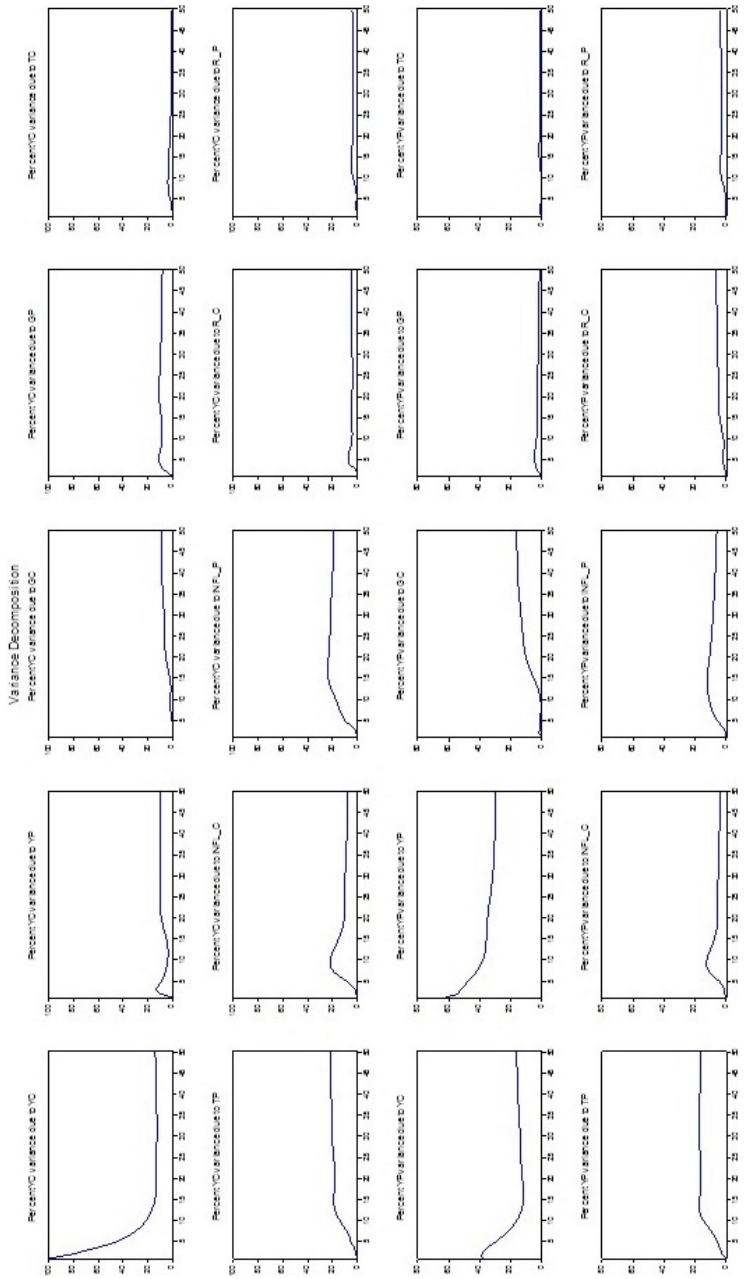

Figure 18: Forecast error variance decomposition. Percentage of GDP variance explained by tax shocks, government spending shocks, shocks in interest and inflation rates. Sample: 1991-2011.

Ягафарова, А. Е. Мультипликаторы и внешние эффекты фискальной политики на примере стран Европы : препринт WP12/2012/05 [Текст] / А. Е. Ягафарова ; Нац. исслед. ун-т «Высшая школа экономики. – М. : Изд. дом «Высшей школы экономики», 2012. – 66 с. (на англ. яз.)

В данной работе построена статическая модель для двух стран. Целью является анализ краткосрочных мультипликаторов и внешних эффектов фискальной политики в монетарном союзе. Монетарный союз рассматривается на примере двух стран, которые представляют собой большие открытые экономики. Эмпирический анализ оценки мультипликаторов и внешних эффектов основан на использовании модели векторной коррекции ошибок (VECM) на примере стран Еврозоны в период с 1979 по 2011 г. Результаты оценки показывают, что фискальные мультипликаторы являются положительными, но небольшими, предполагая, что эффект вытеснения является достаточно большим. Внешние эффекты также положительны. Кроме того, мультипликатор и внешний эффект от проведения политики изменения государственных расходов по абсолютной величине больше, чем от проведения политики изменения налогов.

Ключевые слова: большая открытая экономика, фискальная политика, внешний эффект фискальной политики, модель векторной коррекции ошибок, еврозона.

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Серия WP12
Научные доклады Лаборатории макроэкономического анализа

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(*на английском языке*)