Public spending, monetary policy and growth: Evidence from EU countries

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Abstract

This study examines whether differences in monetary policy are associated with diverging effects of public spending on growth. At first stage, we estimate public spending multipliers for each country of the European Union (EU). Their size varies considerably across countries. Then we incorporate in the analysis the role of monetary policy and examine whether real interest rates affect the relationship between public spending and growth. The main result of the econometric analysis is that government spending can affect growth positively only when real interest rates become negative. This result remains robust to several changes in the econometric specification and measures of interest rate.

Keywords: Public spending, Fiscal multipliers, Monetary policy, Economic growth.

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1. Introduction

Following the 2007-2008 crisis, the response of fiscal policy became highly expansionary in several countries. A lot of European Union (EU) economies adopted fiscal stimulus measures to address weaknesses in the financial sector and restore aggregate demand. During the same period, central banks reduced nominal interest rates to unprecedented levels as a means to increase liquidity in the private sector. Real interest rates still remain negative for most EU countries.

As a result fiscal positions of many countries deteriorated leading to higher public sector deficits and rapid accumulation of government debt. At a later stage, the fiscal policy stance shifted into a restrictive regime across several EU countries in response to the deepening of the sovereign debt crisis. Figure 1 briefly illustrates the percentage of GDP that each EU country allocates to public spending in the form of public consumption and public investment.

The question that arises is whether and to what extent has fiscal policy of recent years affected growth of EU countries? And if so, is this effect uniform across countries? This paper tries to answer this question by putting emphasis on the role of monetary policy in shaping the relation between public spending and growth. This study relates to a number of recent studies having examined the impact of fiscal policy in the USA using structural Dynamic Stochastic General Equilibrium (DSGE) models. We try to empirically answer the same question for a number of EU countries.

At first stage we follow the approach of Balnchard and Perotti (2002) to set up a structural VAR econometric framework and estimate multipliers of public spending. Quarterly time series datasets are compiled for each EU country. The obtained econometric results confirm that responses of output after a shock in government spending are not uniform and vary significantly across EU countries. The influence on output is positive for the majority EU countries. However it remains low or becomes even negative for fewer ones.

Next we incorporate in the analysis the role of monetary policy. Based on annual cross country data covering the period 2004-2014, we examine whether the real interest rate affects the relationship between public spending and growth. The main result that arises from the econometric analysis is that monetary policy indeed matters in shaping the influence of public spending on growth. It is shown that its impact on output can be effective only when real interest rates become negative. This result remains robust to several changes in the econometric specification and measures of monetary policy.

The paper proceeds as follows: section 2 discusses the findings of the relevant literature. Section 3 estimates fiscal multipliers for EU countries. Section 4 discusses the role of monetary policy in the EU. Section 5 examines the influence of the real interest rate on the public spending-growth relation. Finally, section 6 concludes.

2. Related literature

This study is related to a large literature which examines the effects of fiscal policy on growth. Predictions of the literature are ambiguous as regards the influence of public spending on growth. General equilibrium new Keynesian models show that the government spending multiplier can be close or above one (Gali et al. 2007; Monacelli and Perotti 2008). On the other hand, standard real business cycle models are in sharp contrast to new Keynesian ones and deliver multipliers which are well below one (Baxter and King 1993; Burnside et al. 2004; Ramey 2011). The main reason for such significant variation is that real business cycle models feature infinitely lived Ricardian households, whose consumption depends on an intertermporal budget constraint. Therefore any increase in government spending lowers the present value of income after taxes, generates negative wealth effects and leads to a decrease in consumption. [2]

Similarly, predictions of the empirical literature on the effects of fiscal policy are not uniform. Blanchard and Perotti (2002) show that shocks in government spending are associated with higher output of the US economy during the post war period, with the size of the multiplier being close to one. Monacelli et al. (2010) estimate a VAR model to evaluate the effects of U.S. government spending on output and employment. Their results are in favor of a multiplier which is larger than one.

On the contrary, a part of the literature has identified non Keynesian effects of fiscal policy on output. Perotti (1999) evidenced several countries whose private consumption increased rather than contracted in periods of large fiscal consolidation and showed that in such periods the influence of fiscal policy is very different than in 'normal' times. Alesina and Ardagna (2010) showed that fiscal stimulus based on tax cuts is more likely to increase growth as compared to fiscal expansion based on spending increases. They also showed that adjustments based on spending cuts rather than tax increases are less likely to create recessions. In the same spirit Mountford and Uhlig (2009) showed that deficit financed government spending has weaker effects on

[2] Several studies have tried to reconcile predictions of neoclassical models with observed evidence which were in favor of a raise in consumption after an increase in government spending. Gali et al. (2007) extended a standard new Keynesian model to allow for the co-existence of infinite horizon Ricardian consumers and 'rule of thumb' consumers, which do not save and do not borrow. They showed that an interaction of rule of thumb consumers with sticky prices and deficit financing of government spending can account for higher consumption when spending increases. In a similar way, Hall (2009) developed a dynamic general equilibrium model which has as main features the decline in markups of prices over costs when output raises and the elastic response of employment when demand increases. With these features the model delivers quite high multipliers and increase in consumption. Recently, Cogan et al. (2010) showed that government spending multipliers are much smaller in new Keynesian models than old Keynesian ones, with the estimated stimulus in GDP being one sixth of what is predicted in old Keynesian ones.

output of the US economy as compared to deficit financed tax cuts. It seems, however, that the impact of fiscal policy on private consumption and output has become weaker over time, with the influence being stronger in the pre 1980 period (Perotti 2005; 2007).

Another part of the literature shows that the response of output depends on country specific characteristics related to the exchange rate regime, trade openness, level of development and public sector debt (Chung and Leeper 2007; Favero and Giavazzi 2007; Ilzetzki et al. 2013). A number of recent studies has demonstrated that the stance of monetary policy matters in determining the growth influence of public spending. Christiano et al. (2011) show that the government spending multiplier can be very large when monetary policy does not respond to changes in prices, mostly in cases when the nominal interest is very close to zero. In contrast, when the central bank follows a Taylor rule, then the value of the government spending multiplier is less than one.

Davig and Leeper (2011) used o DSGE model with price nominal rigidities and Markov-switching rules for U.S. monetary and fiscal policy. They showed that the influence of fiscal policy depends on whether monetary policy remains passive or becomes active. The highest response of output occurs when fiscal policy is expansionary while the central bank policy rate remains unchanged to price increases. Eggertsson (2011) examined the influence of fiscal policy when the short-term nominal interest rate is zero by using a standard new Keynesian DSGE model. His main result implies that cutting taxes on labor or capital is contractionary as it leads to deflationary pressures and increases in the real interest rate. On the contrary, the effect of a temporal increase in government spending is large and much larger than under normal circumstances. Conenen et al. (2012), using seven different structural

DSGE models, showed that fiscal policy, especially in the form of public spending and targeted transfers, is effective in raising output when monetary policy remains accommodative. Moreover, they showed that fiscal policy is mostly effective when it has moderate persistence, while a permanent increase in public spending implies significantly lower fiscal multipliers.

3. Public investment multipliers

A common approach to study the effects of fiscal policy on output is to use a standard VAR model. We start with estimating the following reduced form VAR for each EU country:

$$Z_t = A(L)Z_{t-1} + U_t \quad (1)$$

where $Z_t \equiv (g_t, t_t, y_t)$ is the vector of endogenous variables. This specification includes quarterly data on the logs of government spending (g_t), defined as government consumption plus government investment, taxes net of government transfers (t_t) and GDP (y_t), with all four variables entering in real terms. [3] All variables are seasonally adjusted except the GDP deflator and the interest rate. $A(L)$ is the autoregressive polynomial in the lag operator L and $U_t \equiv (u_t^g, u_t^t, u_t^y)$ is the vector which contains the reduced form residuals.

A major drawback of the standard VAR specification is that if covariance between error disturbances is not zero, which is often the case, then the common component of error innovations is falsely attributed to the first variable entering the VAR. In order to avoid this kind of bias, after estimating the reduced form model of equation (1), we proceed with the estimation of a structural VAR specification to

[3] Several other relevant variables (such as the inflation rate, the current account or the interest rate) could be included in vector Z. However, limited availability of data across time did not allow us to utilize more than 3 variables in our model.

identify exogenous fiscal policy shocks. These shocks are then used to derive impulse responses of output. More details on the construction of the structural VAR model are found in the Appendix.

For each EU country, except Croatia, Greece and Lithuania for which the data availability is very limited, we have compiled quarterly data from the National Accounts' database of Eurostat (2014),. The length of the time span that data covers all variables differs across countries.[4] We have estimated a single VAR model, one for each country, with the optimal number of lags varying across different models. As results often change depending on the number of chosen lags, we set this number equal to 4, as a way to assure that differences across countries are not driven by differences in the number of chosen lags.

After the estimation of the structural VAR's, a series of simulations was performed to trace the impact of shocks in public spending. The shocks were set equal to a positive one standard deviation in the residual of public spending. The impact of these shocks on output is illustrated with impulse responses shown in Figure 2 along with their two standard error confidence intervals. Cumulative public spending multipliers are shown in Table 1 and are defined as the ratio of the cumulative change in output *y* until period *t*, divided by the median interest rate *i*, over the magnitude of the change in the public the spending variable *g* in period *t=0*

$$\textit{Public investment multiplier} = \frac{\sum_{t=1}^{n}(\Delta(y_t)*(1+i)^{-1})}{\Delta(g_{t=0})} \quad (2)$$

For most of the EU countries, we observe that the sign of the government spending multiplier is positive, implying that an increase of public expenditures

[4] For most countries data start either in the first quarter of 1999 or in the first quarter of 2002. Further information is available upon request.

brings about a positive response of GDP. The highest response of output is observed in Germany, Finland, Sweden and Luxemburg for which multipliers remain above 2 eight quarters after the initial shock. For a number of other EU countries we have been provided with positive multipliers which are below one. We also encounter a few countries for which the sign of their multiplier is negative.

Overall, the size and statistical significance (see Figure 2) of fiscal multipliers varies significantly across EU countries implying significant differences on the way the economies are affected by a shock in government spending. The existing empirical literature has proposed a number of reasons for which the effectiveness of fiscal policy differentiates from country to country. In this paper we will try to examine whether the economic outcome of fiscal policy depends on country characteristics related to monetary policy.

4. Monetary policy in the EU

The primary goal of this section is to briefly illustrate monetary policy developments that took place in the EU during the last 10 years. In contrast to other central banks, the main policy objective of the European Central Bank (ECB) is to maintain price stability in the euro area. Further goals of the ECB also include economic growth and financial sector stability. In Figure 3 we observe that pre-crisis real short term interest rates were fairly positive in the majority of the EU economies, with the exception of some countries from eastern Europe. Monetary policy conditions during this period were strict in an attempt of most central banks to fight increasing inflation, mainly pushed by continuing increases in oil and food prices. This policy seemed to work until the end of 2008 when the global financial crisis hit the world economy.[5]

In the years following the subprime and the sovereign debt crisis, monetary policy became the main policy tool to tackle financial instability. However, persistence of low inflation rates as well as ongoing economic depression in the majority of EU countries have brought ECB as well as other central banks in the area of unconventional policies in which nominal interest rates are kept constant at very low levels for prolonged periods. We observe from Figure 4 that real short term interest rates are now negative for the majority of countries in the EU area. Figure 5 also shows that long term interest rates in most EU countries are close or lower than 2%.

It seems that the main policy objective of the ECB during the last years has been to stimulate economic growth and raise the inflation rate which remains close to zero for a long period. Persistence of very low nominal interest rates reflects weaknesses of many industrialized countries to get back to economic recovery. Absence of strong confidence in the private sector as regards future economic developments as well as short expectations for higher aggregate demand have kept shares of private capital formation to their pre crisis levels in the great majority of EU countries. In such a situation, central banks of most countries try to keep their policy rates at low levels to stimulate economic recovery. However, in other countries, prevalence of low interest rates might reflect their primary policy to prevent currency form rising.

[5] It should be notices, the application of a single monetary policy in a diverse economic area entailed pro-cyclicality phenomena in a number of countries in the euro area periphery. In the first years of the euro, the monetary base was growing more rapidly in the euro area periphery, while in years after the advent of the crisis it also fell more steeply in the periphery (Micossi 2015).

5. Public spending, monetary policy and growth

5.1 Econometric model, data and variables

The obtained fiscal multipliers suggest that responses of output after a shock in public spending are not uniform across countries. A meaningful explanation for such variation might be related to differences in monetary policy as reflected by the level of the real interest rate.

The general empirical model used to study the relation between public spending, monetary policy and growth is the following:

$$growth_{it} = a_0 + a_1 pub_{it} + a_2 \operatorname{int}_{it} + a_3 pub_{it} * \operatorname{int}_{it} + \beta X_{it} + u_{it} \quad (3)$$

where $growth_{it}$ is the GDP growth rate of country i at time t, pub_{it} is the share of GDP allocated to public spending in the form of public consumption and public investment and int_{it} is the level of the real interest rate. We wish to examine whether the value of the real interest rate affects the impact of public spending on growth and, therefore, we include in our model the interaction term of public spending with the real interest rate $pub_{it}*int_{it}$. X is a set of other macroeconomic variables which are expected to influence economic growth and u_{it} is the stochastic disturbance. We follow the literature and include in vector X the variables of private investment, tax revenues and trade (exports plus imports), all of them denoted as shares of GDP. We further include the variables of tertiary school enrollment rate, the logarithm of lagged GDP and the lagged growth rates of GDP, to control for convergence effects as well as for dynamic influences of past growth, respectively. Vector X also includes time and country specific effects, in the form of dummy variables, to account for time invariant unobserved heterogeneity and common macroeconomic shocks.

We work with annual data for 28 EU countries which cover the period 2004-2014. The variable of the growth rate of GDP is provided by the Penn World Table

8.0 Database (see Feenstra et al. 2013). Real GDP of countries is expressed at constant 2005 chained PPP dollars. PWT also provides us with the variable of trade, while the variables of public spending (expressed as the sum of public consumption and public investment) and total investment were provided by the National Accounts of Eurostat. Tertiary school enrollment rates and tax revenues were provided by the World Development Indicators (2015). As for the real interest rate variable we use several measures provided by the AMECO Database (2015).

5.2 Basic results

When estimating Equation (3), a possible source of bias could be the existence of unobserved country specific factors which affect growth and are contemporaneously related to policy decisions regarding public spending. In such a case the econometric estimates could be subject to an estimation bias. We have chosen to use the system GMM panel data estimator (see Arellano and Bover 1995; Blundell and Bond 1998) which is the augmented version of the first difference panel data estimator (Arellano and Bond 1991). This estimator eliminates such country specific effects and controls for the presence of endogeneity in covariates included in Equation (3). It has been designed for panel datasets with many panels and few periods as is the case for our model. Instead of the one step estimator, we chose the two step estimator, since it is asymptotically more efficient than the one step estimator and its standard covariance matrix is robust to panel specific autocorrelation and heteroskedasticity. We use its robust version to get the corrected covariance matrix.

Column 1 of Table 2 reports the results when the identification strategy involves only the variable of public spending, time specific and country specific effects. We have allowed for endogeneity of public spending which entails the use of its lagged levels as instruments in the regression. As a rule of thumb for the choice of the number of lags, we chose to keep it at low levels, as a large number of instruments could lead to biased diagnostic tests. Therefore, the public spending variable was instrumented with its once lagged level. The results of the first column clearly suggest that public spending does not affect significantly economic growth.

Columns 2-4 present econometric estimates after successively including in the model the variables of the real short run interest rate, its interaction with public spending and private investment. We construct a multiplicative term between the variable of public spending and the short run interest rate. Given that their correlation might be high, these variables are mean centered (new variables are generated by subtracting their means). In such a way, we are allowed to interpret the coefficient of government spending at the average level of the short term interest rate rather than at the point where it is zero. The results of columns 3-4 in Table 2 show that the interaction term enters the estimated equation with a negative and statistically significant coefficient. This implies that in countries where the real interest rate is high, the growth impact of public spending is inferior. The coefficient estimates of the interaction variable are -0.023 and -0.027 (column 3 and column 4, respectively). These point estimates will be used later to assess the growth contribution of public spending at various levels of the short run interest rate.

The estimates of Table 2 confirm that the impact of private investments on growth is positive and statistically significant. The variable of the short run interest rate is negative and statistically significant only in the estimates shown in column 2. Its influence on growth becomes statistically insignificant in the estimates shown in columns 3-4.

The system GMM panel data estimator reports several diagnostic tests. The first one is the Hansen test which tests for the validity of instrumental variables. The hypothesis being tested is that they are uncorrelated with the residuals and therefore are acceptable instruments. The GMM estimator also reports a test for autocorrelation, which is applied to the first differenced residuals. If the null of no autocorrelation is rejected, then the test indicates that lags of the used instruments are in fact endogenous and thus are considered as weak instruments. The results of both tests verify that the instruments are not correlated with the residuals and that no autocorrelation exists in the first differenced residuals.

5.3 Robustness analysis

We examine the robustness of the obtained results by extending the empirical specification. We first test whether the inclusion of other relevant macroeconomic variables affects the obtained results. Next, we examine whether estimates remain unchanged when including the long run interest rate instead of the short run interest rate in the baseline specification.

The robustness analysis is conducted on model 4 of Table 2, which is our preferred model specification. In the first five columns of Table 3 we report results when the baseline specification involves the variables of the volume of trade, tax revenues (both expressed as shares of GDP), the variable of the tertiary school enrolment rate, the lagged level of GDP and the once lagged GDP growth rate. We also test whether the choice for the number of lags as instruments for the variable of public spending affects the obtained results. Therefore we repeat econometric estimates when the specification includes two lags as instruments for the variable of public spending. We also report results after treating the variable of private investment as endogenously determined, as it might be affected by past outcomes of growth or may be correlated with the error term. Finally, we report results when GDP growth is regressed on the once lagged level of the short run interest rate. In such a way we control for reverse causality between economic growth and monetary policy. The obtained results for most variables remain practically unchanged. The coefficient estimates of the interaction variable between public spending and the interest rate remain statistically significant and range between -0.015 and -0.031 across various specifications.

Table 4 repeats the econometric estimates shown in Tables 2 and 3 when the baseline specification involves the real long run interest rate instead of the short run policy rate. Although reported estimates on the variables of public spending and long run interest rate are not always statistically significant, their multiplicative term remains negative and statistically significant for most econometric specifications.

Public consumption and public investment are likely to entail quite different influences on output. In order to control for varying influences of these components on GDP, the baseline specification is further elaborated by breaking down the variable of total public spending to the variables of public consumption and public investment. Estimates of Table 5 show that output is mostly affected by government consumption whose impact on growth is negative and statistically significant in all specifications. The influence of public investment on growth is positive but not statistically significant while coefficient estimates of the interactions of public spending, public consumption and public investment with the interest rate remain negative and statistically significant.

As a final check, we explore whether coefficient estimates of interactions of public spending with the interest rate differentiate at various growth regimes. Without using any formal technique, we have created three dummy variables which identify three different growth regimes. The first one proxies for low or negative growth rates and receives ones when the variable of the GDP growth rate is below 1%. The second one accounts for medium growth rates, between 1% and 3% and the third one for relatively high growth rates, above 3%. Table 6 reports econometric estimates based on interactions of these dummy variables with the multiplicative terms of public spending with the interest rate. All interactions of these dummy variables with multiplicative terms remain negative. However the only statistically significant interaction term is based on the dummy variable which proxies for low and negative growth regime, indicating that a combination of high public spending and expansionary monetary policy is relevant only when GDP growth rates are low or negative.

5.4 Discussion

The interpretation of the main coefficient of public spending (a_1) is its effect on growth when the real interest rate is zero. This becomes evident when taking the partial derivative of equation (3) with respect to public spending:

$$\frac{\partial(growth_{it})}{\partial(pub_{it})} = \alpha_1 + \alpha_3 * \text{int}_{it} \quad (4)$$

Similarly, when estimating a model with interaction terms, the resulting output of standard errors is misleading. We re-calculate standard errors of public spending conditional on various levels of the real interest rate (int=x_j) with the following formula:

$$s_{a_1+a_3 \text{int}|\text{int}=x_j} = (\text{var}[a_1] + x_j^2 \,\text{var}[a_3] + 2x_1 \,\text{cov}[a_1, a_3])^{\frac{1}{2}} \quad (5)$$

We get a more realistic insight into the influence of public spending on growth by using equations (4-5) as well as regression results reported in Table 2 (column 4). The variances and co-variance matrix in (5) are directly obtained from the variance-covariance matrix in the original output.

Figure 6 provides us with estimates of the growth contribution of public spending (vertical axis) at various levels of the real short term interest rate (horizontal axis) along with its two standard error confidence intervals. We observe that the impact of public spending is positive and statistically significant only at negative levels of the real interest rate. However, as its value increases at levels higher than zero the growth impact of fiscal policy becomes negative, implying that monetary policy really matters when assessing the growth contribution of public spending.

It seems that the influence of government spending on output can become large when monetary policy does not respond to changes in fiscal policy, mostly in cases when the nominal interest is close to zero. In such a case, an increase in government spending leads to an initial rise in output. With nominal interest rates held constant at zero, the expected rise in inflation drives down the real interest rate. Thus, private spending increases and this in turn leads to a further increase of output. On the contrary, when monetary policy responds by increasing the nominal interest rate the impact of public spending on growth becomes lower.

The main policy lesson to be learned from this study is that fiscal policy can be an effective tool for raising output in periods when the nominal interest rates approach the zero lower bound or when the economies suffer from insufficient demand. In such cases, economic policy should focus on ways to increase government spending. On the other hand fiscal policies that expand supply, via cuts in direct income taxation, may induce deflationary pressures and bring about negative effects on growth.

6. Concluding remarks

The purpose of this study was to examine whether differences in real interest rates account for the influence of public spending on growth of EU countries. The associated fiscal multipliers confirm that the response of output after a shock in government spending is positive for the majority EU countries. However, significant disparities exist between countries on the magnitude of public spending multipliers.

Panel data econometric results show that the influence of government expenditure on growth can be positive and significant only when the real interest rates become negative. This result remains robust to several changes in the econometric specification and measures of monetary policy.

The impact of fiscal policy on growth is still an open issue. Further research may focus on which components of GDP are mostly affected by expansionary fiscal policy or on whether country specific factors related to bureaucracy or corruption account for the influence of fiscal policy.

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Appendix

Relying on Blanchard and Perotti (2002) and Perotti (2005), the reduced form residuals for government spending u_t^g and taxes u_t^t can be expressed as a linear function of: (a) automatic responses to movements in the variable of GDP, (b) discretionary response of fiscal policy to macroeconomic news and (c) random exogenous fiscal policy shocks (e_t^g, e_t^t). The latter components are the structural shocks in government spending and taxes that we try to indentify in order to measure responses of output. The reduced form residuals for government spending u_t^g, and net taxes u_t^t can be represented as:

$$u_t^g = a_{g,y} u_t^y + \beta_{g,t} e_t^t + e_t^g \quad \text{(A1)}$$

$$u_t^t = a_{t,y} u_t^y + \beta_{t,g} e_t^g + e_t^t \quad \text{(A2)}$$

In order to recover structural residuals from the reduced form VAR, we need to have estimates for the $a_{i,j}$*'s* and $\beta_{i,j}$*'s*. The use of quarterly data allows us to set the contemporaneous response of discretionary fiscal policy to innovations in GDP equal to zero, since it takes more than a quarter to approve and implement new measures. Therefore, the $a_{i,j}$*'s* coefficients in equations (A1) and (A2) only reflect automatic responses of fiscal variables to movements in the variable of GDP.

The output elasticity of government spending $a_{g,y}$ is set equal to zero, as there is no evidence in favor of any substantial response of this variable to changes in GDP, within one quarter. The output elasticities of net taxes have been obtained from Veld et al. (2012).[6] Once output and price elasticities have been obtained, the fiscal shocks can be expressed in the following way:

$$u_t^g - a_{g,y} u_t^y = \beta_{g,t} e_t^t + e_t^g \quad \text{(A3)}$$

[6] In countries for which we do not have available the elasticities of taxes to GDP, we use the average of the Euro area countries.

$$u_t^t - a_{t,y} u_t^y = \beta_{t,g} e_t^g + e_t^t \quad \text{(A4)}$$

We have assumed that spending decisions come first and taxes follow so that $\beta_{g,t} = 0$. The reduced form residuals for GDP are a linear combination of fiscal variable shocks:

$$u_t^y = \gamma_{y,g} u_t^g + \gamma_{y,t} u_t^t + e_t^y \quad \text{(A5)}$$

The final econometric specification can be written as:

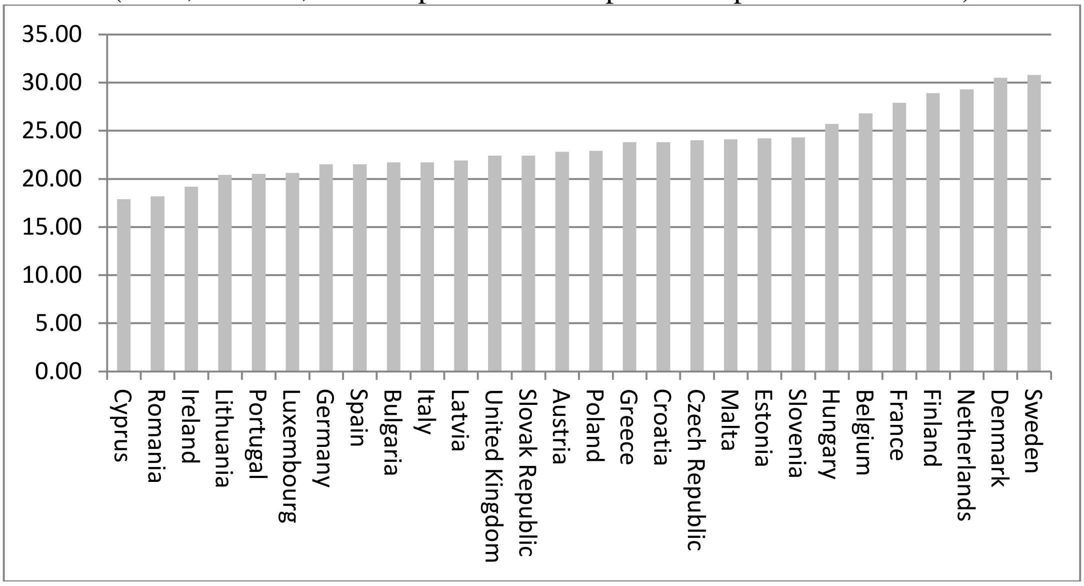
$$AU_t = BV_t \quad \text{(A6)}$$

where $V_t \equiv (e_t^g, e_t^t, e_t^y)$ is the vector including orthogonal structural shocks, with:

$$A = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & -a_{t,y} \\ -\gamma_{y,g} & -\gamma_{y,t} & 1 \end{bmatrix} \text{and } B = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

Tables and figures

Figure 1 Public spending across EU countries
(2014, % GDP, Sum of public consumption and public investment)



Source: Eurostat, National Accounts.

Figure 2 Responses of GDP after a shock in public spending

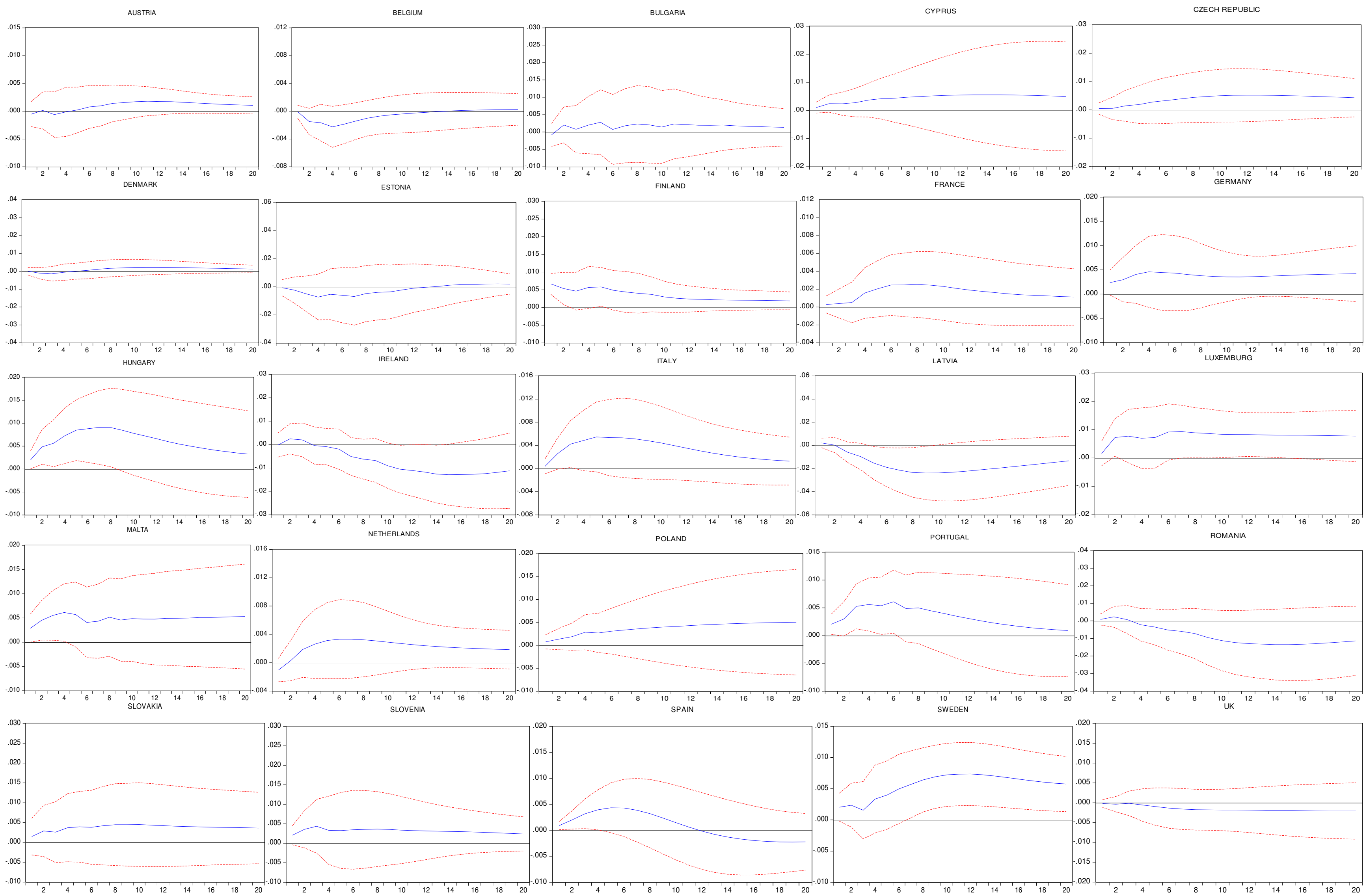
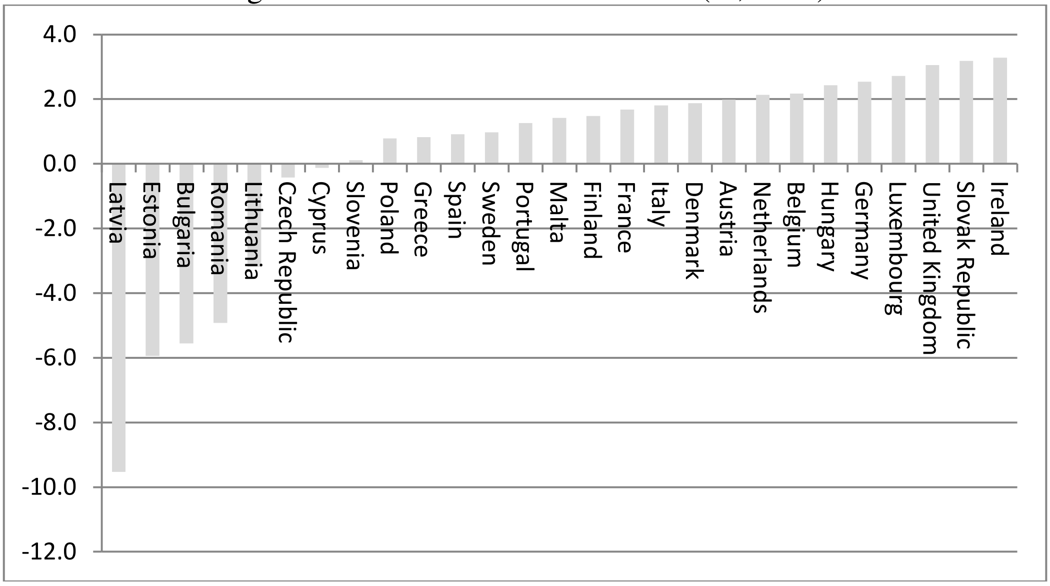


Table 1 Public spending multipliers

	QUARTER 1	QUARTER 2	QUARTER 4	QUARTER 8
Latvia	0.05	0.06	-0.28	-1.80
Estonia	-0.03	-0.12	-0.36	-1.32
Belgium	-0.01	-0.14	-0.46	-0.84
United Kingdom	-0.01	-0.04	-0.09	-0.40
Ireland	-0.01	0.07	0.12	-0.29
Romania	0.01	0.03	0.02	-0.09
Denmark	0.01	-0.09	-0.27	0.01
Bulgaria	-0.01	0.02	0.05	0.14
Austria	-0.05	-0.03	-0.09	0.15
Czech Republic	0.01	0.02	0.07	0.29
Cyprus	0.02	0.07	0.17	0.45
Poland	0.03	0.08	0.25	0.63
Slovak Republic	0.04	0.12	0.27	0.63
Portugal	0.04	0.10	0.30	0.66
Malta	0.07	0.17	0.41	0.78
Hungary	0.05	0.15	0.40	0.94
Netherlands	-0.11	-0.08	0.35	1.49
Italy	0.02	0.15	0.60	1.58
Spain	0.06	0.20	0.67	1.63
France	0.04	0.10	0.40	1.66
Slovenia	0.16	0.42	0.95	1.80
Luxemburg	0.06	0.34	0.90	2.09
Sweden	0.22	0.47	0.95	2.86
Finland	0.62	1.10	1.99	3.52
Germany	0.37	0.83	2.10	4.37

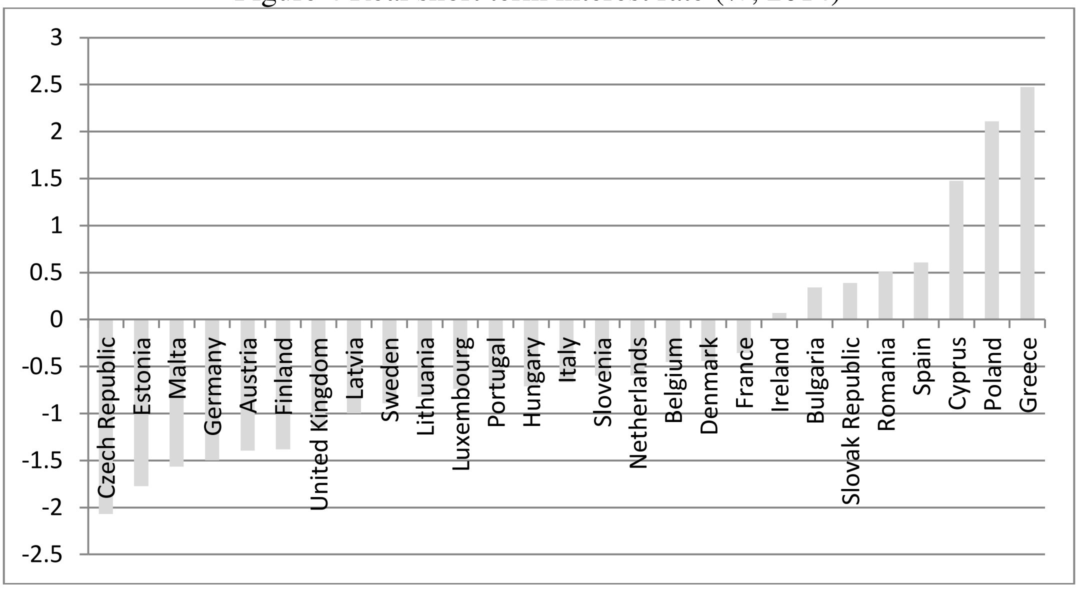
*Countries are ordered in ascending order of the public investment multiplier.

Figure 3 Real short term interest rate (%, 2007)



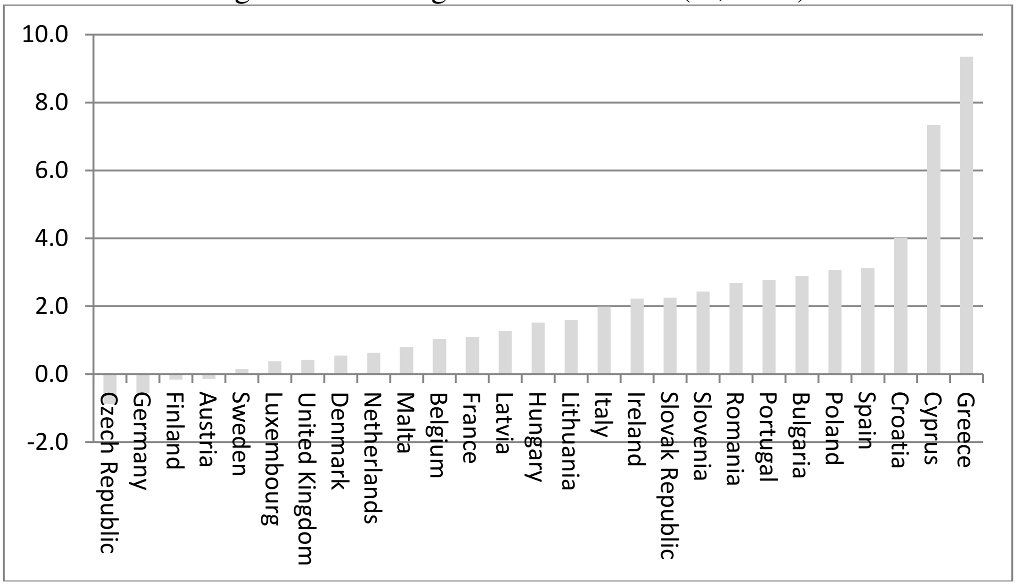
Source: AMECO.

Figure 4 Real short term interest rate (%, 2014)



Source: AMECO.

Figure 5 Real long term interest rate (%, 2014)



Source: AMECO.

Table 2 System GMM Econometric Estimates (Baseline results)

Dependent variable: Growth rate of GDP				
	(1)	**(2)**	**(3)**	**(4)**
Public spending	0.001 (0.52)	-0.001 (-0.70)	-0.005* (-1.68)	-0.006 (-1.45)
Short run interest rate		-0.003** (-2.79)	-0.002 (-1.43)	0.001 (0.40)
Public spending* Short run interest rate			-0.023** (-2.24)	-0.027** (-2.05)
Private investment				0.006** (3.34)
Constant	-0.013 (-0.21)	0.072 (1.26)	0.120 (1.61)	0.035 (0.29)
Country Fixed Effects	Yes	Yes	Yes	Yes
Time Effects	Yes	Yes	Yes	Yes
Hansen test (p-value)††	21.40 (0.31)	20.91 (0.28)	17.29 (0.43)	12.97 (0.67)
Autocor. Test (p-value)†††	-0.15 (0.88)	-0.34 (0.73)	-1.19 (0.23)	-1.58 (0.11)
Observations	308	301	301	301

† The z-statistics are reported in parentheses.
†† The null hypothesis is that the instruments used in the regression are valid.
††† The null hypothesis is that the errors in the first-differenced regression exhibit no second order serial correlation.
** Significant at the 5% level. * Significant at the 10 level.

Table 3 System GMM Econometric Estimates (different econometric specifications)

Dependent variable: Growth rate of GDP								
	Trade	*Taxes*	*Tertiary schooling*	*Lagged GDP*	*Lagged growth rate*	*Number of instruments as lags*	*Endogenous private investment*	*Lagged interest rate*
Public spending	-0.003 (-1.13)	-0.006 (-1.37)	-0.002 (-0.78)	-0.006 (-1.48)	-0.004 (-1.31)	-0.003 (-1.02)	0.0008 (0.18)	-0.006** (-2.37)
Short run interest rate	0.002 (0.96)	0.0009 (0.29)	0.002 (0.77)	0.001 (0.54)	0.003 (1.18)	0.002 (0.80)	-0.0003 (-0.11)	-0.001 (-0.59)
Public spending* Short run interest rate	-0.023** (-2.49)	-0.031** (-2.01)	-0.018** (-2.31)	-0.026** (-2.16)	-0.024** (-2.57)	-0.018** (-2.67)	-0.015* (-1.88)	-0.026** (-2.37)
Private investment	0.006** (3.28)	0.005** (2.46)	0.0009 (0.39)	0.007** (3.35)	0.007** (3.62)	0.006** (3.39)	0.005** (3.00)	0.002* (1.90)
Trade (% of GDP)	-0.008 (-0.94)							
Taxes (% of GDP)		-0.001 (-0.71)						
Tertiary school enrollment rate			0.001** (2.48)					
Lagged once GDP				0.002 (0.64)				
Growth rate of GDP (-1)					-0.031 (-0.08)			
Constant	-0.034 (-0.49)	0.086 (0.54)	-0.023 (-0.26)	-0.011 (-0.09)	-0.032 (-0.33)	-0.034 (-0.40)	-0.115 (-0.83)	0.109 (1.64)
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Hansen test (p-value)††	10.48 (0.78)	12.47 (0.64)	8.76 (0.84)	12.15 (0.66)	11.72 (0.70)	14.27 (0.97)	15.57 (0.48)	12.88 (0.68)
Autocor. Test (p-value)†††	-1.80 (0.07)	-1.58 (0.11)	-1.42 (0.15)	-1.61 (0.11)	-0.99 (0.32)	-1.70 (0.09)	-1.25 (0.21)	-1.57 (0.11)
Observations	294	301	247	301	301	301	301	300

† The z-statistics are reported in parentheses. †† The null hypothesis is that the instruments used in the regression are valid. ††† The null hypothesis is that the errors in the first-differenced regression exhibit no second order serial correlation. ** Significant at the 5% level. * Significant at the 10% level.

Table 4 System GMM Econometric Estimates (Long run interest rate)

Dependent variable: Growth rate of GDP								
	Initial specification	*Trade*	*Taxes*	*Tertiary schooling*	*Lagged GDP*	*Lagged growth rate*	*Number of instruments as lags*	*Endogenous private investment*
Public spending	-0.007* (-1.79)	-0.007** (-2.35)	-0.007* (-1.82)	-0.004 (-1.22)	-0.005 (-1.14)	-0.004 (-0.72)	-0.001 (-0.24)	-0.005 (-1.50)
Long run interest rate	-0.005 (-1.50)	-0.006* (-1.68)	-0.005 (-1.26)	-0.003 (-1.02)	-0.004 (-1.22)	-0.001 (-0.25)	-0.003 (-0.88)	-0.003 (-1.33)
Public spending* Long run interest rate	-0.023** (-2.01)	-0.022 (-1.39)	-0.021** (-2.09)	-0.026* (-1.73)	-0.017* (-1.83)	-0.026 (-1.30)	-0.006 (-0.64)	-0.014** (-2.36)
Private investment	0.002 (1.41)	0.004 (1.28)	0.002 (1.45)	0.0007 (0.18)	0.002 (1.10)	0.001 (0.20)	0.0006 (0.30)	0.002 (1.00)
Trade (% of GDP)		-0.00002 (-0.08)						
Taxes (% of GDP)			-0.0003 (-0.24)					
Tertiary school enrollment rate				0.0001 (0.19)				
Lagged once GDP					0.006 (0.81)			
Growth rate of GDP (-1)						0.297 (0.64)		
Constant	0.146 (1.30)	0.106 (0.80)	0.151 (1.19)	0.099 (0.65)	0.031 (0.36)	0.098 (0.55)	0.026 (0.37)	0.097 (0.84)
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Hansen test (p-value)††	11.74 (0.76)	16.34 (0.36)	10.86 (0.76)	16.54 (0.28)	12.68 (0.62)	9.29 (0.86)	17.50 (0.91)	16.42 (0.42)
Autocor. Test (p-value)†††	-1.15 (0.25)	-0.95 (0.34)	-1.08 (0.28)	-1.03 (0.30)	-0.88 (0.37)	-0.12 (0.90)	-0.24 (0.81)	-0.70 (0.48)
Observations	300	293	300	247	300	300	300	300

† The z-statistics are reported in parentheses. †† The null hypothesis is that the instruments used in the regression are valid. ††† The null hypothesis is that the errors in the first-differenced regression exhibit no second order serial correlation. ** Significant at the 5% level. * Significant at the 10% level.

Table 5 System GMM Econometric Estimates
(public consumption-public investment)

Dependent variable: Growth rate of GDP			
	(1)	*(2)*	*(3)*
Public consumption	-0.008** (-2.48)	-0.010** (-2.21)	-0.007** (-2.17)
Public investment	0.011 (1.28)	0.005 (0.68)	0.005 (0.83)
Short run interest rate	0.002 (0.68)	-0.002 (-0.71)	0.003 (1.35)
Public spending* Short run interest rate	-0.022** (-3.72)		
Public consumption* Short run interest rate		-0.033** (-3.39)	
Public investment* Short run interest rate			-0.036** (-6.11)
Private investment	0.003 (1.17)	0.003 (1.14)	0.002 (1.09)
Constant	0.059 (0.57)	0.136 (1.48)	0.094 (1.04)
Country Fixed Effects	Yes	Yes	Yes
Time Effects	Yes	Yes	Yes
Hansen test (p-value)††	7.49 (0.94)	12.34 (0.65)	5.22 (0.99)
Autocor. Test (p-value)†††	-1.48 (0.14)	-1.56 (0.12)	-2.25 (0.02)
Observations	301	301	301

† The z-statistics are reported in parentheses.
†† The null hypothesis is that the instruments used in the regression are valid.
††† The null hypothesis is that the errors in the first-differenced regression exhibit no second order serial correlation.
** Significant at the 5% level. * Significant at the 10% level.

Table 6 System GMM Econometric Estimates
(different growth regimes)

Dependent variable: Growth rate of GDP			
	(1)	*(2)*	*(3)*
Public spending	-0.0008 (-0.26)	-0.001 (-0.52)	-0.001 (-0.53)
Short run interest rate	0.003 (0.89)	-0.002 (-0.75)	-0.002 (-1.31)
Public spending* Short run interest rate*Low growth regime	-0.018** (-2.06)		
Public spending* Short run interest rate*Medium growth regime		-0.047 (-0.76)	
Public spending* Short run interest rate*High growth regime			-0.035 (-1.60)
Private investment	0.006** (3.98)	0.004 (1.53)	0.002 (1.01)
Constant	-0.096 (-0.99)	-0.040 (-0.52)	-0.007 (-0.10)
Country Fixed Effects	Yes	Yes	Yes
Time Effects	Yes	Yes	Yes
Hansen test (p-value)††	13.01 (0.67)	19.63 (0.24)	17.83 (0.33)
Autocor. Test (p-value)†††	-1.30 (0.19)	-0.49 (0.62)	-1.19 (0.23)
Observations	301	301	301

† The z-statistics are reported in parentheses. †† The null hypothesis is that the instruments used in the regression are valid. ††† The null hypothesis is that the errors in the first-differenced regression exhibit no second order serial correlation. ** Significant at the 5% level. * Significant at the 10% level.

Figure 6 Growth impact of public spending
at various levels of the short term interest rate