The Government Spending Multiplier at the Zero Lower Bound: Evidence from the Euro Area

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Abstract

We use an Interacted Panel Vector Autoregressive (IPVAR) model, to investigate the effects of a government spending shock when the interest rate is at zero lower bound (ZLB). We also compare the responses of variables of interest at the ZLB with what we get when a government spending shock occurs in normal times (i.e. when the interest rate is larger than 0.25). We identify the government spending shock by sign restrictions and use the European Commission forecasts of government expenditure to account for fiscal foresight. For the baseline specification we find lower multipliers in times in which the ZLB is binding. However, fiscal foresight is not the only problem in fiscal VARs related to limited information problems. Usually, VAR models can only consider a limited number of variables due to degree of freedom problems. Several authors have shown (see Stock and Watson(2005) for a survey) how principal components extracted from a larger number of variables, can approximate unobserved factors driving most (if not all) of the macroeconomic variables. Therefore, we develop a Factor-Augmented IPVAR model (FAIPVAR) and find that the multipliers are very similar among states, ranging between 1.08 and 1.41 at the ZLB and between 1.26 and 1.39 away from it. We also divide our sample, considering two groups of countries in terms of high and low debt-to-GDP ratios. We find that countries with high levels of debt-to-GDP ratio show relatively lower multipliers. Considering the FAIPVAR model, the government spending multiplier ranges between 2.69 and 3.54 for core countries and between 0.82 and 1.37 for peripheral countries. Therefore, our findings support some recent studies, which suggest that the government spending multiplier is even larger if the debt-to-GDP ratio is low.

JEL Classification C32, E32, E40, E52, E62, H50

Keywords Interacted VAR, Fiscal Policy, Public Debt, Government Spending, Zero Lower Bound
**Introduction**

The recent world financial crisis and the Great Recession that has followed have renewed interest for the use of discretionary fiscal policies. Starting from 2009, many OECD and developing countries have implemented expansionary fiscal policies with the purpose to soften the effects of the Great Recession. In Europe, the European Commission launched the “European Economic Recovery Plan” (EERP) with the aim to provide coordinated fiscal stimulus to the Euro Area economies. A natural question arises: has this expansionary fiscal policy succeeded to help Eurozone economies? More specifically, what is the magnitude of the government spending multiplier when monetary policy is constrained at the Zero Lower Bound (ZLB)? Is it larger or smaller than in normal times? There is much uncertainty about these questions: on the one hand, there are researchers who support fiscal stimulus and consequently highlight the Keynesian multiplier effects of a rise in government spending which is even stronger at the ZLB; on the other hand, there are other researchers who criticize fiscal stimulus, arguing that a rise in government spending leads to a very low or even negative fiscal multiplier due to the crowding-out of private consumption and investments.

We join the debate by estimating the government spending multiplier for a set of countries which belong to the Euro Area, in the period that goes from 2000q2 to 2015q4. To this end, we use the Interacted Panel VAR Model (IPVAR) developed by Sá et al. (2014) and Towbin and Weber (2013). Furthermore, in order to account for fiscal foresight, we use the forecasts of government spending made available by the European Commission. The fiscal foresight is due to the fact that most of the fiscal policies are preannounced and so the economic agents take into account their consequences before they would be actually put in place. More precisely, we add this variable to our specifications with the purpose to purge them from the innovations in the exogenous government spending which are anticipated by agents. Using a sign restrictions approach we identify two shocks: the first identifies the forecast of government spending made at time $t - 1$; the second, which is our shock of interest, will be orthogonal to the first and therefore it does not contain expectations made at time $t - 1$.

In this baseline specification we find that the government spending multiplier ranges between 0.33 and 0.88 at the ZLB, while away from it, a higher multiplier is found ranging between 1.10 and 1.29. However, although we use a fiscal VAR shared by a large part of the literature (see Blanchard and Perotti (2002) for their baseline specification, for example) results might be driven by misspecification concerns in terms of important information that we do not include in our model, but that might be potentially considered by economic agents in determining their choices. Several authors have shown (see Stock and Watson (2005) for a survey) how principal components extracted from a large number of variables, can approximate unobserved factors driving most (if not all) of the macroeconomic variables. We therefore consider a Factor-Augmented IPVAR specification to address such concerns. The results show generally similar multipliers among states. The government spending multiplier ranges between 1.08 and 1.41 in the low interest rate state, and between 1.26 and 1.39 in the high interest rate state. These results show no significant difference between multipliers found in the low and high interest rate states. Overall, we find multipliers that are larger than one, in line with New-Keynesian theoretical predictions.

Then, we proceed our analysis by investigating whether the debt-to-GDP ratio can influence the size of the government spending multiplier. To this end, we consider two different sets of countries. The first is constituted by countries that have had high levels of public debt (higher than 90%)
during the 2009-2015 (Belgium, Ireland, Italy, Portugal and Spain). The second one includes countries that during the same period have a debt-to-GDP ratio lower than 90% (Austria, Finland, France, Germany and Netherlands). We find that the government spending multiplier is generally higher for countries which have a lower debt-to-GDP ratio. Considering the specification augmented with factors, the government spending multiplier for countries with low debt-to-GDP ratio ranges between 3.11 and 3.54, while it ranges between 0.82 and 1.18 for peripheral countries, at the ZLB. The main purpose of this additional exercise is to show qualitative differences between the government spending multipliers at different level of the debt-to-GDP ratio, since they are all subject to the same monetary policy. From our point of view, the findings we get from the full sample specifications are more accurate because they consider countries that all together represent 95.6% of the EA-19 Total GDP.

Our paper is related to a growing theoretical literature which analyses the size of the government spending multipliers when the interest rate is at the ZLB. Among the others, Christiano et al. (2011), Eggertsson (2010), Woodford (2011), Davi and Leeper (2011) and Coenen et al. (2012) develop New Keynesian DSGE Models which predict higher multipliers at ZLB. On the other hand, Braun et al. (2013), Mertens and Ravn (2014) and Aruoba et al. (2017) argue that the government spending multiplier at ZLB is very small and also lower than in normal times. Despite the uncertainty about the sign and magnitude of the government spending multiplier, very few studies concerning the effects of government spending at the ZLB have been devoted to the Euro Area. Kilponen et al. (2015) compute the fiscal multiplier using a set of structural macroeconomic models adopted by the European System of Central Banks (ESBC). They find that if temporary fiscal shock happens simultaneously in the Euro Area (as in our empirical strategy), the government spending multiplier has a stronger impact at the ZLB than in normal times. On the other hand, if this shock hits only the economy of one country the relative government spending multiplier is very low and similar to the multiplier computed in normal times. Coenen et al. (2012) evaluate the effectiveness of the implemented fiscal policies during the Great Recession. Specifically, they use the European Central Bank’s New Area-Wide Model (NAWM) and find that discretionary exogenous policies of 1% lead to an increase of 1.6% of real GDP. On the opposite side, Cwik and Wieland (2011) find no higher effects of the government spending shock, unless the ZLB state was anticipated and holds for at least two years. Among the models used, the only European Central Bank’s Area-Wide Model provides evidences in favor of a government spending multiplier which is higher at the ZLB.

With regard to the literature analyzing the relationship between fiscal multipliers and different level of debt-to-GDP ratio, Sutherland (1997), for example, shows how government spending shocks have expansionary effects when the debt-to-GDP ratio is low, becoming contractionary at high level of debt-to-GDP ratio. Perotti (1999) develops a model which analyzes the effects of both tax and expenditure shocks, finding that the reaction of consumers to a government spending shock can be very different, depending on the initial level of public debt-to-GDP ratio. At a high level of debt-to-GDP ratio, expectations of future increase in taxation generate higher negative wealth effects on fiscal multipliers. On the empirical side, Ilzetzki et al. (2013) follow the Blanchard and Perotti (2002) methodology, estimating a VAR which includes 44 countries from 1960q1 to 2007q4. They find that the size and the sign of government spending multiplier depend on country-specific characteristics. In particular, they find that if debt-to-GDP ratio exceeds 60% of GDP, the fiscal multiplier is not statistically different from zero on impact and negative in the long run (i.e the fiscal multipliers is negative). Kirchner et al. (2010) analyze the effects of government spending shock and the transmission mechanism within the euro area from 1980 to 2008. They find that an

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3 To be more precise, for Spain the public debt is lower and around 85%. However, it has been one of the countries most hit by the sovereign debt crisis. From a low public debt level before the crisis, the latter has caused a rapid deterioration of its public finances.

4 According to their studies, the government spending multiplier at ZLB is in the range of 3 to 5.
increase in debt-to-GDP ratio causes the short run effect to be negative. Nickel and Tudyka (2014) develop an Interacted Panel VAR for 17 European countries from 1970 to 2010, analyzing fiscal multipliers which depend in their model nonlinearly from the debt-to-GDP ratio. Their findings are in line with previous works: the effects of a government spending shock are positive when debt-to-GDP ratio is low, while become negative when this ratio is high.

The paper proceeds as follows: Section 1 describes the methodology we use, data and how we calculate the multipliers; Section 2 discusses the results of our baseline specification; Sections 3 describes result for baseline specification augmented with factors; Section 4 shows results for high and low levels of debt-to-GDP ratio.

1. Methodology

1.1 Empirical Model

Our model is built on the Interacted Panel VAR model developed by Sá et al. (2014) and Towbin and Weber (2013). The introduction of interaction terms, allow us to evaluate non-linearities and the reaction of variables of interest at different values of the interest rate.

The model we specify has the following structural form:

$$B_{i,t}y_{i,t} = \sum_{j=1}^{N} \kappa_j D_{j,i} + \sum_{j=1}^{N} \sum_{k=1}^{L} \Gamma_{j,k} D_{j,i} y_{i,t-k} + \kappa^1 x_{i,t} + \sum_{k=1}^{L} \Gamma_{k}^1 x_{i,t} y_{i,t-k} + \epsilon_{i,t}$$ (1)

where \( t = 1, \ldots, T \) denotes time, \( i = 1, \ldots, N \) denotes the country, \( k = 1, \ldots, L \) denotes the lags, \( \kappa_j \) is country-specific intercepts, \( \Gamma_{j,k} \) is a matrix of autoregressive coefficients , \( D_{j,i} \) is an indicator for each country\(^5\), \( \epsilon_{i,t} \) is the vector of residuals which, by assumption, are uncorrelated across countries and normally distributed such that \( \epsilon_{i,t} \sim N(0, \Sigma_i) \). The interaction term \( x_{i,t} \) has the capacity to influence both the level and the dynamic relationship between endogenous variables through \( \kappa^1 \) and \( \Gamma_{k}^1 \).

The matrix \( B_{i,t} \) is a \( q \times q \) lower triangular matrix with ones on the main diagonal. Each component \( B_{i,t}(w, q) \) of \( B_{i,t} \) matrix represents the contemporaneous effect of the qth-ordered variable on the wth-ordered variable. It is constructed as follows:

$$B_{i,t} = \begin{cases} B_{i,t}(w, q) = 0 & \text{for } q > w \\ B_{i,t}(w, q) = 1 & \text{for } q = w \\ B_{i,t}(w, q) = B_j(w, q) D_{j,i} + B^1(w, q) x_{i,t} & \text{for } q < w \end{cases}$$ (2)

where the coefficients \( B_j \) and \( B^1 \) represent the marginal effect of a change in the variable and interaction term, respectively. Moreover, a recursive structure has been imposed to matrix \( B_{i,t} \) which means that the covariance matrix of the residuals \( \Sigma_i \) is diagonal.

Imposing the shadow rate (i.e.\( sr \)) as an interaction term, the coefficient matrices for a country \( i \) will be equal to:

$$\Gamma_{sr,k} = \sum_{t=1}^{N} \frac{\Gamma_{t,k}}{N} + \frac{\Gamma_{1}^{sr}}{N}$$ (3)

$$\kappa_{sr,k} = \sum_{t=1}^{N} \frac{\kappa_t}{N} + \kappa^{sr}$$ (4)

\(^5\) It is equal to 1 if \( i = j \), and 0 otherwise.
By using this setting, our results will be averaged across countries and we can compute IRFs for a specific value of interaction term.

1.2 Baseline Specification

Our dataset consists of quarterly data for 10 countries that have adopted the Euro from 1999Q1, for which the sample analyzed ranges between 2000Q2 and 2015Q4. Appendix A provides further details about the composition of our dataset and the filter used.

Concerning our baseline specification, we choose variables which are commonly used in this literature:

\[ y_{i,t} = [EU_{F_{i,t}}, G_{i,t}, GDP_{i,t}, T_{i,t}]^{\prime}. \] (5)

where \( G_{i,t}, GDP_{i,t} \) and \( T_{i,t} \) represent real government spending, real gross domestic product and average tax revenue, respectively. All the variables are in real term and considered in levels, the average tax revenue is computed by dividing the Total Nominal General Government Revenue series by the nominal GDP. The \( EU_{F_{i,t}} \) series represents the forecast of government spending published by the European Commission every six months. In this way, we have the opportunity to purge our VAR from the change in government spending which is anticipated by agents (i.e. fiscal foresight).

We simplify the procedure related to the government spending multipliers computation by dividing all endogenous variables except average taxes by real potential GDP of the corresponding country. In this way we do not use the log of variables and therefore avoid potential bias related to ex post conversion to dollar equivalents of the estimated elasticities.

We use as interaction term the European Central Bank Shadow Rate developed by Wu and Xia (2017). It allows us to be more accurate in terms of inference during the ZLB period. As a matter of fact, after the ZLB is reached, Wu and Xia (2017) develop a shadow-rate term structure model (SRTSM) to describe the economic environment with negative interest rates. Since this rate is available from 2004Q3 onwards, we splice the European Central Bank Shadow Rate with the Main Refinancing Operations (MRO) rate. Thanks to the interaction term we are able to investigate how the government spending shock affects our variables of interest at the different levels of the interest rate. On the other hand, when we set a specific value of the interaction term, our empirical model implies that the shadow rate remains the same for the 20 quarters, corresponding to the horizon over which we calculate impulse responses. For this reason we investigate the effects of a government spending shock at different percentiles of the shadow rate, specifically at 5th, 15th and 31.7th percentiles on one hand and 50th percentile of its distribution on the other hand. We consider the range between the 5th and the 31.7th percentile as the low interest rate state. In particular, the latter percentile corresponds to a value of the shadow rate equal to 0.25, which is conventionally considered by the literature as the lower bound for monetary policy. Furthermore, we consider the 50th percentile as the normal time interest rate state.

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6 We follow the same methodology used by Sá et al. (2014). As explained by Canova and Ciccarelli (2009), the mean group estimator is particularly efficient if dynamic heterogeneity is present. Therefore, also in our case, it should be preferred to a pooled estimator.

7 Beginning of our sample is due to the computation of the Real Potential GDP.

8 The fiscal foresight is the phenomenon for which private agents, due to legislative and implementation lags, can anticipate future movements in government spending previously announced, so that not accounting for them in the identification of government spending shocks might give rise to exogeneity problems. See also Leeper et al. (2013) for a theoretical illustration.

9 Ex-post conversion require sample averages which might bias the computation of fiscal multipliers. This problem is even more acute in nonlinear models, such as the one we are adopting here. For further details related to these issues see Ramey and Zubairy (2017).

10 We choose the MRO rate because it is the most similar rate to the European Central Bank Shadow Rate developed by Wu and Xia (2017).
In order to avoid potential endogeneity problems that might bias our estimates, due to reversed causality issues, we use the first lag of the shadow rate, i.e. $sr_{t-1}$. We also choose a lag length of $L = 1$. We have chosen the lag length on the base of the Hannan-Quinn(HQ) and Schwarz-Bayes(SBC) information criteria.

1.3 Inference and Identification

As in Sá et al. (2014), we start by estimating the structural recursive form presented in equation 1. More precisely:

1. We proceed by estimating the structural model equation by equation using OLS. We adopt a Bayesian strategy for inference utilizing an uninformative independent Normal–Wishart prior, which use a Montecarlo simulation to recover the posterior distribution of the structural parameters.

2. A draw of the posterior is made and evaluated at prespecified values of the interaction terms.

3. We derive the corresponding reduced form, by pre-multiplying equation 1 for the inverse of $B_{it}$.

4. We use a sign restriction strategy to identify an unexpected government spending shock. More specifically, we follow the same procedure of Sá et al. (2014), by using the algorithm developed by Rubio-Ramírez et al. (2010). Defining $V^d_x$ as the Cholesky decomposition of the reduced form variance-covariance matrix $\Sigma^d_x$ obtained in step 3, we draw an orthonormal matrix $Q$ such that $Q'Q = I$, from which follows $B^d = V^d_x Q$ and $\Sigma^d_x = B^d B'^d = V^d_x Q' Q V^d_x$ where $d$ indicates a stable draw from the posterior distributions. To achieve identification, the impulse responses implied by $B^d$ have to satisfy the following two sets of restrictions: a government spending shock, which raises $GDP_{it}$ and $G_{it}$ for at least four quarters. Following Auerbach and Gorodnichenko (2012), in order to control for anticipation effects, we also identify a forecast government spending shock, imposing an increase for at least one quarter on the response of $EUF_{it}$, $G_{it}$ and $GDP_{it}$ (see also table 1). Orthogonality of the two shocks should ensure exogeneity of the government spending shock.

5. For every 100 draws of the Q matrix which meet our sign restrictions we save its median value.

6. We repeat step 2 to 5 making 5000 draws from the posterior distributions and use the median over the 5000 medians obtained as our central estimate of interest.

1.4 Multipliers

Since we estimate our model in normalized levels, we avoid any concerns related to the ex-post conversation. On this way, we can compute multipliers following the approach of Ramey and Zubairy (2017). Specifically, we compute three types of multipliers. The first is a discrete approximation of the integral of the median IRFs over time horizon $h = 0, 1, \ldots, 20$ and it is based on Ramey (2011b):

$$M_1 = \frac{\sum_{h=0}^{20} dGDP(h)}{\sum_{h=0}^{20} dG(h)} \quad (6)$$

Multipliers 2 and 3 are numerical integration computed using Trapezoidal and Simpson’s rule, respectively.

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For more details see Canova and De Nicolò (2002), Faust and Rogers (2003) and Uhlig (2005), among the others.

As in Sá et al. (2014); Cogley and Sargent (2005); Primiceri (2005), we discard any explosive draws from the unrestricted posterior.

Note that we consider the first 10000 parameter draws as burn-in draws.
\[ M_{2,3} = \frac{\int_0^h (dGDP(h))dh}{\int_0^h (dG(h))dh} \] (7)

2. Results for Baseline Specification

The impulse response functions for our baseline specification are showed in Figure 1. The four columns show the reactions of our variables of interest to an unexpected government spending shock when the shadow rate is at 5th, 15th, 31.7th and 50th percentile of its distribution, respectively. Overall, the responses of our variables of interest are not very persistent. In both states, government spending reacts strongly on impact, it reaches its peak after two quarters, and subsequently reverts quite rapidly to its long run level. The GDP is also very similar among states, even though its reaction seems to be stronger in the high interest state. However in both states, the responses of GDP become insignificant after a few quarters. Average taxes are very different among states: following a government spending shock, they do not rise very much in the high interest state, while there is substantially no response in the low interest rate state. Overall, their behavior suggests that the government spending shock is mainly deficit financed.

The government spending multiplier (table 2) is quite small when the interest rate is at the ZLB. Specifically, it ranges between 0.33 and 0.88 at the ZLB, and from 1.10 and 1.29 away from it.

3. Results for Factor-Augmented Specification

Since our results can be influenced by the choice we made about variables and the number of variables is constrained in order to preserve parsimony of the model, defined by the literature as generic limited information problem which can give rise to nonfundamentalness of the shocks (for further details see Forni et al. (2009), Forni and Gambetti (2011)), we develop a FAIPVAR model. As a matter of fact, by augmenting our model with principal components as proxies for the unobserved factors affecting most of the macroeconomic variables, we incorporate in our model a large informational dataset and contemporaneously preserve the parsimony of the model.

As in Di Serio et al. (2017), we implement a two-step estimation procedure similar to Bernanke et al. (2005). First, we use the method of principal components to extract summarized information from a large informational dataset. Then, we add the three factors extracted to \( Y_t \). Thus, our FAIVAR model has the following vector of endogenous variables:

\[ y_{t,t} = [EU_{F,t}, G_{t,t}, GDP_{t,t}, T_{t,t}, F_t]' \] (8)

where \( F_t \) is a 1 × 3 vector which is common to all countries, but that have a different impact for each country and allows to capture potential spillover effects between countries.

The resulting IRFs are showed in figure 2. The first important difference we observe is related to the behavior of the government spending response. As we can see, it is stronger and more persistent in the low interest rate state. Moreover, at the ZLB, GDP increases a lot on impact, then reverts smoothly to its long run level. On the other hand, in the high interest rate state, GDP response becomes insignificant after a few quarters.

The government spending multiplier (table 2) is almost equal among states: it ranges between 1.08 and 1.41 in the low interest rate state and between 1.26 and 1.39 in the high interest rate state.

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14 Note that by adding the variable \( EU_{F,t} \) to our specifications, we have already accounted for another kind of limited information problem, which is the fiscal foresight.

15 For further details about these two issues see Di Serio et al. (2017) and Fragetta and Gasteiger (2014).

16 For this purpose, we downloaded (if available) from Thomson Reuters Datastream Economics database, the corresponding variables listed in Fragetta and Gasteiger (2014) for all ten countries considered in our analysis. In this way, our informational dataset includes 418 series.

17 To establish the number of factors to extract, we use the Bai and Ng (2007) \( IC_{p2} \) information criterion.
Although these findings do not provide evidences of relevant differences among states, they are in line with theoretical studies which support New-Keynesian government spending effects. Among the others, Coenen et al. (2012) use the European Central Bank’s New Area-Wide Model (NAWM) and find multipliers greater than one, as in our case. On the other hand, these findings are in contradiction with Cwik and Wieland (2011), Burriel et al. (2010) and Forni et al. (2009) who find government spending multipliers for the Euro Area below unit.

In addition, comparing these findings to results we get from the baseline specification, we can conclude that the limited information problem, related to the difference in terms of information set usually considered by the econometrician and the one considered by the economic agents, have a significant impact on the results. As a matter of fact, these results prove that our baseline specification underestimates the government spending multipliers, especially when the interest rate is at the ZLB.

4. Sub-samples Analysis

The results of section 3, show very similar multipliers for both high and low interest rate state. Although these findings broadly support New-Keynesian predictions, they are somehow in contradiction with the theoretical works of Christiano et al. (2011), Eggertsson (2010), Woodford (2011), Davig and Leeper (2011) and Coenen et al. (2012), who find higher multipliers at the ZLB, ranging from 3 to 5. It may be the case that our results are influenced by countries which have high level of debt-to-GDP ratio, which may lower the average value of government spending multipliers, especially at the ZLB.

In this section, we investigate if the reactions of variables of interest may vary across countries conditioned on their level of debt-to-GDP ratio. For this purpose, we create two subsets of countries. The first subset includes countries that have a debt-to-GDP ratio higher than 90% from 2009 on. Basically this subset includes peripheral countries, with the exclusion of Greece which joined the Euro Area only in 2001 and for which data have been continuously revised and with the inclusion of Belgium. The second group is composed by countries that, during the same period, have a debt-to-GDP ratio lower than 90%. Thus, we name the first subsample, which includes Belgium, Ireland, Italy, Portugal and Spain, “Peripheral Countries” and the other subsample as “Core Countries”.

In the next subsections we show results we obtain for the two specifications described in section 1.2 and section 3.

4.1 Results for Baseline Specification

Figure 3 and 5 show IRFs for peripheral and core countries, respectively. As we can see, there is a huge difference in responses of our variables of interest. Considering peripheral countries, we can note that the response of government spending exhibits more or less the same pattern for both states. Government spending reaches its peak after very few quarters for both states, and it seems a little bit more persistent in the high interest rate state. GDP response mimics the behavior of government spending but it reverts more slowly to zero at the ZLB. Government spending multiplier results are slightly higher at the ZLB, ranging between 1.38 and 2.05, while it ranges between 1.37 and 1.46 away from it. It is also important to point out that the response of average tax is insignificant at the ZLB, while it is quite strong and significant away from it.

Core countries show huge responses of variables of interest to a government spending shock. The responses of government spending and GDP show very similar patterns between the two different states, even if the IRFs away from the ZLB seem to be more persistent for both variables. They are also very large compared to peripheral countries results: at the ZLB, the government spending multiplier ranges between 3.01 and 3.90, while away from the ZLB it ranges from 4.18 to 4.21. Also
in this case, the response of average taxes is insignificant at the ZLB, and not so huge in the high interest rate state.

### 4.2 Results for Factor-Augmented Specification

Figure 4 show IRFs for peripheral countries. As we can see, Government Spending reacts on impact in the same way for both states. However, its response is more persistent in the low interest rate state. On the other hand, the responses of GDP, is slightly larger in the high interest rate state, although, the GDP response becomes insignificant after a few quarters for both states. The corresponding multipliers are somehow in contradiction with the results of section 4.1. As a matter of fact, table 3 shows multipliers between 0.82 and 1.18 at the ZLB, and between 1.29 and 1.37 away from the ZLB.

As shown in figure 6, results for core countries show generally a huge response of variables of interest to an increase in government spending. The responses of government spending have substantially the same intensity among states. However, the behavior of GDP is very different among states. It mimics the response of government spending at the ZLB, while it exhibits a hump-shaped pattern away from the ZLB. Average taxes rises hugely on impact, especially at the ZLB.

Once again, the government spending multipliers (Table 4) are in contradiction with the baseline results: it ranges between 3.11 and 3.54 in the low interest rate state, and between 2.69 and 2.87 in the high interest rate state.

### 4.3 Further Considerations

We can make three considerations from the results we get in section 4.1 and 4.2. First and foremost, our results support the theoretical works of Sutherland (1997) and Perotti (1999), which predict that a government spending shock is even more effective if the average value of debt-to-GDP ratio is low.

Considering the factor augmented specifications, the government spending multiplier for core countries ranges between 2.87 and 3.54, while it ranges between 0.82 and 1.37 for countries with high debt levels (regardless if it was caused by the crisis or not). Our results are also qualitatively similar to the empirical works of Ilzetzki et al. (2013), Kirchner et al. (2010) and Nickel and Tudyka (2014).

Second, the results of section 4.2 show lower multipliers for peripheral countries at the ZLB. This might be due to the stronger negative effect that the higher debt-to-GDP ratio have on this subset of economies, with respect to positive potential effect at the ZLB predicted by part of the literature. In fact, we find for core countries a higher multipliers at the ZLB. Therefore, this might explain the magnitude of the government spending multipliers obtained for the full sample.

Third, we point out that with this additional exercise we are aiming to find qualitative differences between the government spending multipliers at different levels of the debt-to-GDP ratio, since in this analysis we are missing an important common factor: monetary policy. Therefore we tend to consider the results shown in sections 2 and 3 as more reliable.\(^{18}\)

### 5. Conclusions

This paper tried to infer on what are the consequences of a rise (decrease) in government spending for countries belonging to the Euro Area. In order to identify an unexpected government spending shock, we use an Interacted Panel VAR model utilizing a sign restrictions identifying approach. We consider ten countries belonging to the Euro Area (which represents 95.6% of the

\(^{18}\) Computing average GDP which take into account both the cross sectional and time dimension for the full sample, we find that all together represent the 95.6% of the EA-19 Total GDP.
developing two different specifications: one with variables commonly used in the literature, and a more robust specification with a larger dataset, which allows us to avoid an important limited information problem. In both specifications we use the European Commission forecasts of government expenditure to account for fiscal foresight.

The first part of our analysis focused on the size of the government spending multipliers for different levels of the interest rate. Specifically, we tried to answer the following question: is the government spending multiplier at the ZLB larger than in normal times? The baseline specification suggests that the answer is no. We find very low multipliers at the ZLB ranging between 0.33 and 0.88, while they are above unit away from the ZLB, ranging between 1.10 and 1.29. However, these results might be biased due to the few variables considered. For this reason, we have also considered a factor augmented Interacted Panel VAR, where it is possible to take into account a larger amount of information. Considering results obtained using the FAIPVAR model, we find very similar multipliers among states: they ranges between 1.08 and 1.41 at the ZLB and between 1.26 and 1.39 away from it. Overall, we can conclude that these findings are in line with New-Keynesian theoretical studies which argue that a raise in government spending leads to an effects on GDP greater than one. However, these results seems to not support the theoretical predictions of Christiano et al. (2011), Eggertsson (2010), Woodford (2011), Davig and Leeper (2011) and Coenen et al. (2012), who find higher multipliers at the ZLB. Our interpretation is that our findings may be influenced by a subset of countries that experienced high level of debt, which we show to have a depressive effect on the multipliers. Our work, which is not meant to be completely exhaustive, has shown how important is to take into account potential nonlinearity and different structural characteristics when computing fiscal multipliers. Other structural characteristics such as the heterogeneity of labor markets in setting wages, or different taxation in countries belonging to the Euro area might potentially reveal positive or negative effects on the fiscal multipliers that the policy makers should take into account.
References


Appendix 1 Data

Our dataset is composed of quarterly data and goes from 2000q2 to 2015q4. We consider ten out of eleven countries which joined the Eurozone when it came into existence: Austria, Belgium, Finland, France, Germany, Ireland, Italy, Netherlands, Portugal and Spain. According to Auerbach and Gorodnichenko (2013), we exclude Luxembourg because it is a small economy which exhibits large and volatile changes in government spending series.

Our variables of interest are Gross Domestic Product, Total General Government Revenue and Final Consumption Expenditure of Government. All the variables of interest are downloaded from the Eurostat database available on Thomson Reuters Datastream Economics database. We transform Gross Domestic Product and Final consumption expenditure of Government in real terms using GDP implicit price deflator. Then we normalize them by diving by real potential GDP. We also divide Total General Government Revenue by Gross Domestic Product to generate the average taxes series. The details of the Real Potential GDP computation are described in appendix 4.3.

We use in our specifications the forecast of the annualized growth of Government Consumption Expenditure made available by the European Commission. Then we normalize these series by subtracting to it the annualized growth rate of real potential GDP.
**Appendix 2 Computation of Real Potential GDP**

In order to compute the Real Potential GDP series we use the Hamilton (2017) filter to recover the cyclical component of Real GDP and successively subtract to the latter the resulting series. As discussed by Hamilton (2017), his filter should be preferred to the HP filter because the latter exhibits a persistence in the cyclical component which is far from from the underlying data generating process.

Considering the two-side HP filter, we calculate $g_t^*$ as:

$$
\min_{\{g_t^*\}_{t=1}} \left\{ \sum_{t=1}^{T} (y_t - g_t^*)^2 + \lambda \sum_{t=1}^{T} [(g_t - g_{t-1}) - (g_{t-1} - g_{t-2})]^2 \right\}
$$

By setting $\lambda$, which is the smoothness penalty, we choose the degree in which it is close to the data. Considering quarterly data and $t$ far away from the start or end of the sample (at least 15 years), we can approximate the cyclical component $c_t = y_t - g_t^*$ by the following equation:

$$
c_t = \frac{\lambda (1 - L)^4}{F(L)} y_{t+2}
$$

As we can see, this formula generates a stationary series if the fourth differences of our series is stationary. Anyhow, as demonstrated by De Jong and Sakarya (2016), it can be the case the non stationarity may come from the begin or the end of the sample. Moreover, Phillips and Jin (2015) claim that the HP filter may not remove the trend even if the series is $I(1)$. Cogley and Sargent (2005) consider a random walk $y_t = y_{t-1} + \epsilon_t$, where the first differences are unpredictable and show that equation 10 can be written as:

$$
c_t = \frac{\lambda (1 - L)^3}{F(L)} \epsilon_{t+2}
$$

By setting $\lambda = 1600$ (the usual choice for quarterly data), the HP filter leads to a random $\epsilon_t$ and a cycle, which either predict the future as a function of future errors and is predictable as a function of past errors.

Hamilton (2017) highlights that the coefficients of $F(L)^{-1}$ depend on the value of $\lambda$. Consequently, it does not reflect the data generating process, and for this reason there might be persistence of the cycle. In addition, since the filter depends on the future realizations, its ability to predict the future is questionable. He proposes to make a forecast of $y_{t+h}$, which is made two years in advance and which is based on current and past values.

Considering quarterly data, $h$ should be equal to 8 and $p = 4$. The resulting forecast error would be taken as the cycle at time $t + h$ of the probably not stationary series. As a matter of fact, Hamilton (2017) shows that the main reason of most of macroeconomic and financial variables wrong predictions is due to cyclical component. Moreover, as shown by Den Haan (2000), the forecast error should be stationary for many nonstationary processes.

Considering the population linear projection of quarterly data,

$$
y_{t+h} = \beta_0 + \beta_1 y_t + \beta_2 y_{t-1} + \beta_3 y_{t-2} + \beta_4 y_{t-3} + v_{t+h}
$$

Hamilton (2017) shows that if we want to estimate the cycle at time $h$, and so $v_{t+h}$, it is not necessary to know the nature of nonstationary or to have the correct forecasting model. For example, if we have an I(2) series, and considering $p > d$, equation 12 (which have $p = 4$ ) uses two coefficients to get stationary residuals and the other coefficients will be defined by the parameters which characterize the stationary variable $v_{t+h}$.
Appendix 3 Figures

Figure 1  Impulse Response Functions - Full Sample - Baseline Specification. The blue solid lines represent the median of the median distribution of IRFs for each parameter draw, and the red dotted lines report the 16th and 84th of the set of accepted impulse-response functions for all parameter draws.

Figure 2  Impulse Response Functions - Full Sample - Specification with $F_t$. The blue solid lines represent the median of the median distribution of IRFs for each parameter draw, and the red dotted lines report the 16th and 84th of the set of accepted impulse-response functions for all parameter draws.
Figure 3  Impulse Response Functions - Peripheral Countries - Baseline Specification. Peripheral Countries includes Belgium, Ireland, Italy, Portugal and Spain. The blue solid lines represent the median of the median distribution of IRFs for each parameter draw, and the red dotted lines report the 16th and 84th of the set of accepted impulse-response functions for all parameter draws.

Figure 4  Impulse Response Functions - Peripheral Countries - Specification with F_{L}. Peripheral Countries includes Belgium, Ireland, Italy, Portugal and Spain. The blue solid lines represent the median of the median distribution of IRFs for each parameter draw, and the red dotted lines report the 16th and 84th of the set of accepted impulse-response functions for all parameter draws.
Figure 5  Impulse Response Functions - Core Countries - Baseline Specification. Core Countries includes Austria, Finland, France, Germany and Netherlands. The blue solid lines represent the median of the median distribution of IRFs for each parameter draw, and the red dotted lines report the 16th and 84th of the set of accepted impulse-response functions for all parameter draws.

Figure 6  Impulse Response Functions - Core Countries - Specification with $F_t$. Core Countries includes Austria, Finland, France, Germany and Netherlands. The blue solid lines represent the median of the median distribution of IRFs for each parameter draw, and the red dotted lines report the 16th and 84th of the set of accepted impulse-response functions for all parameter draws.
Appendix 4 Tables

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<th>Variable</th>
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<td>$T_{it}$</td>
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Table 1  Sign Restrictions for Identifying the Government Spending Shock

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<td>$\mathcal{M}_3$</td>
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$x_t = sr_{t-1}$ and $F_t$

| 5th | 15th | 31.7th | 50th |
| $\mathcal{M}_1$ | 1.41 | 1.24 | 1.22 | 1.39 |
| $\mathcal{M}_2$ | 1.29 | 1.11 | 1.08 | 1.26 |
| $\mathcal{M}_3$ | 1.26 | 1.10 | 1.09 | 1.29 |

Table 2  Multipliers Full Sample.

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<tr>
<td>$\mathcal{M}_2$</td>
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<tr>
<td>$\mathcal{M}_3$</td>
</tr>
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</table>

$x_t = sr_{t-1}$ and $F_t$

| 5th | 15th | 31.7th | 50th |
| $\mathcal{M}_1$ | 0.98 | 1.14 | 1.18 | 1.37 |
| $\mathcal{M}_2$ | 0.82 | 1.00 | 1.05 | 1.29 |
| $\mathcal{M}_3$ | 0.83 | 1.01 | 1.06 | 1.31 |

Table 3  Multipliers Peripheral Countries.
\( x_t = s_{t-1} \)

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\( x_t = s_{t-1} \) and \( F_t \)

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Table 4  Multipliers Core Countries
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   *Capital Subsidies and Underground Production*

2005, 95   Lucio Valerio SPAGNOLO, Mario CERRATO
   *No euro please, We’re British!*

2005, 94   Roberto BASILE, Mauro COSTANTINI, Sergio DESTEFANIS
   *Unit root and cointegration tests for cross-sectionally correlated panels. Estimating regional production functions*

2005, 93   Sergio DESTEFANIS, Raquel FONSECA
   *Matching Efficiency and Labour Market Reform in Italy. A Macroeconometric Assessment*

2005, 92   Cesare IMBRIANI, Antonio LOPES
   *Banking System Efficiency and the Dualistic Development of the Italian Economy in the Nineties*

2005, 91   Carlo ALTAVILLA, Antonio GAROFALO, Concetto Paolo VINCI
   *Designing the Optimal Length of Working Time*

2005, 90   Marco MANACORDA, Barbara PETRONGOLO
   *Regional Mismatch and Unemployment: Theory and Evidence from Italy, 1977-1998*

2004, 89   Roberta TROISI
   *Teoria dell'impresa e responsabilità parapenale: le implicazioni organizzativo-gestionali*

2004, 88   Roberta TROISI
   *Enti non profit: tipologie ed opzioni organizzative*

2004, 87   Lavinia PARISI
   *La povertà: una rassegna sul confronto tra due approcci. Capability vs. Unidimensionalità*

2004, 86   Giuseppe CELI
   *Quality Differentiation, Vertical Disintegration and the Labour Market Effects of Intra-Industry Trade*

2004, 85   Niall O’HIGGINS
   *Recent Trends in Youth Labour Markets and Employment Policy in Europe and Central Asia*

2004, 84   Carlo ALTAVILLA, Floro Ernesto CAROLEO
   *Evaluating Asymmetries in Active Labour Policies: The Case of Italy*

2004, 83   Floro Ernesto CAROLEO, Francesco PASTORE
   *La disoccupazione giovanile in Italia. La riforma dei sistemi d'istruzione e di formazione professionale come alternativa alla flessibilità numerica per accrescere l'occupabilità*

2004, 82   Francesco PASTORE, Izabela MARCINKOWSKA
   *The Gender Wage Gap among Young People in Italy*

2004, 81   Elisabetta MARZANO
   *Dual Labour Market Theories And Irregular Jobs: IsThere a Dualism Even in The Irregular Sector?*

2004, 80   Corrado ANDINI
   *Unemployment and Welfare Partecipation in a Structural VAR: Rethinking the 1990s in the United States*

2004, 79   Floro Ernesto CAROLEO
   *Fondamenti teorici della rigidità salariale nell'ambito dei "Non Market clearing Models"*

2004, 78   Adalgiso AMENDOLA, Floro Ernesto CAROLEO, Gianluigi COPPOLA
   *Regional Disparities in Europe*

2003, 77   Fernanda MAZZOTTA
   *Flessibilità, povertà e istruzione: un approccio Sen – istituzionale*

2003, 76   Adalgiso AMENDOLA, Annamaria NESE
   *Mobilità intergenerale nel livello d'istruzione nella società femminile italiana ed endogenità del titolo di studio in un modello di partecipazione alla Forza Lavoro.*

2003, 74   Antonio LOPES
   *Innovazione nel Sistema Creditizio del Mezzogiorno negli Anni Novanta*

2003, 73   Sergio DESTEFANIS, Vania SENA
   *Public Capital and Total Factor Productivity New Evidence from the Italian Regions*

2003, 72   Giuseppina AUTIERO, Bruna BRUNO
   *Social Preferences in Wage Bargaining: a Neocorporatist Approach*

2003, 71   Gianluigi COPPOLA, Maria Rosaria GAROFALO, Fernanda MAZZOTTA
   *Industrial Localisation and Economic Development. A Case Study*

2002, 70   Francesco GIORDANO, Fernanda MAZZOTTA
   *Salario di Riserva, Probabilità di Occupazione ed Efficacia dell'Istruzione Universitaria: un'Analisi sugli Studenti dell'Università di Salerno*

2002, 69   Giuseppe RUSSO
   *Istituzioni del Mercato del Lavoro e Occupazione: dai Costi di Aggiustamento all'Appropriabilità*

2002, 68   Floro Ernesto CAROLEO, Francesco PASTORE
   *Training Policy for Youth Unemployed in a Sample of European Countries*

2002, 67   Maria Rosaria GAROFALO, Maria Rosaria SUPINO
   *Il Disegno Normativo del Welfare Municipale in Italia come Strumento per lo Sviluppo Economico e...*
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