Public investment fiscal multipliers:

An empirical assessment for European countries

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Public investment fiscal multipliers:
An empirical assessment for European countries

Matteo Deleidi, Francesca Iafrate and Enrico Sergio Levrero*

Abstract

This paper aims to estimate fiscal multipliers in 11 Eurozone countries. To do this, we make use of yearly data provided by the OECD for the 1970-2016 period. By using the local projections approach on a panel dataset and considering different model specifications, we estimate the magnitude assumed by fiscal multipliers in order to assess whether an increase in government investment generates a 'Keynesian effect' on the level of the GDP. Our findings suggest that fiscal multipliers tend to be larger than one and an increase in public investment produces a permanent and persistent effect on the level of output. Additional model specifications suggest that government investment fiscal multipliers are lower when the post-crisis period is excluded by our sample and are larger in Southern countries than Northern ones.

Keywords: fiscal multipliers; government investment; local projections; euro area

JEL codes: E12, H54, E62

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1. Introduction

The recent global crisis has encouraged many governments of advanced economies to implement fiscal stimulus packages to speed up recovery. At the same time, in early 2010, many euro area countries were affected by the sovereign debt crisis and adopted austerity measures to reduce fiscal imbalances and boost market confidence in sovereign borrowing. These measures were also intended to foster economic activity following the idea of expansionary austerity (Alesina et al. 2015).

Although several European countries have significantly reduced fiscal imbalances, these policies have not led to a reduction of the debt-to-GDP ratio. Instead they have led to stagnant economic activity combined with a higher unemployment rate. Both a failure to achieve the expected and alleged growth rates and a need to foster economic activity in response to a fear of secular stagnation have revived the debate on whether expansionary fiscal policy is effective in stimulating private activity. In particular, such a debate has recently gained momentum among international institutions and academic scholars regarding the estimates of fiscal multipliers using different theoretical and empirical approaches.

However, despite the increase in contributions in this field, there is still little consensus on the effect of government spending on macroeconomic aggregates. The International Monetary Fund (IMF) – one of the main proponents of fiscal consolidation measures – has recently questioned the effectiveness of these policies. Its chief economist, Olivier Blanchard, has claimed that austerity failed to boost economic activity and employment growth because the fiscal multiplier was higher than the one assumed by economists (Blanchard and Leigh 2013). Similarly, in the World Economic Outlook of October 2014, the IMF suggested that push-up public investment might allow economies to get out of stagnation, especially in this specific historical period, which is characterised by an accommodative monetary policy and low interest rates.

Another point to be highlighted is that the literature on fiscal multipliers has mostly focused on the effects of total public expenditure on GDP. Few works have dealt with the effects of its single components, namely government investment and consumption (Perotti 2004b), despite the strategic role of government investment in supporting economic growth underlined by international institutions such as the IMF and the European Commission (EC). For instance, the IMF highlights that an increase in government investment boosts output both in the short and the long run. While in the short run government investments are supposed to increase output through the fiscal multiplier and a virtual crowding-in effect on private investment, in the long run this effect is supposed to occur by enlarging productivity capacity (IMF 2014). Analogously, public investments in infrastructure have been recognised by the EC to be one of the main policy levers supporting economic growth: in 2014, with the support of the European Investment Bank (EIB), it advocated a public investment plan to get out of the economic stagnation which started at the beginning of 2008.

For the abovementioned reasons, this paper aims to estimate the value assumed by government investment fiscal multipliers by analysing the average effect of a fiscal policy intervention in order to provide a clear picture of the effect of government investment on the output level in selected euro area countries.

To do this, we focus on 11 European countries for the 1970-2016 period. In the spirit of the analysis developed by Auerbach and Gorodnichenko (2017) and Jordà (2005), our main contribution is to estimate fiscal multipliers by using the local projections approach applied to public investment in order to assess whether public investment generates permanent and persistent effects on the level of economic activity. Such an analysis is especially relevant for the current slowdown experienced by several European countries which have implemented austerity policy measures, as well as for the scant literature in this field. In accordance with IMF contributions (IMF 2014), our main findings suggest that the fiscal multiplier of government investments: (i) is close to one on impact and assumes a value larger than one in the subsequent periods; (ii) assumes a lower value when the recent recession years are excluded by our sample; and (iii) is asymmetric when Northern and Southern countries are considered, assuming a larger magnitude for the second group. Additionally, findings show that an increase in government investment generates permanent and positive effects on the level of economic activity (Deleidi and Mazzucato 2018).

The paper is organised as follows. Section 2 provides a review of existing literature by distinguishing between theoretical and empirical findings. Section 3 shows data and methods employed for estimating the fiscal investment multiplier, namely the effect of public investment on GDP. Section 4 and Section 5 present the main findings and some robustness checks respectively. Finally, in Section 6, conclusions are given and potential policy implications explored.

2. Literature review

In the recent macroeconomic literature, fiscal multipliers are estimated by a range of different methods. A first approach is based on simulations built within the Dynamic Stochastic General Equilibrium (DSGE) models, such as Real Business Cycle (RBC) and New-Keynesian (NK) models. The other approach applies empirical analysis based on structural VAR (SVAR) and local projections (LP) models. This section surveys the existing literature by emphasising differences between these two classes of models.

2.1 The model-based approach

The literature on the effect of fiscal policy on GDP is increasingly building on DSGE models such as Real Business Cycle (RBC) and New-Keynesian (NK) models which incorporate rational expectation and forward-looking agents for whom Ricardian equivalence holds. In both RBC and NK models, the effects of an expansionary fiscal policy on GDP are not measured via a Keynesian demand effect, but by considering Neoclassical wealth and substitutions effects (Baxter and King 1993). In particular, by assuming Ricardian households, an increase in government spending is supposed to generate a negative wealth effect which induces them to reduce consumption and leisure, determining an increase in labour supply. In addition, the rise in the real interest rate – stemming from a reaction of the monetary policy based on the Taylor rule – is considered to generate an additional fall in consumption through the negative relation implicitly assumed in the

Euler equation (the consumption intertemporal substitution effect). This implies that the size of the effect of an increase in government spending on GDP, that is the fiscal multiplier, usually between 0 and 1, depends on the elasticity of labour supply and the intertemporal elasticity of consumption (Hall 2009).

Nevertheless, NK models provide larger fiscal multipliers than RBC models by introducing monopolistic competition and nominal rigidities which allow for possible demand-side effects in the short run. In this case, the reaction of the labour market is different: as suggested by Pappa (2009b), firms reduce their mark-up and increase labour demand in excess of labour supply, determining an increase in real wages that causes a positive effect on consumption. Nevertheless, some of the multiplier estimations remain lower than one because the negative wealth and substitution effects on consumption are only partially compensated. For instance, Hall (2009) and Kaszab (2011) obtain an impact fiscal multiplier approximately equal to 0.9.

Within this literature, fiscal multipliers larger than one are obtained only by introducing additional hypotheses, for example, on households' preferences. As shown by Linnemann (2006), using a separable utility function, i.e. the complementarity between consumption and hours worked, it is possible to obtain a positive co-movement between private consumption and government expenditure. In this case, the rise in hours worked, determined by the negative wealth effect, increases the marginal utility of consumption. Hence, households desire to work more and consume more, mitigating the negative effect on consumption. By introducing this hypothesis, Kaszab (2011) estimates fiscal multipliers greater than those mentioned above and equal to 1.05. Nonetheless, despite the complementarity assumption, Hall (2009) defines an impact fiscal multiplier less than one and a negative effect on consumption equal to -0.03. The reason for this seems to lie in a low degree of complementarity, because Christiano et al (2011), assuming the same utility function but a larger degree of complementarity, obtain a positive effect on consumption of a government spending positive shock and estimate an effect on GDP equal to 1.2 on impact.

Similar results are also obtained by introducing a share of non-Ricardian (rule of thumb) consumers who consume all their disposable income (Galí et al. 2008). Under this hypothesis, the positive effect on real wages is immediately spent by this group of consumers. Hence, the effect on private consumption can be positive, depending on the share of rule-of-thumb consumers in total consumers. This additional hypothesis is used to estimate a fiscal multiplier approximately equal to 1.3 (Furceri and Mourougane 2010; Forni et al. 2007).

Finally, in these models, the size of the fiscal multiplier also depends on the reaction of the real interest rate. Many contributions obtain estimations larger than one by assuming the Zero Lower Bond (ZLB); that is, the condition in which nominal interest rates are held constant and equal to zero (Eggertsson 2010; Woodford 2011). In this case, a deficit-financed positive shock of public spending, by boosting inflation expectations, decreases the real interest rate, implying a positive effect on private consumption. Specifically, using this hypothesis, Hall (2009) estimates an impact fiscal multiplier equal to 1.07 and Christiano et al. (2011) find that expansionary fiscal policies determine a multiplier effect of between 3.7 and 4. Furthermore, Leeper and Davig (2009) find a multiplier in a range of 1.5 and 1.9, by assuming an active fiscal policy and a passive monetary policy, and a multiplier ranging between 0.1 and 0.4 when a passive fiscal and active monetary policy are supposed. Finally, Freedman at al. (2010) evaluate how the extent of the monetary accommodation matters. In their analysis, the positive effect on GDP ranges from 1.2% without monetary accommodation to 1.4% and 1.8% for one and two years of monetary accommodation respectively.

Although the major models presented in this section show a positive effect generated by an expansionary fiscal policy, the magnitude assumed by fiscal multipliers is model-dependent. Specifically, results are strongly sensitive to the different, alternative hypotheses of the models and the values ascribed to specific parameters.

2.2 The empirical approach

In parallel to the model-based approach, the dynamic of macroeconomic variables is widely studied by applying various econometric techniques which propose estimations of fiscal multipliers by minimising the theoretical relationship imposed on the variables taken into consideration. Although from an empirical perspective the literature has developed distinct methods to derive fiscal multipliers, we focus on the widely used approaches, namely structural autoregressive (SVAR) models and local projections.

The SVAR models are based on the identification of exogenous shocks in fiscal policy stances. The identification of exogenous fiscal policy shocks derives from the fact that the model assumes causation running from fiscal variables to output, while there could be reverse causality through automatic stabilisers and discretionary fiscal policy responses of policymakers to output (Perotti 2007). Therefore, it becomes crucial to isolate pure exogenous fiscal shocks. In this respect, this literature has developed four different identification strategies (Caldara and Kamps 2008). The first is the recursive approach based on zero restrictions that tries to resolve the endogeneity issue by applying a Cholesky decomposition (Fatás and Mihov 2002). Grounded on this first approach, the second approach additionally picks up the coefficient that describes the contemporaneous relationship between taxes and output by making use of institutional information (Blanchard and Perotti 2002). Third, in the sign restriction approach, the exogenous fiscal shocks are identified by imposing restrictions only on the sign of the response function, usually in line with the dominant economic theory (Pappa 2009a). Finally, the narrative approach achieves the identification by combining VAR models with dummy variables identified through a more qualitative and subjective assessment of the nature of the fiscal episodes, which are supposed to be uncorrelated with the business cycle (Ramey and Shapiro 1998).[1]

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[1] Further information on the identification strategies employed in VAR models is available in Ramey (2016). Nowadays, SVAR models are also used to analyse the non-linearity of the fiscal multiplier. Using a regime-switching model with seven quarters moving average of output growth rate as the threshold variable, we find higher multipliers in recession, reaching 2.5 after 20 quarters and close to one in expansion. State-dependent fiscal multipliers are provided also by Batini et al. (2012), who present estimations for USA, the euro area, Japan, Italy and France. In contrast to Auerbach and Gorodnichenko (2012), they define the regime in terms of the sign of real GDP growth rate and find that, while in an expansionary phase the fiscal multiplier ranges from 0.25 to 1.39, in recession it is greater and lies between 1.34 and 2.6. The idea that fiscal multiplier depends on the state of the economy is also supported by other scholars (see, among others, Baumet al. 2012; Fazzari 2012; Herbert 2014).

The variety of identification strategies leads to a variety of estimations of fiscal multipliers proposed by SVAR models, although it is usually found that real GDP increases in response to a government spending shock following a hump-shaped pattern (Bilbiie et al. 2008; Blanchard and Perotti 2002; Burriel et al. 2010; Fatás and Mihov 2002; Pappa 2009). For example, Blanchard and Perotti (2002) estimate an impact fiscal multiplier of government spending equal to 0.84 in the US economy, whereas Bilbiie et al. (2008), Pappa (2009) and Ramey (2011) find it equal to 0.94, 1 and 0.76 by employing the recursive, sign restriction and narrative approach respectively. Additionally, Burriel at al. (2010) and Pappa (2009) propose a fiscal multiplier of 0.75 and 0.16 for the euro area. Furthermore, Perotti (2004a) shows that estimations diverge across countries: by considering five OECD countries, he finds that the government spending multiplier varies in the range -0.3/0.36.

From an empirical point of view, the recent literature also estimates fiscal multipliers by employing the local projections method. It is an alternative methodology that relies on running separate regressions for each horizon and then constructing the impulse response.[2] By applying this approach, Auerbach and Gorodnichenko (2017) estimate a government spending multiplier equal to 0.228 and 0.663 using semi-annual and annual data respectively. Moreover, the value of fiscal multiplier increases, reaching a value of 0.65 when fiscal policy shocks are identified by applying the conventional approach of Blanchard and Perotti (2002). Similarly, Riera-Crichton at al. (2015) find a fiscal multiplier of 0.4 after three quarters, emphasising that the economy does not respond symmetrically to increases or decreases of government spending: only the estimations of fiscal multiplier associated with increases of government spending are significantly different from zero and assume values larger than one, reaching a peak of 1.36. The same methodology is employed by Abiad at al. (2016) who determine a public investment multiplier equal to 1.4 in the medium term.

The review of the literature carried out in this section brings out two fundamental aspects that led us to a direct estimation of the fiscal multiplier. The first concerns the variety and uncertainty of the results achieved, particularly by the model-based approach and by SVAR models, that could be ascribed to the chosen identification strategy for the latter methodology, and to the alternative hypotheses and the different values assumed by specific parameters that described the consumers' behaviour for the former. However, the second aspect is related to the fact that the prevailing literature has focused especially on the effect on GDP of total public spending, defined as the sum between government consumption and investment, without distinguishing between the multiplicative effect generated by these single components. Our estimates will focus precisely on this point by estimating fiscal multipliers associated with government investment for the Eurozone.

[2] This methodology is explained in detail in Section 3.

3. Data and methodology

3.1 Data

In order to implement our econometric analysis, which is based on advanced panel techniques, we build a dataset for 11 euro area countries – Austria, Belgium, Finland, France, Germany, Ireland, Italy, Luxemburg, the Netherlands, Portugal and Spain – by considering the 1970-2016 period. We use yearly macroeconomic data, such as real GDP (y); public investment (I_g); total public expenditure (g) defined as government current disbursements plus government fixed capital formation net of interest payments[3]; the real effective exchange rate $(REER)$; and the long-term interest rate (r). Despite the availability of quarterly data, we use annual data since they are available for more European countries allowing us to provide a clear picture of the size of fiscal multipliers. Most of the considered variables are provided by the OECD's Economic Outlook database and the World Bank's World Development Indicator (WDI). All selected variables are converted to real terms by using the GDP deflator. More details on sources and definitions of the variables used in this paper are provided in Appendix A.

3.2 Methodology

To estimate the fiscal multiplier for selected European countries, we apply the local projections (LP) method. As pointed out by Auerbach and Gorodonichenko (2017) and Dell'Erba et al. (2018), the LP method is a natural alternative for obtaining impulse response functions (IRFs). As argued in Jordà (2005), there are multiple advantages to using the LP method. For example, LPs can be estimated by single-regression techniques, they are more robust to misspecifications and they easily accommodate highly non-linear and flexible specifications.

The LP approach (Jordà 2005) entails the estimation of individual single regressions in which the variable of interest is considered in each horizon following the realisation of the shock. LP method can be formalised as follows in equation (3.1)

$$y_{t+h} = \alpha_h + \Psi_h(L)X_t + \beta_h D_t + \varepsilon_{t+h} \tag{3.1}$$

where y is the variable of interest considered at each horizon $h = 1, \dots H$;X is a vector of control variables and $\mathrm{D_t}$ is the selected fiscal variable. The coefficient β_h is the response of y at horizon $t + h$ to the shock at time t, and $\Psi_h(L)$ is a polynomial lag. In this approach, coefficients contained in the polynomial lag are not used for constructing the IRFs, but they are used as a control to clear the coefficients β_h from the dynamic effects of control variables. In other words, IRFs are directly built from the β_h coefficients. In practice, the LP approach regresses the variable of interest for

[3] Since the main goal of the analysis is to estimate government investment multipliers, total government expenditure (g) is only considered as a control variable in all regressions.

each time $t+h$ on a change of fiscal variable at time t and via this constructs the average response of the dependent variable h periods after the shock: hence IRFs are constructed by estimating a set of regressions for each horizon h.

3.2.1 Two-way fixed effects model

To study the effects on GDP of a change in public investment by using the LP method, a dynamic two-way fixed effects model is estimated. Following Auerbach and Gorodonikencho (2017) and Furceri at al. (2016), the estimated model assumes the following form as shown in equation (3.2)

$$\Delta y_{i,t+h} = \alpha_i^h + \delta_t^h + \beta^h I_{g,i,t} + \psi_j^h \boldsymbol{X}_{i,t+h} + \sum_{j=1}^{p} \phi_j^h \Delta y_{i,t-j} + \sum_{j=1}^{p} \varphi_j^h \Delta g_{i,t-j} + \varepsilon_{t+h} \qquad (3.2)$$

where i and t index countries and time respectively; $\alpha_{\mathrm{i}}^{\mathrm{h}}$ is the countries fixed effects; and δ_i^h is the time fixed effects[4]. $\Delta y_{i,t+h}$ represents the change in GDP between $t-1$ and $t+h$[5]; and $I_{g,i,t}$ represents the fiscal variable, namely the public investment rate of growth[6], defined as $\log(I_{g,t}) - \log\,(I_{g,t-1})$. In the spirit of Riera-Crichtonet al. (2015) and Owyang et al. (2013), a set of control variables are introduced in equation (3.2). Particularly, we consider $\Delta y_{i,t-j}$ and $\Delta \mathrm{g}_{\mathrm{i,t\text{-}j}}$ which are the GDP growth rate and government spending rate of growth at time $t-j$ respectively.[7] Additionally, X is a vector which contains the REER and the long-term interest rate which is included to control for the stance of monetary policy (Auerbach and Gorodnichenko 2017).

To estimate the dynamic fiscal multipliers associated with a change of our fiscal variable, namely public investment (I_g), we need to estimate the value of the coefficient β^{h}. Since $\mathrm{I_g}$is the rate of growth of government investment, estimated coefficients (β^{h}) are expressed in terms of elasticities and thus multipliers are built by multiplying the coefficients $\beta^{\mathrm{h}}$by ${}^{\mathrm{Y}}/_{\mathrm{I}}$[8]. By applying this

[4] The introduction of time effects, with the so-called year dummies, has been dictated by the need to control the presence of factors that could have simultaneously affected all countries. Furthermore, the choice of introducing the time effects has been confirmed by the Wald test estimated on the coefficients of the individual time dummies. Results allow us to refuse the null hypothesis for which all the coefficients associated with them are equal to zero.

[5] In particular, $\Delta \mathrm{y}_{\mathrm{i,t+h}} = \log(\mathrm{y}_{\mathrm{t+h}}) - \log\,(\mathrm{y}_{\mathrm{t-1}})$.

[6] The rate of growth of public investment is defined as $\log(\mathrm{I_{g,t}}) - \log\,(\mathrm{I_{g,t-1}})$, similarly to Grazia and Klemm (2016), who identify the discretionary fiscal measures as the gap between actual spending and an expenditure benchmark, which is the previous year's government primary spending uprated by inflation.

[7] In all specifications, we consider lag equal to one for both the rates of growth. However, when we estimate the model using lags equal to two, findings do not change. In addition, we estimate the model by introducing four lags for the rate of growth of GDP and government expenditures, and we find that the model reporting the lowest value in AIC and BIC criteria is the one with lag equal to one. Results are available upon request.

[8] As a robustness check, following Ramey and Zubairy (2018), we consider the growth rate of public investment multiplied by ${}^{\mathrm{I}}/_{\mathrm{Y}}$ as our new fiscal variable. In doing so, we scale the fiscal variable so that changes in public investment

method, partial derivatives represent the euro-change in GDP (y) of a one-euro increase in public investment (I_g).

After controlling for heteroscedasticity, autocorrelation and cross-sectional correlation[9], we use robust Driscoll and Kraay (1998) standard errors to make statistical inferences. Furthermore, the model specification considers variables as stationary. This assumption is supported by the panel unit roots tests reported in Table 1. The Im, Pesaran and Shin (IPS), the Levin, Lin and Chu (LLC), and the Pesaran CADF tests reject the null hypothesis for which 'all panels contain unit roots'. The only exception is the long-term interest rate which is reckoned as first difference.

Table 1. Panel unit root test

	IPS test	LLC test	CADF test
Rate of growth of y	-9.5 (0.00)	-6.36 (0.00)	-6.11 (0.000)
Rate of growth of I	-11.2 (0.00)	-4.42 (0.00)	-8.72 (0.000)
Rate of growth of g	-9.84 (0.00)	-5.44 (0.00)	-6.5 (0.000)
REER	-2.71 (0.003)	-3.05 (0.001)	-2.64 (0.004)
Long-term interest rate (r)	4.79 (1.00)	-4.12 (0.00)	-3.01 (0.001)

IPS=Im, Pesaran and Shin test, LLC=Levin, Lin and Chu test, CADF=Pesaran CADF test. When performing the LLC test, we restrict the reference period to the period for which we have all data because it requires a balanced panel (1991-2016). The P-value is shown in ().

We estimate three model specifications considering different control variables. In the first (Model 1), non-controls other than country and time fixed effects, and the lag of GDP growth rate, are included in the regression. In the second specification (Model 2), we add the lag of the government spending growth rate. Finally, in the last specification (Model 3), continuing to consider a full set of controls as in Model 2, we also include other control variables, such as the real effective exchange rate ($REER$) and the long-term interest rate (r). All findings are provided in Section 4. Additionally, robustness checks on all model specifications are provided in Section 5. As a first step, we control whether the recent recession has had an impact on the magnitude assumed by the fiscal multiplier. To do this we drop the 2008-2016 period. As a second step, we analyse whether differences in estimations among groups of countries exist by considering Northern and Southern European countries separately. Finally, taking into account the method of

are measured as a percentage of GDP, implying that the coefficients β^h is the fiscal multiplier. These findings are shown in Section 5.

[9] We use the modified Wald test, the Wooldridge test and the Pesaran CD test for heteroscedasticity, autocorrelation and cross-sectional correlation respectively.

conversion of elasticities in multipliers proposed by Ramey and Zubairy (2018), we change our independent variable in order to directly obtain the magnitude of the fiscal multiplier.

3.3 Endogeneity issue

In order to avoid potential endogeneity bias in our analysis, we consider whether public investment reacts contemporaneously or not to macroeconomic conditions such as changes in GDP growth rate. Since we use yearly data on a large sample of European countries, our aim is to assess whether public expenditure and especially public investment can be considered independently of the GDP growth rate within the year.[10] To do this, the current sub-section deals with the potential endogeneity issues by: (i) developing a narrative discussion of the reasons according to which public investment can be considered exogenous in the year; and (ii) testing annual government investment exogeneity by applying a procedure similar to the one proposed by Born and Muller (2012).

As a first step, in order to discuss the exogeneity of public spending within the year, we have to consider institutional and political aspects which may affect fiscal policy decisions. Usually, fiscal authorities are not induced to implement discretionary fiscal policies whenever there is a cyclical fluctuation of GDP. Fiscal authorities rely on the action of monetary policy and automatic stabilisers. In particular, the preference for monetary policy intervention has been justified by emphasising that a discretionary monetary policy could be implemented more quickly than a fiscal policy decision. Monetary policy is much less subject to implementation lags than fiscal policy and is much more nimble than fiscal policy, especially in the case of reversing policy action (Taylor 2000; Fontana 2009). This argument is strengthened by the way in which monetary policy has been conducted in the last few years and by the fact that discretionary fiscal stimulus has been effected when monetary policy became powerless in boosting the economic activity. For example, at the beginning of one of the major economic crises of the last decades in 2008, the European Central Bank and other worldwide central banks (e.g. the FED) implemented expansionary monetary policies before the implementation of discretionary fiscal policies by governments. More specifically, it was only when the Zero Lower Bound was reached by monetary authorities that fiscal authorities acted with a set of discretionary instruments for boosting the depressed economic activity. Furthermore, the use of automatic stabilisers represents an effective tool for overcoming the lags of discretionary fiscal policy (Auerbach 2002). This aspect is emphasised by Taylor (2000; 2009) who has demonstrated that the relation between discretionary fiscal policy and business cycle has lower intensity than the relations between automatic stabilisers and the cycle.

These arguments posit fiscal policy at a disadvantage as a countercyclical tool (Taylor 2000): this means that fiscal authorities tend to react discretionally only to prolonged and pronounced changes in the level of output or more general macroeconomic conditions. If we identify a

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[10] Most of the econometric analysis recognises the exogeneity of public spending by using quarterly time series data (Blanchard and Perotti 2002).

prolonged change in GDP as a recession or a boom phase of business cycle, defined when a fall or a boost in real GDP is observed for at least two consecutive quarters, we can conclude that fiscal authorities may not consider intervening discretionally until six months from the beginning of change in output. Additionally, as suggested by Sims (1998), it is important to consider the time span between the moment when the change in the level of output arises and the moment when authorities act. Prior to any fiscal action, authorities have to identify the problem and this identification requires gathering and analysing economic data which are not available instantaneously because they are released only infrequently (information delays). For example, data on GDP are collected quarterly and are released about two months after the end of a quarter (Jovanovski and Muric 2011). Hence, information on prolonged change in GDP will be available only two months after the end of the second quarter. This implies that authorities will begin to consider the idea of implementing a discretionary fiscal policy only at the end of the following fiscal quarter. Consequently, we can talk about endogeneity issues only if discretionary fiscal policy in response to a change in macroeconomic conditions is implemented in the last quarter of the year. Because of the presence of decision lags, it has been argued, however, that a discretionary fiscal policy takes more than one quarter to be decided, approved and made operational (Blanchard and Perotti 2002; Kilian and Lütkepohl 2017). In support of this idea, it has been documented that, after the recent crisis which began in January 2008[11], the European Economic Recovery Plan was made operational only at the beginning of 2009. Similarly, two major European countries – Italy and Germany – implemented and made a discretionary fiscal policy operational after one year, at the beginning of 2009 (Hamburg at al. 2010).

Finally, in our analysis we do not consider public expenditure, that is government consumption plus government investments, but only the last component. They are strategic expenditures which – unlike government expenditures for the purchase of consumption goods – increase the national capital stock. The strategical feature ascribable to public investment bases these public project decisions on bureaucratic and institutional decisions which last longer than the fiscal year. Public investment decisions are based on feasibility studies, and projecting and planning activities, as well as approval decisions which may involve different policy, public and private institutions, and which delay the decision process. For instance, the Turin–Lyon high-speed railway (TAV) – a strategic example of public investments in infrastructures – was conceived of 20 years ago. The first feasibility study was carried out by Italian and French governments in 1991 and a contract for development of the project was signed by the two governments ten years later, in 2001.

As a second step, we take into account that exogeneity of yearly government spending is also justified in the econometric literature. For instance, Beetsma et al. (2009) evaluate the validity of the identification restrictions constructing within-period changes in variables for a model estimated with annual data. These changes are based on estimates obtained from a quarterly data

[11] Here we are hypothesising that the recent Great Recession began in the first quarter of 2008 according to the Euro Area Business Cycle Dating Committee of the Centre for Economic Policy Research (CEPR). This conclusion is also in agreement with the recession indicator proposed by the FRED, effected considering the Composite Leading Indicators (CLI) provided by the OECD.

model. They do not find evidence of government spending responding to GDP shocks within a year. Thus, they conclude that it is reasonable to impose zero restrictions to identify government spending shocks using low frequency data. In addition, Born and Muller (2012), following a different approach, reach the same conclusion. More precisely, they specify and test restrictions in a quarterly data model that ensures government spending is predetermined annually. In fact, they find that IRFs obtained under this restriction are virtually identical to those obtained under the conventional Blanchard and Perotti (2002) identification assumption.

In order to detect whether public investment is influenced by the output level, we follow a procedure similar to that suggested by Born and Muller (2012). More specifically, we use quarterly data to test whether annual government investment is exogenous by evaluating whether the rate of growth of public investment responds to the rate of growth of GDP within the year. To do this, we estimate the regression specified in equation (3.3), which consists of the rate of growth of government investment (I_g), its lags and the lags of GDP growth rate (y).

$$I_{g,t} = \gamma_1 x_{t-1} + \gamma_2 x_{t-2} + \gamma_3 x_{t-3} + \gamma_4 x_{t-4} + \varepsilon_t \tag{3.3}$$

where $x = [I_{g,t-j}, y_{i,t-j}]'$ and $\gamma_j = [\gamma_{I_g,I_g}^{(j)}, \gamma_{I_g,y}^{(j)}]$. By making use of the Wald test, we analyse if the coefficients related to lagged values of the rate of growth of GDP are jointly statistically significant. The linear restrictions shown in equation (3.4) are tested by means of the Wald test.

$$\gamma_{I_g,x}^{(1)} = \gamma_{I_g,x}^{(2)} = \gamma_{I_g,x}^{(3)} = 0 \tag{3.4}$$

The findings show whether the lagged values of quarterly GDP growth rate (y) are able to affect the rate of growth of public investment at time t ($I_{g,t}$). If the estimated *p-values* are greater than a lower bound of 5%, we can affirm that public investment could be regarded as exogenous variables also when annual variables are considered in the models.

We apply the Wald test by considering the larger set of countries for which quarterly data on government investment are available, over the period 1970-2016. The country sample consists of Belgium, Finland, France, Germany and the Netherlands. To explore the robustness of our findings, the Wald test is applied to coefficients stemming from equations singularly estimated for each considered country and for the whole panel[12]. Results are reported in Table 2 and show that we cannot reject the Wald test null hypothesis for the whole panel and for all the countries taken into consideration. These findings allow us to support the idea that yearly government investment growth rates are exogenous to macroeconomic conditions, namely the GDP growth rate. These

[12] When we estimate the equation 3.3 for the whole panel, we add the country and time fixed effect.

results are preconditions for estimating fiscal multipliers through the aforementioned methodology based on the LP method.

Table 2. Wald Test

	Wald test
Panel	2.90 (0.1651)
Belgium	0.13 (0.9425)
Finland	0.79 (0.5024)
France	0.48 (0.6993)
Germany	1.26 (0.2944)
Netherland	1.24 (0.2981)

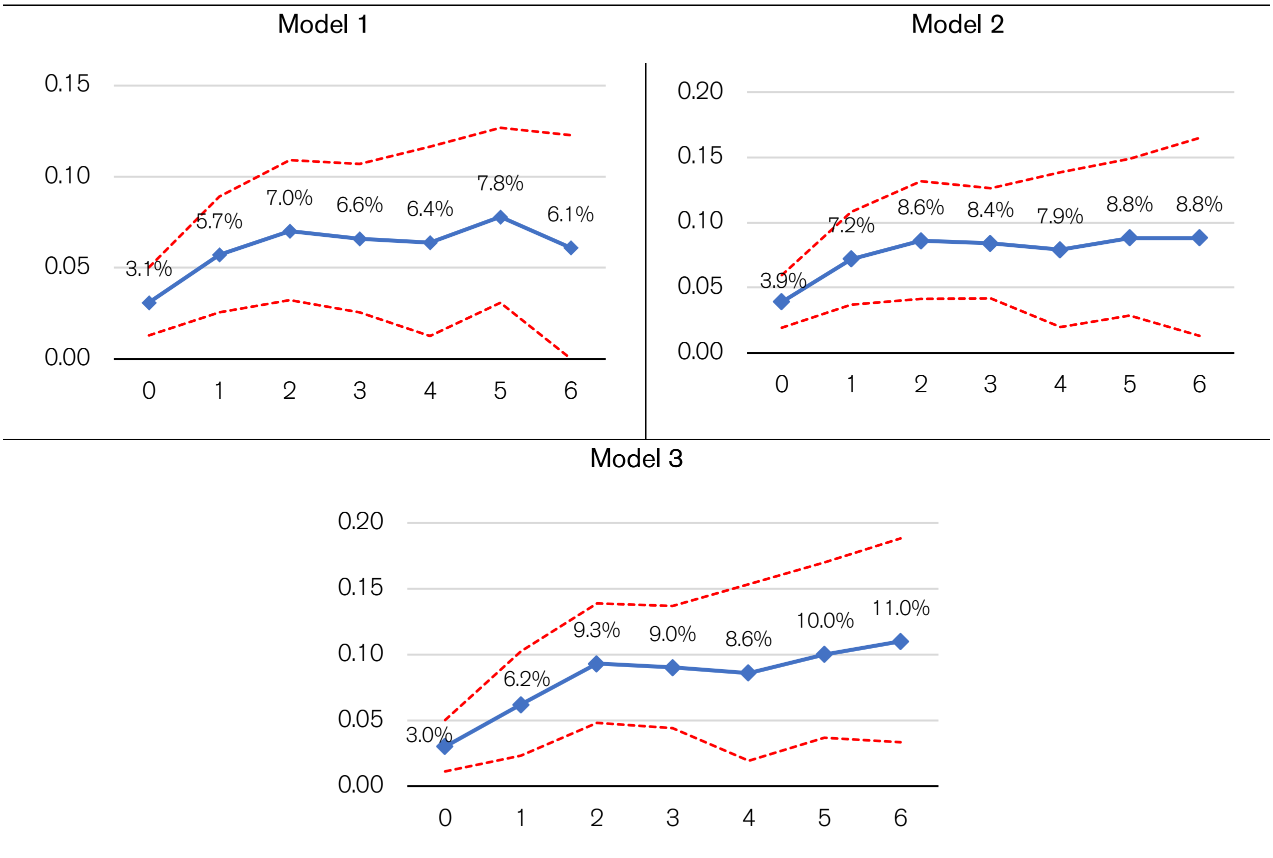
Values are test statistics. The first row displays results for the whole panel, others show results for each county. The P-value is shown in ()

4. Findings

We estimate local projections for six years ahead ($h = 6$) for three different model specifications, defined in Section 3.2.1. In Figure 1 we depict elasticities of output to government investment changes, whereas the results of fiscal multipliers measured as a one-euro increase in the level of government investment spending are reported in Table 3.

In Model 1, the 1% increase in the rate of growth of government investment determines a positive effect on output equal to 3.1% in the same year (Figure 1, Model 1). When elasticities are converted to multipliers, a one-euro increase in public investment generates an impact multiplier of about 0.96 (Table 3, Model 1). In Model 1, the peak elasticity and multiplier are equal to 7.8% and 2.43 per one-euro spending after five years respectively. After six years, the elasticity is 6.1% and the multiplier of public investment is equal to 1.9. All results in Model 1 are significant at 5% confidence level. According to the Model 1 findings (reported in Figure 1 and Table 3), changes in public investment have a long-lasting and permanent effect on output. Furthermore, multipliers assume values which are close to 1 on impact and are larger than one in the years ahead.

Figure 1. Elasticities of output to government investment changes



Years on x-axis. Dashed lines denote 95% confidence bands

Table 3. Government investment fiscal multiplier

	(1) Year 0	(2) Year 1	(3) Year 2	(4) Year 3	(5) Year 4	(6) Year 5	(7) Year 6
Model 1	0.96***	1.78***	2.18***	2.06***	1.99**	2.43***	1.90**
Model 2	1.21***	2.24***	2.68***	2.62***	2.46**	2.74***	2.74**
Model 3	0.93***	1.93***	2.90***	2.81***	2.68**	3.12***	3.43***

*** p-value < 0.01, ** p-value < 0.05, * p-value < 0.1

In Model 2, in which we also include the lagged rate of growth of government spending, the response of output to changes in public investment remains qualitatively similar, as depicted in Figure 1 (Model 2). Despite this, the size of elasticities and investment spending multiplier is greater than the previous one: the 1% increase in the rate of growth of public investment generates a higher GDP of about 3.9%. Furthermore, considering that the average share of public investment in GDP is approximately equal to 3.2%, this implies an impact investment spending multiplier of about 1.21 (Table 3, Model 2). In this case, the multipliers reach a peak of 2.74 during the fifth year after changes in public investment and this remains constant in the year ahead.

Finally, in the last model specification (Model 3), which also incorporates the real effective exchange rate and the long-term interest rate, results are consistent with others in terms of statistical significance and persistence of the effects on GDP (Figure 1, Model 3), although the magnitude of fiscal investment multiplier is different (Table 3, Model 3). On impact, the GDP elasticity is 3% and the corresponding public investment multiplier is 0.93. Moreover, by using this model specification, we obtain the greatest value of the peak multipliers that is equal to 3.4 six years after the change in government investment.

Our results clearly show that an increase in the level of public investment engenders a positive and permanent effect on the level of GDP. Furthermore, fiscal multipliers assume values which are extensively larger than one, which confirms the idea that a fiscal expansion generates a Keynesian effect on the output level. Our results can be confirmed for all considered models in which different specifications are assumed.

5. Robustness analysis

This section provides a series of robustness checks in order to measure the sensitivity of our results to alternative specifications. First, we explore the robustness of our findings by varying the sample period. In particular, we re-estimate the three models described in Section 3.2.1 by dropping the recent recession period: hence the sample runs over the period 1970-2007.[13] This allows us to check whether the years of the Great Recession have had an impact on the estimations and magnitude assumed by fiscal multipliers. Furthermore, we look at the possible differences in the magnitude of fiscal multiplier between countries. For this purpose, we estimate the abovementioned three model specifications for two different groups of countries. The first one incorporates those countries termed as PIIGS, namely Portugal, Ireland, Italy and Spain;[14] the second one, on the other hand, consists of the remaining seven countries, namely Austria, Belgium, Finland, France, Germany, Luxemburg and the Netherlands. This robustness check was implemented in order to evaluate whether government investment spending had a different multiplier effect in countries in which the impact of the recession was stronger. Finally, we re-estimate the same regressions by changing the form of the exogenous variable used in the estimation, namely government investment (I_g). As suggested by Ramey and Zubairy (2018), we use the growth rate of government investment multiplied by the share of government investment on GDP instead of the simple rate of growth. The independent variable is, therefore, defined as

[13] Here we are hypothesising that the recent Great Recession began in the first quarter of 2008 according to the Euro Area Business Cycle Dating Committee of the Centre for Economic Policy Research (CEPR). This conclusion is also in agreement with the recession indicator proposed by the FRED, effected considering the Composite Leading Indicators (CLI) provided by the OECD.

[14] The PIIGS group of countries also contains Greece, but we do not consider it because it is not included in our sample.

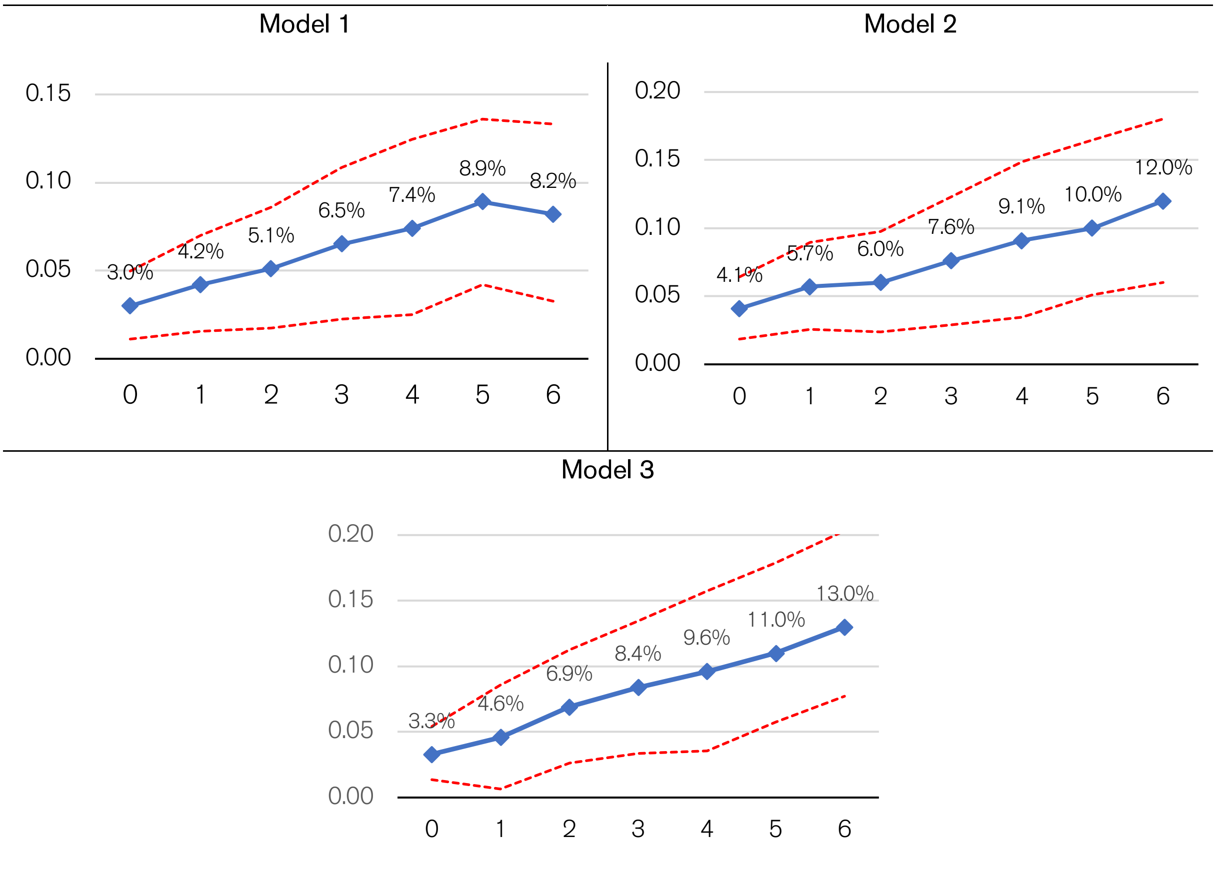
changes in public investment as a share in GDP, that is $I_{g,t} - I_{g,t-1}/y_{t-1}$[15]. The advantage of using this definition is that the coefficient β^h directly identifies the size of fiscal investment multiplier as GDP and public investment is expressed in the same unit. Therefore, we do not need any ex-post conversion factor[16]. We find that all specifications have the same qualitative properties and that they produce similar results in terms of sign and persistence of the effects. The response of GDP is positive and significant five and six years after the change in government investment in all three robustness checks (Figure 2, Figure 3 and Figure 4).

First, when the recent recession years are dropped, in the first model specification we find that changes in government investment determine an effect on GDP equal to 3% on impact and which reaches a peak of about 9% five years after the change (Figure 2, Model 1). Considering that in this case the average share of public investment on GDP is equal to 3.3%, these elasticities imply an impact multiplier of 0.91 and a peak multiplier equal to 2.7 (Table 4, Model 1). In the second model specification (Table 4, Model 2 and Figure 2, Model 2), the elasticity of output to government investment is equal to 4.1%, implying a fiscal multiplier of 1.25 on impact. Additionally, the elasticity and the multiplier reach a peak after six years, assuming values of 12% and 3.65 respectively. Finally, when Model 3 is considered, we find that a 1% increase in government investment generates an increase in the level of GDP of around 3.3% on impact, which becomes 13% six years later (Figure 2, Model 3). Therefore, the corresponding multipliers are 1 and 3.96 respectively (Table 4, Model 3). Furthermore, compared with the baseline results, in this case the magnitude of investment multiplier is higher in the first three years after the change in fiscal variable and lower in the last three years, allowing us to conclude that the years of the Great Recession have had an impact on the magnitude of fiscal multipliers.

[15] Note that $\left(I_t - I_{t-1}/I_{t-1}\right) * \left(I_{t-1}/y_{t-1}\right) = I_t - I_{t-1}/y_{t-1} \approx [\log(I_t) - \log(I_{t-1})] * I_{t-1}/y_{t-1}$

[16] Further information is available in Ramey and Zubairy (2018).

Figure 2. Robustness check: elasticities of output to government investment changes in pre-crisis years (1970-2007)



Years on x-axis. Dashed lines denote 95% confidence bands

Table 4. Robustness check: government investment fiscal multiplier in pre-crisis years (1970-2007)

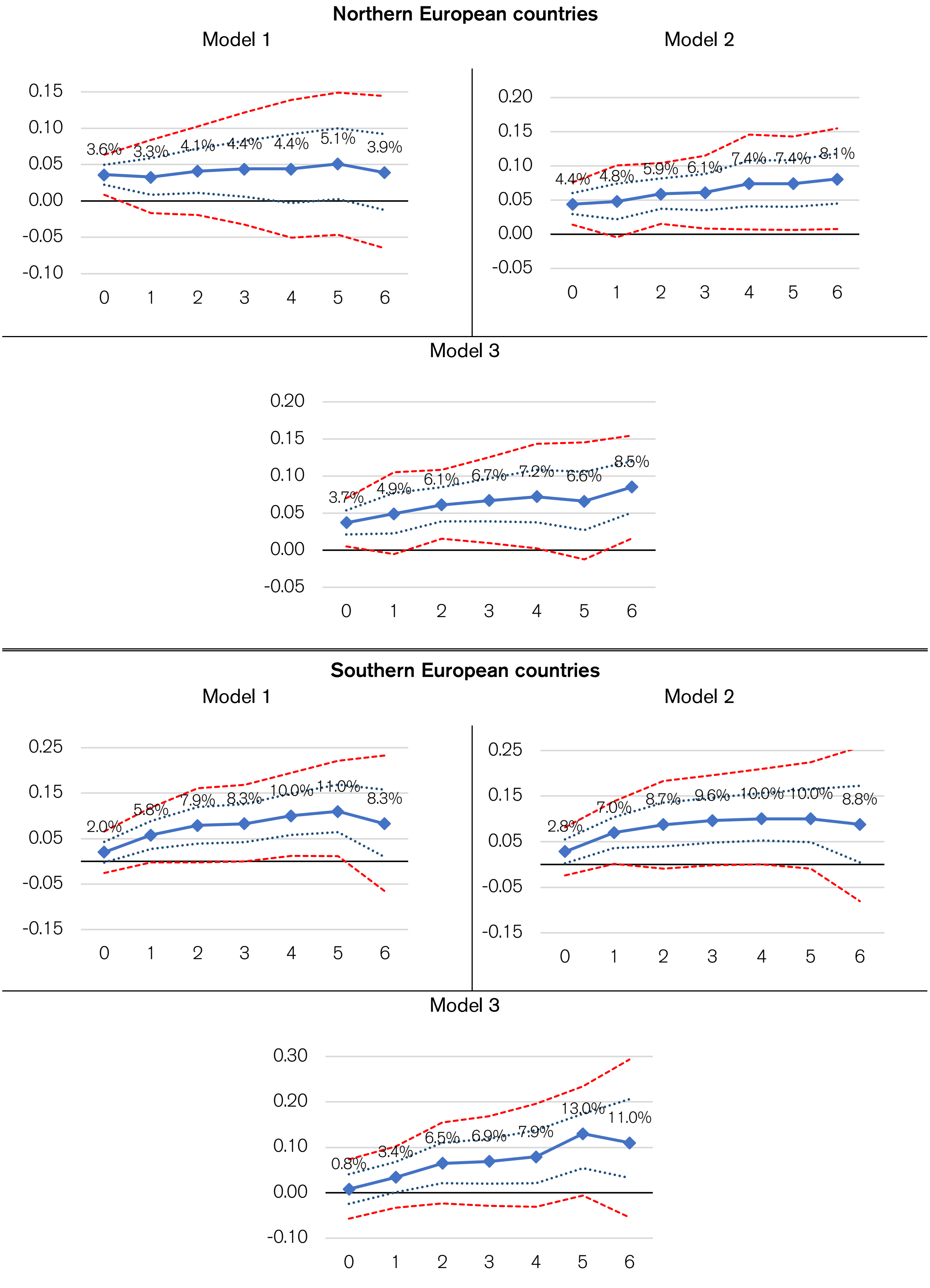
	(1) Year 0	(2) Year 1	(3) Year 2	(4) Year 3	(5) Year 4	(6) Year 5	(7) Year 6
Model 1	0,91***	1,27***	1,55***	1,98***	2,25***	2,71***	2,5***
Model 2	1,25***	1,73***	1,83***	2,31***	2,77***	3,04***	3,65***
Model 3	1,00***	1,4***	2,1***	2,56***	2,9***	3,35***	3,96***

*** p-value < 0.01, ** p-value < 0.05, * p-value < 0.1

Second, when two different groups of countries are considered, we find that the magnitude of multiplier effect of an increase in government investment tends to be larger in Southern countries than in Northern ones, except on impact (Figure 3 and Table 5)[17].

[17] Following Blanchard and Perotti's (2002) seminal work, we have also reported for this robustness check error bands at one standard deviation, namely at 68% confidence bands

Figure 3. Robustness check: elasticities of output to government investment changes in Northern and Southern countries



Years on x-axis. Red dashed lines denote 95% confidence bands and blue dotted lines denote 68% confident bands.

Table 5. Robustness check: government investment fiscal multiplier in Northern and Southern countries

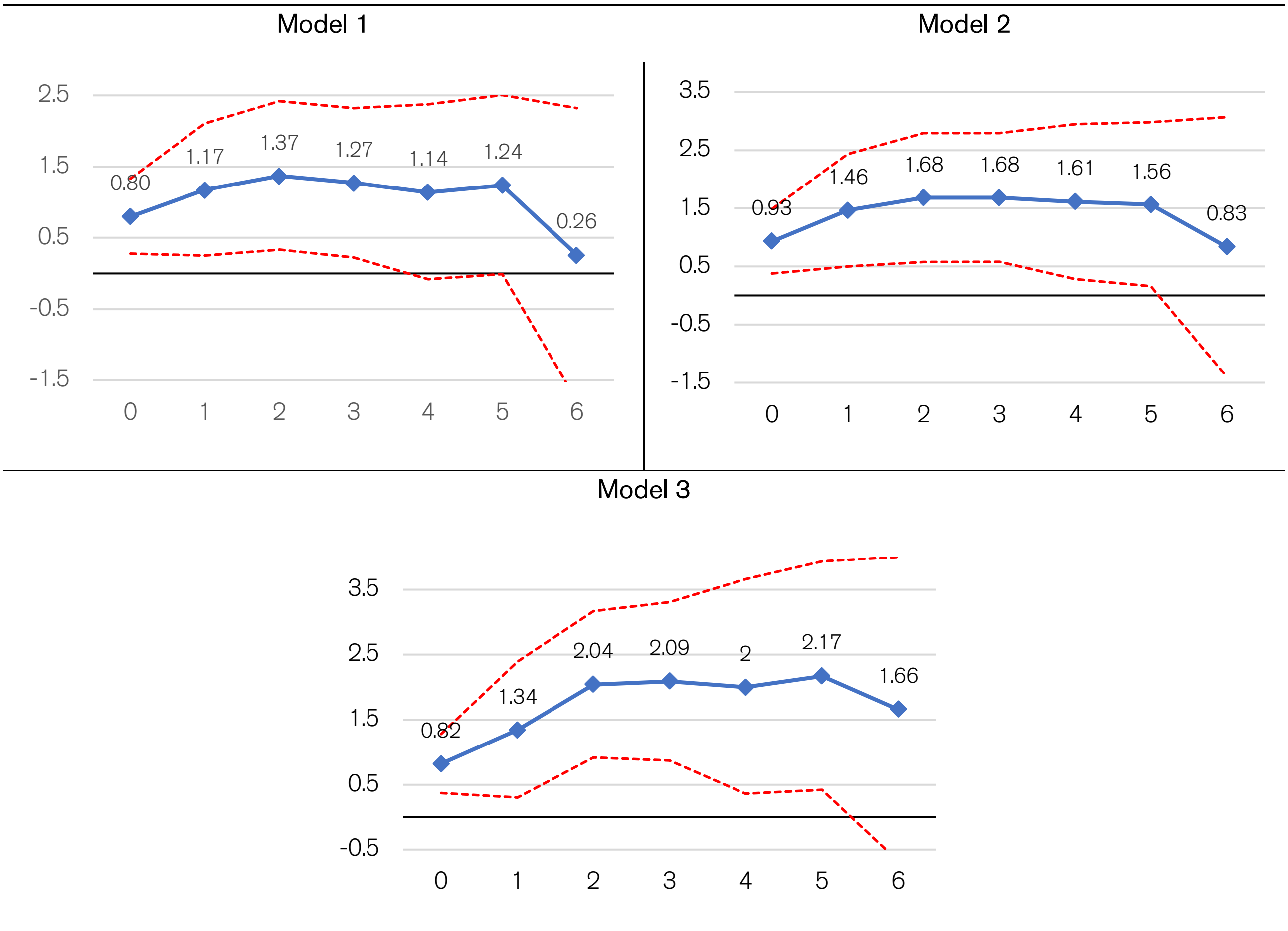
	(1) Year 0	(2) Year 1	(3) Year 2	(4) Year 3	(5) Year 4	(6) Year 5	(7) Year 6
Northern European countries							
Model 1	1.036***	0.95+	1.18+	1.27+	1.27	1.47+	1.12
Model 2	1.27***	1.38*	1.7***	1.75**	2.13**	2.13**	2.33**
Model 3	1.06**	1.4*	1.75***	1.93**	2.07**	1.89*	2.44**
Southern European countries							
Model 1	0.71	2.07*	2.82**	2.96**	2.57**	3.93**	2.96+
Model 2	1+	2.5**	3.10*	3.42**	3.57**	2.57*	3.14+
Model 3	0.29	1.21+	2.31+	2.46+	2.81+	4.63*	3.92+

*** p-value < 0.01, ** p-value < 0.05, * p-value < 0.1, + p-value<0.32

Specifically, relative to the first model specification, the elasticities of GDP to government investment expenditure on impact are 2% and 3.6%, and hover around 5% and 11% in the subsequent five periods for North and South countries respectively (Figure 3, Model 1). When these elasticities are converted to multipliers, a one-euro increase in public investment in the Northern countries engenders a multiplier effect of 1.036 on impact and 1.47 five years ahead. On the other hand, when Southern countries are considered, we obtain a multiplier effect equal to 0.71 on impact, which reaches a peak of 3.93 in the fifth year (Table 5, Model 1). Similarly, when the second specification (Model 2) is estimated, the GDP elasticities are 4.4% and 2.8% on impact and the corresponding public investment multipliers are 1.27 and 1 in the Northern and Southern countries respectively. Moreover, we obtain a peak multiplier of 2.33 for Northern countries and 3.57 for Southern countries after six and four periods respectively (Figure 3, Model 2 and Table 5, Model 2). In the last model specification (Model 3), results are consistent with other findings (Figure 3, Model 3), although the magnitude of fiscal investment multiplier is different (Table 5, Model 3). Specifically, the GDP elasticities are 3.7 for Southern European countries and 0.8 for Northern ones on impact and the corresponding public investment multipliers are 1.06 and 0.3 respectively. Moreover, we obtain a peak multiplier equal to 4.63 after five years for the Southern countries and 2.44 after six years for the Northern ones. In line with the Kaldorian perspective (Kaldor 1955), a higher fiscal multiplier in Southern countries may reflect the fact that these countries are characterised by a lower GDP per capita than the Northern ones and therefore a higher marginal propensity to consume.[18]

Finally, when the Ramey and Zubairy definition is used for the independent variable, the size of the fiscal investment multiplier is less than that estimated in the baseline model. The estimation lies between 0.8 and 0.95 on impact and it reaches a peak of 2.17 in Model 3 five years after the change in public investment occurs (Figure 4 and Table 6).

Figure 4. Robustness check: government investment fiscal multiplier by using Ramey and Zubairy definition



Years on x-axis. Dashed lines denote 95% confidence bands

[18] Furthermore, this finding is also consistent with a Keynesian view according to which countries with a higher propensity to import have a lower fiscal multiplier. Considering Italy and Germany as the main countries in the two considered groups, the share of import to GDP is higher in the latter than in the former.

Table 6. Robustness check: government investment fiscal multiplier by using Ramey and Zubairy definition

	(1) Year 0	(2) Year 1	(3) Year 2	(4) Year 3	(5) Year 4	(6) Year 5	(7) Year 6
Model 1	0,8***	1,17***	1,37**	1,27**	1,14*	1,24*	0,26
Model 2	0,93***	1,46***	1,68***	1,68***	1,61**	1,56**	0,83
Model 3	0.82***	1.34**	2.04***	2.09***	2**	2.17**	1.66

*** p-value < 0.01, ** p-value < 0.05, * p-value < 0.1

However, despite these differences, these findings still confirm that changes in government investment have a positive and significant effect on GDP: for each of the considered specifications the fiscal investment multiplier is approximately one on impact and greater than one throughout the considered period, namely up to five years.

6. Conclusion

Motivated by the importance given to government investment by international institutions such as the IMF and the EC, we examined the macroeconomic effects of changes in public investment on GDP by focusing on 11 Eurozone countries for the 1970-2016 period. We implemented the local projections methodology (Jordà 2005). This allows us to determine the magnitude of fiscal multipliers by constructing impulse response functions which quantify the dynamic effect of public investment on GDP. To this aim, we estimated three models which consider different control variables (e.g. total government spending, long-term interest rate and real effective exchange rate) providing a clear and robust picture of the value assumed by investment fiscal multipliers.

Our findings suggest that an increase in the government investment positively affects economic growth, both in the short and in the long run, by generating a permanent and positive effect on the level of economic activity. Our econometric analysis indicates an investment fiscal multiplier close to one on impact, which reaches a value of about two five years after the fiscal policy is implemented. These results are robust since they are consistent when several years are dropped as well as when the comparison between Northern and Southern countries is taken into consideration. In addition, when the years 2008-2016 are dropped, the fiscal multiplier assumes a lower value than the one estimated in the baseline model. We can therefore conclude that the Great Recession has contributed to increasing the magnitude of the fiscal multiplier. Moreover, when countries are divided into two different groups, findings suggest that the fiscal multiplier effect is asymmetric and larger in Southern countries than in Northern ones. This may reflect the fact that the latter – by having a higher output per capita than the former – are characterised by a lower marginal propensity to consume.

In line with Deleidi and Mazzucato (2018), our findings are in sharp contrast with conventional wisdom and the view sustained by supporters (cf. Alesina et al. 2015) of the expansive austerity measures: a cut (increase) in government investment is able to lower (increase) the level of the

GDP, thus engendering a pure ‘Keynesian effect’. Furthermore, our results show that an increase in public investment determines a permanent and persistent positive effect on the level of output. According to our estimations, the recent perspective put forward by the IMF (2014) is strongly confirmed: public investment has a positive and permanent effect on output both in the short and in the long run. Consistently, the policy implication of our findings suggests that demand policies – especially based on the financing of public investment plans – stimulate GDP, allowing European countries to emerge from the current stagnation. On the contrary, fiscal consolidation measures generally exacerbate the stagnation experienced by euro area countries and they appear to be more contractionary in Southern countries where the burden of austerity measures has been heavier than in the Northern ones.

Appendix A

Real GDP	Gross domestic product, volume, market prices (GDPV), local currency Source: OECD ((Economic Outlook No 100 – November 2016) For Germany and Ireland pre-1991 we used GDP (constant LCU) Source: World Bank, World Development Indicators (WDI).
GDP deflator	GDP deflator (2010=100) Source: OECD ((Economic Outlook No 100 – November 2016) For Germany and Ireland pre-1991 we used GDP deflator (2010=100) Source: World Bank, World Development Indicators (WDI)
Public expenditure	Sum of current disbursements general government (YPG), value, local currency and government fixed capital formation (IGAA), value, local currency net of gross government interest payments (GGINTP), value, local currency. (variables in nominal terms converted to volume by applying the GDP deflator) Source: OECD (Economic Outlook No 100 – November 2016). We rewrote some missing data by using Expenditure (2M) net of interest expense (24). Source: International Monetary Fund, Government Financial Statistics (GFS)
Public investment	Government fixed capital formation (IGAA), value, local currency Source: OECD (Economic Outlook No 100 – November 2016) When possible, we retropolated the series using the net investment in non-financial assets Source: International Monetary Fund, Government Financial Statistics (GFS).
Real effective exchange rate	CPI-based real effective exchange rate Source: Bruegel dataset
Long term interest rate	Long term interest rate Source: OECD (Main Economic Indicator)

Note: all the interpolations mentioned in this table were performed by chaining the series using their growth rates, after checking that the yearly growth rates of the series were very closely correlated to each other.

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