

Government public infrastructure investment and economic performance in Spain (1980–2016)

Economic
performance in
Spain

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Abstract

Purpose – The authors estimate the multiplier effect of government public infrastructure investment in Spain. This paper aims to use annual data of the 17 Spanish autonomous communities for the 1980–2016 period.

Design/methodology/approach – The authors use dynamic acyclic graphs and the heterogeneous panel structural vector autoregressive (P-SVAR) method of Pedroni (2013). This method is robust to cross-sectional heterogeneity and dependence, which are present in the data.

Findings – The findings suggest that an increase in the level of government public infrastructure investment generates a positive and persistent effect on the level of output. Five years after the fiscal expansion, the multiplier effects of government public infrastructure investment reach values above one. This confirms that government public infrastructure investment expansions have Keynesian effects. The authors also find that the multiplier effects differ between autonomous communities with above-average and below-average GDP per capita.

Originality/value – To the best of the authors' knowledge, no research uses dynamic acyclic graphs and heterogeneous P-SVAR techniques to estimate fiscal multipliers of government public investment in Spain by using subnational data.

Keywords Spain, Multiplier effects, Government public infrastructure investment, Heterogeneous panel structural VAR, Dynamic acyclic graphs, Multiplier effects

Paper type Research paper

1. Introduction

After the strong economic impact of the COVID-19, in Spain, there is a debate about what type of fiscal policy should be carried out. The proposals to deal with the current economic and social crisis have been considerably different from those of 2010. For instance, the international Monetary Fund (IMF) and the European Commission (EC) are currently advocating for a public investment push to allow economies recovering from stagnation and to overcome the crisis. Even before the pandemic these institutions had started to advocate

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for public investment to overcome economic crisis and to promote growth (see the reports of the [IMF, 2014, 2020](#); the [EC, 2014, 2016](#); and the [OECD, 2016](#)). Thus, these institutions advocate for a new approach to fiscal policy, based on the idea that fiscal discipline can lead to irreversible social, economic and environmental damage.

Recall that in early 2010, several countries of the euro zone, including Spain, were affected by a sovereign debt crisis and, to maintain their financial credibility, had to adopt contractive measures aimed at reducing their fiscal deficits. However, in many of these economies, the public debt/GDP ratio did not fall, but instead increased ([Della Posta *et al.*, 2020](#)). This apparent contradiction rekindled the debate on fiscal multipliers. The contradiction reached such a magnitude that in 2012 the IMF had to recognize that the fiscal multiplier used to make growth predictions during the crisis (with a value of 0,5) was considerably underestimated, suggesting that its true value was 1,7 ([IMF, 2014](#)).

The decision to undertake a fiscal expansion/austerity policy is linked to the value of public spending multipliers. The value of public spending multipliers indicates how much GDP increases (decreases) when public spending increases (decreases). Proponents of fiscal austerity point out that the multiplier effect of public spending (also called fiscal multiplier) is generally less than one, while those who advocate for fiscal expansions claim that its value is greater than unity.

In this paper, we study the multiplier effect of government public investment expenditure in Spain. We have chosen Spain as a study case for the following reasons. First, because, as [Martínez-Carrión and María-Dolores \(2017\)](#) state, the country has a long history of regional inequalities in terms of economic performance and development (see [Appendix 1](#)). Thus, analysing the effectiveness of public investment at a sub-national level helps considering the different effectiveness that public interventions might have on different regions. Second, Spain was one of the EU countries most affected by the post-Great Recession austerity policies ([Febrero, 2021](#)); and is going to implement one of the most ambitious public investment plans after the Covid-19 pandemic ([de la Fuente, 2021](#)). This makes even more compelling the analysis of the dynamic relationship between fiscal policy and economic activity in Spain.

Our data cover the period 1980–2016 and are disaggregated by regions (autonomous communities), so we have 36 temporal observations and 17 cross-sections, i.e. 612 observations. Although all kind of public investment contributes to foster economic activity, not all of its components do it in the same way ([Villaverde and Maza, 2020](#), p. 86). In this paper, we focus on public investment in productive infrastructure (INFINV), which includes public government investment in roads, ports, hydraulics, urban infrastructure and railways. We choose this kind of investment because the [European Commission \(2016\)](#) considers that it might be one of the main levers of economic recovery [1].

We use the heterogeneous panel structural vector autoregressive (SVAR) approach of [Pedroni \(2013\)](#). This method consistently estimates the responses of the endogenous variables to structural shocks regardless of the channel through which the shocks operate on the variables. Thus, to know the net effect that a structurally identified shock in INFINV has on output, it is not necessary to identify and control for an exhaustive list of the determinants of output ([Pedroni, 2013](#)). Despite the literature has widely used the approach of [Pedroni \(2013\)](#) ([Roch, 2019](#); [Torres-Preciado, 2021](#)); to the best of our knowledge, [Demid \(2018\)](#) and [Deleidi *et al.* \(2021\)](#) are the only works that use this method to evaluate the effects of fiscal policy. The first paper examines the interaction between monetary and fiscal policies, while the second one estimates the multiplier effects of fiscal policy in Italy at a subnational level.

The results of our heterogeneous panel SVAR analysis suggest that an increase in the level of government public infrastructure investment generates a positive and persistent

effect on the level of output. Five years after the fiscal expansion, the multiplier effect of INFINV reaches values above one, thereby confirming that fiscal expansions have Keynesian effects. We also find that the values of the multipliers are asymmetric when we consider above-average-GDPpc and below-average-GDPpc regions (where GDPpc refers to GDP per capita).

The paper proceeds as follows. In Section 2, we provide a review of the existing literature on fiscal multipliers. In Section 3, we review the empirical literature on fiscal multipliers in Spain. In Sections 4 and 5, we explain the data, the methodology and the identification strategy used to estimate the public government infrastructure investment multiplier effects in Spain. Section 6 presents our empirical results. Finally, Section 7 concludes and summarizes the policy implications of our results.

2. Literature review

Measuring fiscal multipliers implies identifying exogenous shocks in public expenditure. This is a difficult task because of the existence of bidirectional causality: government spending has an impact on output, but it is also possible that output has an impact on public spending. To deal with this issue, two main approaches are used: the narrative approach and the SVAR approach.

The narrative approach, also called the “natural experiment” approach (Ramey and Shapiro, 1998), identifies exogenous variations in public spending by looking at fiscal events that are not correlated with the business cycle. Generally, this approach uses military spending to identify really exogenous variations in public spending (Ramey, 2011; Nakamura and Steinsson, 2014; Girardi and Pariboni, 2020).

On the other hand, the structural SVAR approach, developed by Blanchard and Perotti (2002), isolates purely exogenous shocks in government spending by imposing an identification strategy, usually based on short-run restrictions (Auerbach and Gorodnichenko, 2012a, 2012b; and Afonso and Leal, 2019, among others).

The most common identification strategy within the SVAR approach applies the standard Cholesky decomposition, thereby imposing causality running from the variable ordered first in the VAR to the rest of the variables. Government spending is generally ordered first in the VAR. It implies that government spending shocks impact the economy immediately, while shocks in economic activity only affect government spending with a delay (Ramey, 2011; and Bachmann and Sims, 2012). Additionally, Blanchard and Perotti (2002) and Ramey (2016), among others, consider the coefficient of the contemporaneous relationship between taxes and output by making use of institutional information (Deleidi *et al.*, 2020a, 2020b, p. 356). On the other hand, the so-called sign restriction approach identifies exogenous fiscal shocks by imposing restrictions on the sign of the response functions (Pappa, 2009; Mountford and Uhlig, 2009).

The literature finds a wide range of values of government spending multipliers. For example, Perotti (2004) and Ilzetzki *et al.* (2013) find negative values; Blanchard and Perotti (2002), Ramey (2011), Auerbach and Gorodnichenko (2012b, 2017), and Afonso and Leal (2019) find values between 0 and 1; while Ilzetzki *et al.* (2013), Hory (2016) Deleidi and Mazzucato (2019, 2020), and Deleidi *et al.* (2020a, b) obtain values above 1. Such a disparity of results might be due to the state of the business cycle (Auerbach and Gorodnichenko 2012a) and to country specificities (Ramey, 2019), like the accumulated public debt, the degree of development, the exchange rate regime and the openness to trade (Deleidi *et al.*, 2021, p. 5).

It is also worth mentioning the state-dependent fiscal multiplier's literature (Auerbach and Gorodnichenko, 2012b; Fazzari *et al.*, 2015; Afonso and Leal, 2019), whose aim is to

determine whether the multiplier effect of public spending is higher or lower in epochs of expansion and recession. Generally, this literature finds higher values of government expenditure multipliers in epochs of recessions than in expansionary epochs. This is because the crowding-out effects on private expenditure are weaker during economic downturns due to a slower responsiveness of prices and interest rates.

Finally, we highlight the literature that focuses on public investment expenditure multipliers effects. [Burriel *et al.* \(2010\)](#) suggest that government investment has a multiplier effect of 2 and 1,56 for the USA and for the euro area countries, respectively. [Bénétrix and Lane \(2010\)](#) find a peak multiplier effect of public investment of 3,5 for European countries, while [Auerbach and Gorodnichenko \(2012b\)](#) obtain a peak multiplier effect of public investment of 2,12 for the USA. [Boitani and Perdichizzi \(2018\)](#) find that the value of the fiscal multiplier of public investment is 4 for the Eurozone countries. Finally, [Deleidi *et al.* \(2020a, 2021\)](#) sustain that public investment has a peak multiplier effect of 3,5 and 3,28 for the cases of Eurozone countries and Italian regions, respectively. Thus, the literature sustains that public investment generally has a multiplier effect higher than 1, thereby producing Keynesian effects.

3. Public expenditure multiplier effects in Spain

The first study aimed at estimating public spending multiplier effects in Spain is [De Castro \(2006\)](#). For a sample that covers the period 1980:1–2001:2, De Castro uses various specifications that place the spending multiplier between 1,1 and 1,5 in the first years, but then it gradually disappears or even turns negative. However, De Castro shows that public investment seems to be more efficient than public consumption in stimulating economic activity. In fact, the multiplier effect of public investment expenditure is 1,35 after 20 quarters (5 years). This result is in accordance with the results of [Marcellino \(2006\)](#). However, [De Castro and Hernández de Cos \(2008\)](#) sustain that, for the period 1980:1–2004:4, the multiplier effect of public investment in the fifth year after the shock (20th quarter) is less than one (0,69).

On the other hand, [Hernández de Cos and Moral-Benito \(2013\)](#) and [Martínez and Zubiri \(2014\)](#) estimate the multiplier effect of public spending in Spain in times of recession and expansion. [Hernández de Cos and Moral-Benito \(2013\)](#) find that the government spending multiplier effect is larger during recessions and periods of banking stress (about 1,4), but much smaller (or even negative) during tranquil times (about 0,6). [Martínez and Zubiri \(2014\)](#) find that the multiplier effect of public spending is almost 1 in times of growth and almost 1,7 in recessions. [Martínez and Zubiri \(2014\)](#) also show that the (negative) multipliers of spending cuts are higher than those of increases: The reduction in GDP as a result of a reduction in public spending is 2,1 in times of crisis and 1,1 in times of growth.

Although there is a wide literature on the effects of fiscal policy in Spain; to the best of our knowledge no research exploits data at the regional (autonomous community) level. To fill this gap, we use a heterogeneous panel SVAR method to subnational data to assess the multiplier effect of exogenous shocks in government public infrastructure investment in Spain.

4. Data and models

We use an unbalanced panel data. Due to the availability of data, we use annual real data covering the period 1980–2016 for the 17 regions of Spain. The variables included in our analysis are GDP in logs (GDP_{it}) and government public productive infrastructure investment (roads, ports, hydraulics, urban infrastructure and railways) in logs ($INFINV_{it}$) of region i in period t . $INFINV_{it}$ refers to total government public productive infrastructure

investment implemented in region i [2]. The variables are measured in real terms (constant prices of 2010). The data come from the BDmores regional database, which belongs to the Spanish Ministry of Finance (Dabán *et al.*, 2002).

Following the state-dependent multiplier's literature; when we split our data set into recessionary and expansionary periods, we find considerable higher government public infrastructure investment multiplier effects in recessions than in expansions. However, as a result of this split, the effective number of observations is smaller, particularly for recessions, resulting in wider confidence bands for the impulse response functions. On the other hand, the idea of state-dependent fiscal multipliers has been questioned by Owyang *et al.* (2013) and Ramey and Zubairy (2018), who find evidence of an acyclical spending multiplier. Thus, we decided to follow the existing literature on public investment fiscal multipliers for Spain (De Castro, 2006; Marcellino, 2006; De Castro and Hernández de Cos, 2008) and consider the whole period.

We consider two different SVAR specifications. In Model 1, we include real taxes in logs (T_{it}) as control variable. T_{it} is also measured in real terms (constant prices of 2010). Thus, we evaluate a three-variable model (GDP_{it} , $INFINV_{it}$, T_{it}). This procedure is also followed by Blanchard and Perotti (2002), Martínez and Zubiri (2014), Fazzari *et al.* (2015) and Monokroussos and Thomakos (2015), among others.

In Model 2, and with insights from Lago-Peñas *et al.* (2019), we augment Model 1 with a region-specific indicator of competitiveness, such as the foreign balance as percentage of GDP, XN_{it}/GDP_{it} , where XN_{it} indicates net exports. We consider that it allows to control for the differences in the degree of economic development within regions. Additionally, it helps controlling for the "leakages" that might differently weaken the dynamic relationship between $INFINV$ and economic activity. Finally, the EC (2016) attributes an important role to competitiveness in growth and job creation (Sánchez de la Vega *et al.*, 2019, p. 109); so it is important to control for it when evaluating the effects of fiscal policy. All models include a dummy variable for the global financial crisis, which particularly affected the Spanish economy. As stated, the data for GDP_{it} , $INFINV_{it}$, and T_{it} are collected from the database BDmores, while the data for XN_{it} are from Fundación de Economía Aplicada (FEDEA) (see Table A2, in the Appendix 2).

5. Methodology

5.1 Tests for cross-sectional dependence and homogeneity

We first check whether there is cross-sectional dependence in the relationship between our variables of interest. The Spanish regions are expected to be highly integrated through political, financial, commercial, fiscal and cultural ties, among others. This implies that a region may be affected by shocks or cyclical movements that take place in another region. If we do not take this into account, our results might be biased. Therefore, we apply the cross-sectional dependence (CD) test of Breusch and Pagan (1980), which is widely used in the applied economics literature. This method is suitable for our case study, in which N is considerably lower than T .

On the other hand, Pesaran and Smith (1995) showed that if there is cross-sectional heterogeneity in the panel (individual dynamics are heterogenous), aggregating or pooling slopes can lead to biased estimates. Because of that, we proceed to analyse the presence of homogeneity across the regions of the panel. To do this, we use the Pesaran and Yamagata (2008) heterogeneity test, which is an extended version of the Swamy (1970) test. The method is also described in the Appendix 3.

5.2 Heterogeneous panel structural vector autoregressive of [Pedroni \(2013\)](#)

The relationship between INFINV and economic activity is difficult to analyse for several reasons. First, the two variables may be intertwined, such that INFINV has an impact on economic activity and, at the same time, economic activity has an impact on INFINV. The failure to account for this source of endogeneity may bias the results. Endogeneity may also arise because of omitted variables that are correlated either with INFINV or with economic activity. Second, dynamics are likely to be present, in the sense that the feedback between INFINV and economic activity occurs gradually over time and with different intensities over different time horizons. Third, there is no reason for which these dynamic relationships would be the same across regions or income levels; in fact, they may differ because of the economic structure, institutions and policies' inclusiveness, among others. Fourth, shocks that are common to all regions, might induce cross-sectional dependence and omitted variable bias.

To consistently deal with these complexities, we follow the methodology of [Pedroni \(2013\)](#). The original panel VAR (P-VAR) approach uses a Choleski decomposition to obtain impulse responses; however, a Choleski decomposition implies a causal ordering that may itself not be credible. Panel structural VAR (P-SVAR) models explicitly provide an economic or informational rationale behind the restrictions necessary to identify shocks in the variables. Another inherent weakness of a reduced form P-VAR model is its inability to consider the contemporaneous relationship between the variables. This generally causes cross-correlation among the residuals' series. Although this may not undermine the properties of unbiasedness and efficiency of the estimation, it is likely to considerably affect the impulse responses. To deal with it, it is common to introduce a contemporaneous coefficient matrix B_i into the P-VAR model to serve as structural restrictions, thereby constructing a P-SVAR model.

A P-SVAR(p) can be represented as follows:

$$B_i Y_{it} = A_i(L) Y_{it-1} + u_{it}, \quad (1)$$

being Y_{it} the $k \times 1$ vector of endogenous variables in log levels, B_i the matrix of contemporaneous relationships between the k variables in Y_{it} , $A_i(L)$ the $k \times k$ matrix of autoregressive slope coefficients, and u_{it} the vector of serially uncorrelated structural shocks ([Kilian and Lütkepohl, 2017](#)). The B_i matrix is estimated by the Maximum Likelihood method, which requires imposing and identifying restrictions on the contemporaneous relationships between the variables under analysis. Premultiplying by B_i^{-1} gives the reduced-form model:

$$Y_{it} = \pi_i(L) Y_{it-1} + \varepsilon_{it}, \quad (2)$$

where $\pi_i(L) = B_i^{-1} A_i(L)$, $D_{it} = B_i^{-1} X_{it}$, $\varepsilon_{it} = B_i^{-1} u_{it}$ and $\varepsilon_{it} \sim (0, \Omega_i)$. Ω_i is the variance-covariance matrix of the reduced form error, ε_{it} , which is full rank and nondiagonal. It is because the errors are correlated between equations, which implies that the innovations are not orthogonal. We can orthogonalize matrix Ω_i by imposing restrictions on the relationships among the k elements of ε_{it} . Once we orthogonalize matrix Ω_i , innovations are no longer correlated and, thus, we can calculate impulse response functions (IRFs).

The heterogeneous panel SVAR method of [Pedroni \(2013\)](#) accounts for cross-sectional dependence, which emerges because the individual members of the panel react not only to their own member-specific idiosyncratic shocks but also to shocks that are common across the members of the panel. In this way, it enables the member-specific inference for any

individual member of the panel for which the time series data is insufficient for reliable time series analysis (Aslan *et al.*, 2020, p. 4).

Additionally, the method accounts for cross-sectional dynamic heterogeneities, which allows to control for unobserved individual heterogeneity. Moreover, it avoids the potential bias caused by the small number of degrees of freedom, as it uncovers the median relationships between variables despite the shortness of the time series (Pedroni, 2013). The method of Pedroni (2013) has extensively been applied and discussed in the literature (Roch, 2019; Ha *et al.*, 2019; Wu and Xu, 2021, among others), thus, we only display its basic methodology.

In this paper, we use annual data because we do not dispose of quarterly data. For each model (Models 1 and 2), we identify the causal flows between the endogenous variables through the Directed Acyclic Graphs (DAG) method, introduced in the literature by Pearl (1995), Bessler and Akleman (1998) and Spirtes *et al.* (2000) [3]. Thus, we impose short-run restrictions on the relationships among the k elements of ε_{it} based on the DAG method. The results of the DAG analysis suggest contemporaneous causality running from INFINV_{it} to GDP_{it} . This generally coincides with the literature on fiscal multipliers that uses annual data, which considers that a shock on public expenditure has a contemporaneous effect on output, while a shock on output only affects public expenditure in the following year (Auerbach and Gorodnichenko, 2017; and Deleidi *et al.*, 2021, among others) [4].

To allow for heterogeneous dynamics, Pedroni (2013) first estimates and identifies a reduced-form VAR for each cross section i . Since, in our research, $N = 17$:

$$\begin{aligned} Y_{1t} &= \pi_1(L)Y_{1,t-1} + \varepsilon_{1,t} \\ Y_{2t} &= \pi_1(L)Y_{2,t-1} + \varepsilon_{2,t} \\ &\vdots \\ Y_{17t} &= \pi_{17}(L)Y_{17,t-1} + \varepsilon_{17,t}. \end{aligned} \quad (3)$$

Next, another VAR is estimated to recover the common dynamics, which are captured by averages across the members of the panel for each period ($\bar{Y}_t \equiv 17^{-1} \sum_{i=1}^{17} Y_{it}$):

$$\bar{Y}_t = \bar{\pi}_{17}(L)\bar{Y}_{t-1} + \bar{\varepsilon}_t. \quad (4)$$

Then, the structural shocks are recovered by imposing the identifying conditions on the contemporary matrix B_i , obtained through DAG analysis. OLS regressions are run to decompose the shocks into:

$$\begin{aligned} u_{1t} &= \gamma_1 \bar{u}_t + \tilde{u}_{1t} \\ u_{2t} &= \gamma_2 \bar{u}_t + \tilde{u}_{2t} \\ &\vdots \\ u_{17t} &= \gamma_{17} \bar{u}_t + \tilde{u}_{17t}, \end{aligned} \quad (5)$$

where, in our case, u_{it} are composite shocks, $\bar{u}_t$ reflects common structural shocks, and $\tilde{u}_{it}$ represents idiosyncratic region-specific structural shocks. Given orthogonality of idiosyncratic and common shocks and normalizing variances of both u_t and $\bar{u}_{it}$ to unity, the diagonal elements of γ_i are simply the diagonal elements of the correlation matrix between $\bar{u}_t$ and $\bar{u}_{it}$.

Finally, the composite responses can be decomposed into region-specific responses to common shocks and region-specific responses to idiosyncratic shocks:

$$\begin{aligned} R_1(L) &= R_1(L) \gamma_1 + R_1(L) \left(I - \gamma_1 \gamma_1' \right)^{1/2} \\ R_2(L) &= R_2(L) \gamma_2 + R_2(L) \left(I - \gamma_2 \gamma_2' \right)^{1/2} \\ &\vdots \\ R_{17}(L) &= R_{17}(L) \gamma_{17} + R_{17}(L) \left(I - \gamma_{17} \gamma_{17}' \right)^{1/2}. \end{aligned} \tag{6}$$

Thus, $\bar{R}_i(L) \equiv R_i(L) \gamma_i$ is a region-specific response to a common structural shock, while $\tilde{R}_i(L) \equiv R_i(L) \left(I - \gamma_i \gamma_i' \right)^{1/2}$ represents a region-specific response to an idiosyncratic shock. As stated, the [Pedroni's \(2013\)](#) method allows for fully heterogeneous dynamics. Thus, the results obtained are more than *average* parameters and *average* impulse response functions – as they are in traditional panels –, which impose homogeneous parameters ([Góes, 2016](#), p. 9). It is a more informative way of interpreting results than in traditional dynamic panel data analysis.

Following [Pedroni \(2013\)](#), we use the General to Specific (GTOS) information criteria to fit an appropriate member-specific lag truncation in the panel SVAR specification. The variables are used in log levels in the panel SVAR because it allows preserving any cointegrating relationship among the variables under study ([Auerbach and Gorodnichenko, 2012b, 2017](#); [Kilian and Lütkepohl, 2017](#); [Deleidi et al., 2021](#)) [5].

6. Results

We have already mentioned the possibility of cross-sectional dependence (CD) and slope heterogeneity among the regions of our study. [Table 1](#) shows the results of the CD tests and the [Pesaran and Yamagata \(2008\)](#) test. The results of the CD tests confirm the existence of cross-sectional dependence. The results of the [Pesaran and Yamagata \(2008\)](#) test suggest rejecting the null hypothesis of slope homogeneity; therefore, corroborating the presence of region-specific heterogeneity at the 1% significance level. This justifies the use of the heterogeneous panel SVAR of [Pedroni \(2013\)](#), which is robust to cross-sectional heterogeneity and dependence.

Next, in [Figure 1](#), we show the median composite impulse responses along with the 95% confidence bands to a positive composite shock in INFINV, obtained through the heterogeneous panel SVAR of [Pedroni \(2013\)](#). Median composite impulse responses are composed of region-specific responses to common shocks and region-specific responses to

Test	Statistic	Prob.
<i>Cross-sectional dependence tests</i>		
Breusch-Pagan LM	4831,67	0,00***
Pesaran scaled LM	284,72	0,00***
Pesaran CD	69,49	0,00***
<i>Homogeneity tests</i>		
$\hat{\Delta}$	4273,10	0,00***
$\hat{\Delta}_{adj}$	10,32	0,00***

Note: The asterisks *** denote rejection of the null hypothesis of no CD, as well as the rejection of the null hypothesis of slope homogeneity at the 1% significance level

Table 1.
Tests for cross-sectional dependence and homogeneity tests

idiosyncratic shocks through loading factors denoting the relative importance of common shocks for each region. We show median response estimates to composite shocks. Time horizon in x -axis. Dashed lines are 95% confidence intervals based on 1,000 sample bootstraps.

The composite impulse response represents the median response of GDP to unanticipated shocks in INFINV. Despite the effects of INFINV on output are likely to last in the very long run; we follow [De Castro \(2006\)](#), [Marcellino \(2006\)](#) and [De Castro and Hernández de Cos \(2008\)](#) and estimate composite median impulse responses for five years ahead. In [Figure 2](#), we can see that INFINV has an expansionary and persistent effect on output. For example, in Model 1, an increase in INFINV by 1% leads to an increase of 1,87% after 5 years. As the variables are used in logs, the estimated coefficients of [Figure 1](#) (y -axis) are expressed in terms of elasticities ([Deleidi, et al., 2021](#)). To estimate the fiscal multipliers associated with a change in INFINV, we need to multiply these coefficients by the average GDP/INFINV ratio ([Mountford and Uhlig, 2009](#), p. 980; [Mertens and Ravn, 2014](#), pp. S3-S4). By applying this method, partial derivatives represent the euro-change in GDP of a one-euro increase in INFINV ([Deleidi, et al., 2021](#)). As the average share of INFINV in GDP is equal to 1.6%, we calculate the multiplier effects of INFINV on output, which are shown in [Table 2](#). For Model 1, the fiscal multiplier after five years is 1,17; while for Model 2 it is 1,88.

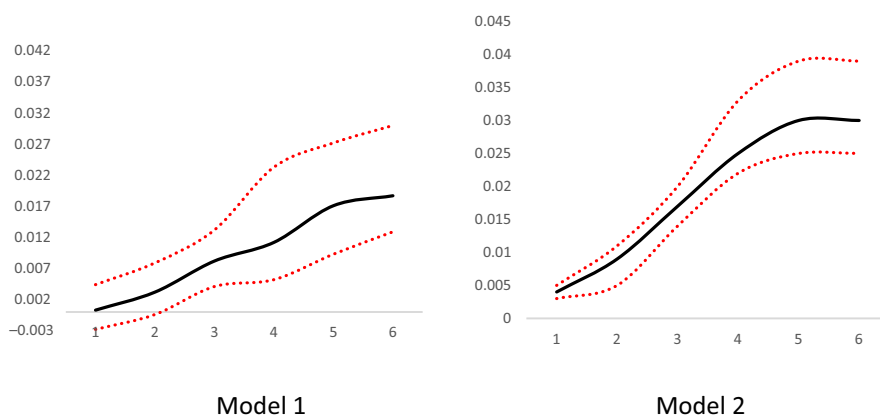


Figure 1.
Elasticities of output
to unanticipated
shock in INFINVit

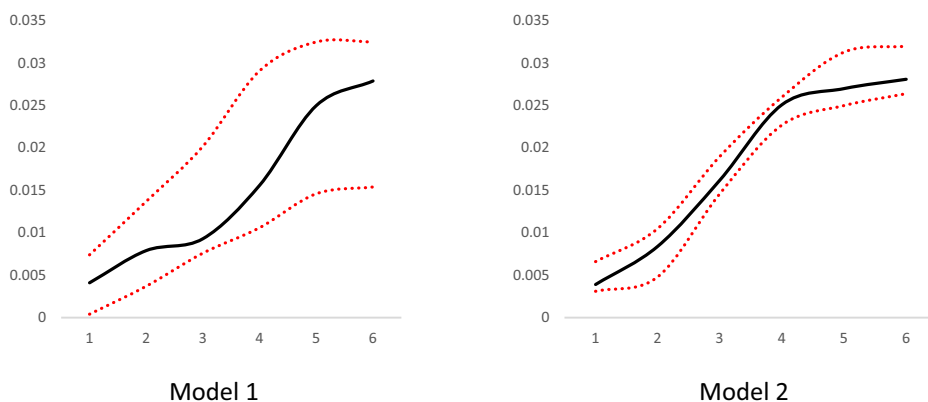


Figure 2.
Elasticities of output
to unanticipated
shock in INFINVit for
regions with a GDP
per capita above the
average one

In general terms, the results of [Table 2](#) suggest that an increase in the level of INFINV generates positive and persistent effects on the level of output. The values of the fiscal multipliers are larger than one, thereby confirming that INFINV expansions have Keynesian effects. The results suggest that public investment in productive infrastructure does not only directly increment the productive capacity of the economy, but through different backward and forward linkages it is capable to carry out notable multiplier effects on output even in the relatively short span of time (5 years) here considered. The fiscal multiplier for Model 2 (1,88) is higher than for Model 1 (1,17). It suggests that controlling for the current account increases the magnitude of the multiplier effect of INFINV. As the effect of XN on GDP is statistically significant, 1,88 is a closer value to the *real* fiscal multiplier effect of INFINV on GDP.

Next, we analyse possible differences in the value of government investment multiplier effects between regions. To this aim, we estimate the abovementioned two model specifications for two different groups of regions. The first group includes the regions whose real GDP per capita has remained above the average (i.e. Spanish) real GDP per capita, namely Aragon, the Balearic Islands, Catalonia, Madrid, Navarra, the Basque Country and La Rioja. The second group includes the remaining 10 regions, those whose real GDP per capita has remained below the average GDP per capita during the period under analysis: Andalusia, Asturias, the Canary Islands, Cantabria, Castilla y León, Castilla-La Mancha, Valencia, Extremadura, Galicia and Murcia. The aim of this exercise is to assess whether INFINV has different multiplier effects within regions with different degrees of economic development.

First, we estimate the median impulse responses to a composite positive shock in INFINV for the panel of regions with a real GDP per capita above the average one ([Figure 2](#)).

Once we obtain the median impulse responses, we calculate the multiplier effects of INFINV on output. [Table 3](#) shows that for Model 1 the multiplier effect is, after five years, 2,79, while for Model 2, it is 2,81.

Next, we estimate the median composite impulse responses to a composite positive shock in INFINV for the panel of regions with a real GDP per capita below the average one ([Figure 3](#)).

Next, we calculate the multiplier effect of INFINV for this group of regions. [Table 4](#) shows that the multiplier effect of INFINV on output for model 1, after five years, is 1,19, while for model 2 it is 1,89.

Interestingly, the present analysis suggests that the multiplier effect of INFINV in above-average-GDPpc regions is higher than that for the below-average-GDPpc regions. The

Table 2.

Multiplier effect of
INFINV

	1 Year 0	2 Year 1	3 Year 2	4 Year 3	5 Year 4	6 Year 5
Model 1	0,02	0,20	0,51	0,70	1,07	1,17
Model 2	0,25	0,56	1,06	1,56	1,88	1,88

Table 3.

Multiplier effect of
INFINV for the
regions with a real
GDP per capita above
the average one

	1 Year 0	2 Year 1	3 Year 2	4 Year 3	5 Year 4	6 Year 5
Model 1	0,41	0,79	0,93	1,56	2,50	2,79
Model 2	0,39	0,85	1,62	2,51	2,51	2,81

multiplier effect of INFINV in above-average-GDPpc regions might be higher because in the below-average-GDPpc regions the leakages are stronger. Leakages can weaken the dynamic relationship between INFINV and GDP. For example, the higher the proportion of INFINV meet with imports, the weaker the Leontief and Keynesian multipliers and the accelerator effects (i.e. the extent to which higher economic growth induces additional private investment demand) of INFINV. On the other hand, since above-average-GDPpc regions have a more solid and autonomous productive capacity, it is likely that the multiplier effect of INFINV is higher. As these regions also have a more consolidated industrial sector (Cuadrado-Roura and Maroto, 2016), it is likely that they operate under stronger backward and forward linkages, higher dynamic economies of scale, more inclination to develop technological innovations and diffuse them, etc. (Neto and Porcile, 2017). The causes of the differences within regions that we propose here are, however, entirely speculative. Thus, further research on this is needed.

7. Conclusions

We have studied the macroeconomic effects that changes in government public infrastructure investment (INFINV) have on economic activity in Spain for the 1980–2016 period. To this aim, we have applied the heterogeneous panel SVAR method of Pedroni (2013). Different models with different control variables (taxes and the weight of external balance of trade on GDP) were estimated.

Our results show that increases in INFINV have both persistent and positive effects on GDP. The multiplier effects on output five years after the fiscal shock are generally above one. Thus, our results confirm that INFINV expansions have Keynesian effects on output. Our results also suggest that the multiplier effects of INFINV in above-average-GDPpc regions are higher than those for the below-average-GDPpc regions. We have offered plausible explanations for these results; however, further research is needed in this field. It is

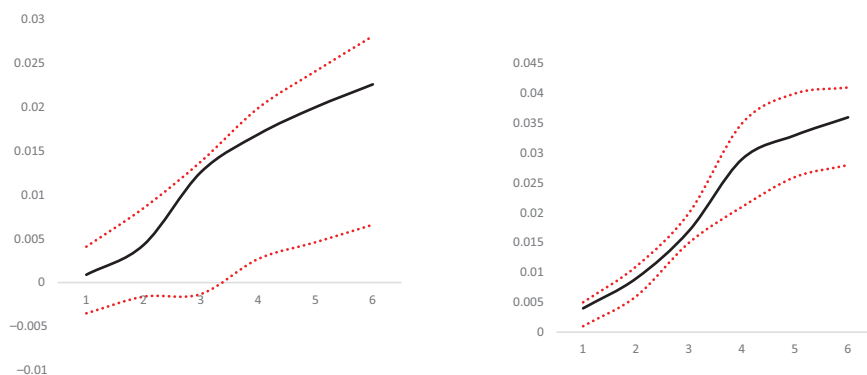


Figure 3.
Elasticities of output
to unanticipated
shock in INFINV for
the regions with a
GDP per capita below
the average one

	1 Year 0	2 Year 1	3 Year 2	4 Year 3	5 Year 4	6 Year 5
Model 1	0,05	0,23	0,66	0,89	1,05	1,19
Model 2	0,21	0,47	0,89	1,53	1,74	1,89

Table 4.
Multiplier effect of
INFINV for the
regions with a real
GDP per capita below
the average one

also worth noting that the size of the multipliers is minor than the obtained in the studies cited in Section 2. This might be mainly explained by differences in development and economic structure, having Spain a considerably higher specialization in services than the countries of the mentioned studies (European countries and the USA).

Our results are in line with the results obtained by some studies on the fiscal multiplier for the case of Spain (De Castro, 2006; Marcellino, 2006; Martínez and Zubiri, 2014). Our results are also in line with Postkeynesian theoretical approaches that focus on the role played by the autonomous components of demand in driving output (Serrano, 1995; Dejuan, 2005; Girardi and Pariboni, 2016, 2020; Lavoie, 2016; Allain, 2021; Pérez-Montiel and Erbina, 2020, 2021; Pérez-Montiel and Pariboni, 2021) [6].

Finally, our results are also in accordance with the reports and recommendations of the International Monetary Fund (2014, 2020), the European Commission (2014, 2016), and the OECD (2016): Government public infrastructure investment has a positive and persistent effect on output. In terms of economic policy, our research suggests that public infrastructure investment plans are recommended for Spain. However, these investment plans can lead to an increase in the economic development gap between the Spanish regions, as the multiplier effect of INFINV is considerably higher in above-average-GDPpc regions.

Our results suggest that, to promote regional convergence, the poorest regions must receive more public infrastructure investment than the richest ones. Additionally, investment plans should be accompanied by proper measures of industrialization, diversification and economic development for the below-average-GDPpc regions. Thus, these regional differences should be considered by the *Recovery Transformation, and Resilience Plan* of Spain to reach the digital transformation, the energy transition and the economic across-regions convergence of the country.

Notes

1. The reports of the IMF in 2014 and 2020 also suggest that government investment fosters economic activity. Finally, a report of the OECD in 2016 sustains that “investment spending has a high multiplier, while quality infrastructure projects would help to support future growth” (OECD, 2016, p. 6).
2. We consider the public infrastructure investment carried out by both the Autonomous Community Administration (Gobierno Autonómico) and the General Government (Gobierno Central).
3. The DAG method allows us to identify the contemporaneous causal structure between multiple time series, thereby providing a data-driven solution to the “identification” issue in a vector autoregression (VAR) model.
4. We have stated that, inspired by Blanchard and Perotti (2002), most of the econometric studies on fiscal multipliers identify government expenditure shocks in quarterly time-series data by ruling out a contemporaneous response of government spending to other macroeconomic aggregates. However, Born and Müller (2012) provide evidence that this assumption may not be too restrictive for annual time-series data. Other scholarly contributions on fiscal policy that estimate multipliers using annual data through this estimation strategy are Beetsma *et al.* (2008), Auerbach and Gorodnichenko (2017) and Deleidi *et al.* (2021).
5. As Phillips (1998) showed that impulse responses from VARs in levels are inconsistent at long horizons, and Faust and Leeper (1997) demonstrated that small mistakes in specifying the cointegrating relations affect the short-run parameters, the safest approach appears to be estimating the model in levels and only focusing on the short-horizon responses (Elbourne, 2008).

6. This approach is nowadays considered a promising benchmark for studying the relationship between public investment, economic activity and growth (Haluska *et al.*, 2020). The current relevance of this approach is such that three journals have recently dedicated symposiums to it. The first one was the *Review of Political Economy* in 2015 (Cesaratto and Mongiovi, 2015). The second one was *Metroeconomica* (Kurz and Salvadori, 2019). Finally, the *Review of Keynesian Economics* has also held a symposium on it (Summa and Freitas, 2020).

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Further reading

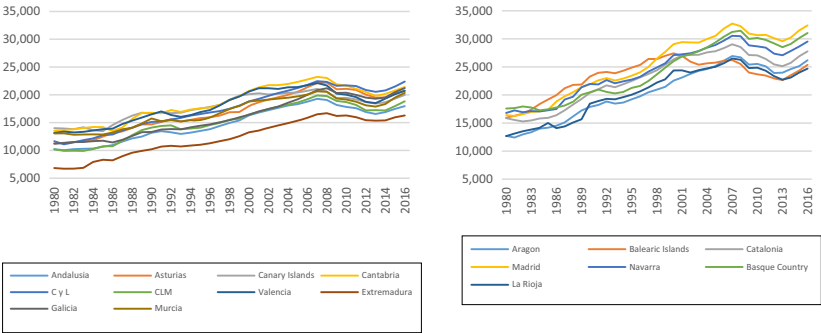
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Appendix 1

Table A1.
Differences in GDPpc
and growth

	1980	2016	Average annual cumulative rate of growth 1980–2016
Average GDPpc of the richer regions	11513,88	15427,95	1,54%
Average GDPpc of the poorer regions	19992,44	28140,69	1,68%

Figure A1.
Elasticities of output
to unanticipated
shock in INFINvit for
the regions with a
GDP per capita below
the average one



Source: Own elaboration with BDmores database

Data	Description	Source	
GDP	Gross domestic product. Thousands EUR, constant prices of 2010, annual data	BDmores regional database	247
INFINV	Government public productive infrastructure investment (roads, ports, hydraulics, urban infrastructure and railways). Thousands EUR, constant prices of 2010, annual data	BDmores regional database	
T	Net taxes on products. Thousands EUR, constant prices of 2010, annual data	BDmores regional database	Table A2. Data description
XN/GDP	External balance of trade over GDP. Percentage	FEDEA	

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