Zárate Marco, Anabel; Vallés Giménez, Jaime

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The interdependence of investment by different levels of government in a federal context

Anabel Zárate-Marco [a] and Jaime Vallés-Giménez [b]

[a]Department of Public Economics, Faculty of Economics and Business (Edificio Lorenzo Normante), University of Zaragoza-Spain, Zaragoza, Spain; [b]Department of Public Economics, Faculty of Economics and Business Gran Vía, 2, University of Zaragoza-Spain, Zaragoza, Spain

ABSTRACT

We use the Stochastic Frontier Approach to analyse for the first time the regions' investment response to the central and local governments' capital expenditure. The Spanish context is very interesting for this analysis because responsibilities are distributed between the three levels of government in a very interesting dual way: the distribution of spending responsibilities between central and regional governments corresponds to an exclusionary attribution of functions, while between regional and local levels, governments opt for cooperation. Results show that capital expenditure undertaken by the central government in the regions acts as substitute for regional investment, while capital expenditure by local governments appears to complement it. These results should be taken into account by public administrations when designing the distribution of responsibilities between different levels of government and their economic policy aims.

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KEYWORDS
Decentralisation; capital expenditure; complementarity and substitution effects; frontier techniques

1. Introduction

During the recent years of economic recession, several countries have started stimulus spending packages, in which sub-central governments have played a very important role in implementing investment recovery strategies (Del Bo & Sirtori, 2016). However, access to traditional sources of investment financing for governments is usually restricted in periods of recession, when public investment may be forced to play its traditional role of financial adjustment (Allain-Dupre, Hulbert, & Vammalle, 2012). In this context of budgetary austerity, each jurisdiction can react differently: raising tax pressure, increasing public indebtedness, or reducing public investment and other expenses, although they may also try to manage public capital expenditure more efficiently.

Alongside these strategies, we have recently observed how several of Spain's regional governments have revised their Statutes of Autonomy, which provide the legislative framework for the sub-central political institutions, adding clauses which guarantee a minimum of direct investment in their region by the central government. The political justification for that rests on a hypothetical historical tort by the central government in

CONTACT Anabel Zárate-Marco azarate@unizar.es Department of Public Economics, Faculty of Economic and Bussiness (edificio Lorenzo Normante), C/ María de Luna s/n, Campus Río Ebro, 50018 Zaragoza, Spain

terms of lower central investment in infrastructure in those territories, or lower per capita funds allocated to those jurisdictions by the national system for regional financing.

Investment by the central or local governments in a region may stimulate or reduce investment by the region itself in its territory, in the same way as public and private investment (crowding in/out effect), although as far as we know, there is no empirical evidence on the relationship between capital expenditure by the different levels of government in a federal context. Exploring this relationship should help us understand what is really behind the interest of the Spanish regions in guaranteeing a minimum investment by the central government ending the political debate around this issue. For this reason, and taking into account that in Spain the regions are the main agents of public investment (making 45% of total public investments), the aim of this paper is to evaluate whether direct investment in the regions, by the central government on one hand and by local governments on the other, have a stimulus or a contracting effect on regional investment, with the ultimate purpose of seeing whether the relationships between these investments are complementary or substitutional.

The Spanish case is very interesting for these analyses, because responsibilities are distributed among its three levels of government in two different ways, which may lead to investments by both levels of government (central and local) having different effects on regional capital expenditure. While the distribution of spending responsibilities between central and regional governments responds to an exclusionary attribution of functions, in distributions between the regional and local levels, these bodies opt for a framework of intensive cooperation in rural development policies and social welfare functions.

To conduct this study, we used a simple but interesting technique, based on frontier investment estimations, which we applied to the sample consisting of the 17 Spanish regions and the period 2000–2012. The results obtained show that investment by local and regional governments is complementary, and that investment by central and regional governments appears to be substitutional. This result is consistent with the distribution of responsibilities mentioned above, and could explain the interest of the regions in guaranteeing a minimum level of investment by the central government, insofar as this allows them to release funds for other purposes.

The work is structured as follows. The second section describes the state of the subject. The third section describes the frontier methodology, the model and the variables we use in our empirical approach. In the fourth section, we present our results. We end the work with our conclusions.

2. Problem statement

Spain is not strictly speaking federal, although it is as heavily politically and economically decentralised as any federal country (İrepoğlu , 2016). The 1978 Constitution (Constitución Española, CE) establishes three levels of government: central, regional, and local; Part VIII of the Constitution sets out the core areas of the decentralisation process, assigning the State exclusive powers (Article 149) to ensure the unity and identity of the Spanish economic system and national economic policy and regulate the sectors with significant externalities. All other matters correspond to the Autonomous Regions (art. 149.3) if they are included in

their Statutes of Autonomy or in Article 148 of the CE (Lopez-Laborda, Martinez-Vazquez, & Monasterio, 2007). Responsibilities at the local level, which consists of municipalities and provinces, are intended to meet the needs of local people and to complement those of other administrations (according to the law establishing the basis of local governance: Ley de Bases del Régimen Local, LBRL). This distribution of responsibilities means that Spain's regional governments are now the ones making the most public spending and investments (Catalina, 2009).

There are two regional funding regimes: the "'Foral'" system in the Basque Country and Navarre, and the "'common'" system applicable in the other fifteen regions. With the Foral system, the Basque Country and Navarre have greater tax autonomy, with practically all tax revenue at their disposal to fund their regional public services, and have to make a contribution to the central government to fund central spending in their territory. In contrast, the 15 regions in the common funding system have the revenue from the taxes established as their own and the state taxes assigned to them, and the transfers from the central government (Autonomous Regions Funding Act, LOFCA). This financing system relegates the funding of regional capital expenditure (Blöchliger & King, 2006; Lago, 2006) to current savings, to borrowing and to income from capital transfers, these last from three sources: European Union funds (EUF), which require co-financing of 15%-85% of the investment; the national Inter-territorial Compensation Fund (ICF),[1] which does not require co-financing; and other transfers which finance part of the investment projects agreed bilaterally (centre-region), without co-financing. However, as the distribution of capital transfers tends to exclude the most developed territories,[2] this obliges the wealthier regions to make more intensive use of savings or borrowing to finance their investment; although given the increasing restrictions on regional debt (budget stability requirements) and the limited tax capacity of regional governments, transfers are increasingly important (Bahl & Bird, 2013).

Different indicators (population, regional income, or size of area) can be used to compare the relative supply of public capital in each region, which clearly leads to controversy when attempting a comparison between jurisdictions. However, regardless of the indicator used to compare them, the large differences between the regions are always clearly revealed (see the first half of Table 1). This heterogeneity in distribution of the stock of public capital between regions has led to several regional governments trying to consolidate a certain "obligatory" participation by central investment in their territory, always responding to the criterion which most favours each of the regions: Andalusia, the Region of Valencia, and the Balearic Islands have managed to get the participation of the central government calculated according to population; Aragon, according to surface area; Catalonia, according to its weight in GDP, etc.

[1]These are studied in Fernández-Leiceaga, Lago, and Álvarez (2013).

[2]The first two funds only apply to regions with per capita income below 75% of the European average, and must be allocated to financing capital expenditure (although since 2001, one third of ICF resources can be allocated to financing current expenditure linked to maintenance of previous investments). Thus, they are instruments of inter-territorial solidarity, intended to reduce gaps in regional development levels. For a recent study of the effect of Cohesion Funds on economic growth, see Berkowitz, Monfort, and Pieńkowski (2019).

Table 1. Territorial distribution of the stock of public capital.

	Regional stock of public capital												Weight of the stock of regional capital in 2012 according to					Regional stock (in millions of €)		
	Per capita				In terms of GDP				In terms of surface area											
	In euros		Compared to national		In euros		Compared to national		In euros		Compared to national					Best option				
	2000	2012	%	Ranking	2000	2012	%	Ranking	2000	2012	%	Ranking	Population	Income	Size (area)	Criteria	%	2000	2012	Average weight 2000–12
Andalusia	8,620	16,000	85.4	14	748	956	113.7	8	716	1,516	89.0	11	18.04	13.6	17.3	Population	18.0	62,778	95,760	16.0
Aragon	13,980	26,409	141.0	2	855	1,064	126.7	6	521	1,079	63.3	14	2.85	3.2	6.3	Size (area)	6.3	15,967	25,538	4.3
Asturias	11,901	25,886	138.2	3	911	1,240	147.6	3	1,576	3,383	198.6	6	2.28	2.1	1.6	Population	2.3	11,546	18,111	3.2
Balearic Islands	7,694	15,247	81.4	15	399	646	76.9	16	277	719	42.2	15	2.39	2.5	4.6	Size (area)	4.6	5,633	10,179	1.6
Canary Islands	9,513	16,200	86.5	13	641	855	101.8	10	549	1,162	68.2	13	4.61	3.9	5.8	Size (area)	5.8	16,678	23,311	4.2
Cantabria	11,427	22,901	122.3	5	782	1,055	125.6	7	65	140	8.2	17	1.26	1.2	18.6	Size (area)	18.6	5,882	9,782	1.6
Castilla y León	12,422	27,604	147.4	1	878	1,255	149.3	2	4,227	9,419	553.0	2	5.37	5.3	1.4	Population	5.4	33,102	47,755	8.5
Castilla-La Mancha	11,335	21,576	115.2	10	922	1,219	145.1	4	2,640	5,920	347.6	4	4.44	3.5	1.5	Population	4.4	20,365	28,577	5.1
Catalonia	8,297	17,570	93.8	12	435	665	79.1	15	653	1,612	94.6	10	15.84	18.8	15.7	Income	18.8	49,171	76,742	12.7
Valencian C.	8,685	14,655	78.2	16	576	752	89.5	13	3,103	6,491	381.1	3	10.89	9.5	2.2	Population	10.9	37,606	50,151	9.4
Extremadura	11,721	24,108	128.7	4	1,177	1,593	189.6	1	260	547	32.1	16	2.35	1.6	9.4	Size (area)	9.4	11,413	18,634	3
Galicia	9,753	22,247	118.8	8	803	1,094	130.2	5	5,257	12,124	711.8	1	5.91	5.4	1.0	Population	5.9	25,689	41,590	6.7
Madrid	8,110	17,734	94.7	11	381	613	73.0	17	1,019	2,729	160.2	7	13.92	18.1	8.2	Income	18.1	47,299	81,310	12.7
Murcia	7,825	14,007	74.8	17	596	777	92.4	12	855	1,952	114.6	9	3.21	2.6	2.1	Population	3.2	10,054	14,458	2.5
Navarre	13,587	22,172	118.4	9	682	778	92.6	11	1,402	2,598	152.5	8	1.36	1.7	1.1	Income	1.7	7,787	10,811	2
Basque Country	11,920	22,340	119.3	7	622	743	88.5	14	2,378	4,551	267.2	5	4.6	6.2	2.1	Income	6.2	22,280	33,653	5.7
Rioja (La)	13,136	22,638	120.9	6	738	899	107.0	9	702	1,398	82.1	12	0.68	0.8	1.0	Size (area)	1.0	2,984	5,277	0.8
Total regions	**9,567**	**18,730**	**100.0**		**611**	**840**	**100.0**		**759**	**1,703**	**100.0**		**100.0**	**100.0**	**100.0**		**140.8**	**3,86,233**	**5,91,639**	**100.0**

Source: Regional database of the Spanish economy **BD.Mores, Base de datos regionales de la economía española-Regional database of the Spanish economy (2017)**

If each region selects the indicator that most benefits it, and more regions join in making these demands, it will be impossible for the central government to comply with all these requirements at the same time (Cucarella, 2011). As shown in the column "best option" in Table 1, this would require a central investment 40.8% higher than the current amount. Moreover, the current investments committed to according to the best criterion would be nearly 60% of the total amount distributed, leaving just a little over 40% to be distributed among the remaining eleven regions. This could reduce investment in regions which do not have this clause in their Statutes of Autonomy.

To understand the regional interest underlying the clauses being adopted by some regions, we will quantify the stimulus effect of direct investments by the central government on the investment of regional jurisdictions. This will let us see whether investments by central and regional levels of government have a relationship of complementarity, which would support and justify these demands (based on arguments of inequities in the stock of capital or lack of funds for investment). However, if the relationship is substitutional, with central government investment being a disincentive for regional investment, the argument behind these clauses is probably more spurious, with the intention of releasing funds for purposes other than capital expenditure. Similarly, we will extend the analysis to study the relationship of complementarity or substitutability between local and regional public investments, as although the degree of financial autonomy of the local level of government is very similar to the regional level,[3] the philosophy underlying the distribution of responsibilities between these sub-central levels of government is different.

For this study, we will need to know the territorial distribution of investment by the different levels of government, which is possible in Spain thanks to the complex task of territorialising the expenditure of the different public administrations, carried out by Uriel and Barberán (2007) and the Fundación BBVA e Ivie (Instituto Valenciano de Investigaciones Económicas)-BBVA Foundation and Valencian institute of Economic Investigations (2015), and later taken on by the Finance Ministry. Therefore, the availability of this information will dictate the period to be studied.

3. Frontier of capital expenditure and investment gap

3.1. Methodology

Any level of government has incentives to try to guarantee external sources of profits, transfers, or investments, regardless of the agents' own expenditure decisions. However, the literature has shown that the effects of a transfer on expenditure depend on the amount of the transfer, and the spending habits and preferences of the receiving government (Rego, 2002). Fiscal federalism theory (Bradford & Oates, 1971) shows us that if the income elasticity of capital expenditure is greater than 1, when it receives the transfer the receiving government will take funds from current spending to allocate to investment. If the receiving governments are required to co-finance a percentage of the subsidised capital

[3]The main source of revenues for Spanish municipalities is taxation, followed by transfers, which provide 62% and 35% of their resources respectively, and most of the transfers come from the central government.

goods (matching grants), the donor and receiving administrations will share the investment cost, reducing the price of capital expenditure for the receiver. In this case, the final result will also depend on the price elasticity of capital expenditure: if it is greater than 1, the receiving government will take funds from other uses and allocate them to capital goods, while if less than 1, part of the transfer will be allocated to current expenditure. In other words, when the transfer is co-financed, a substitution effect is added which reinforces the expansion of capital. Meanwhile, as long as a conditional grant stimulates investment beyond the preferences of the jurisdiction, there will be incentives for the jurisdiction to work towards its own preferences and divert resources to other purposes (Bradford & Oates, 1971; Petchey & MacDonald, 2007). In this way, if there is a strong leakage effect, a conditional grant (or a capital investment by another level of government, as these are equivalent from the point of view of economics) will essentially be equivalent to an unconditional grant, and will therefore have a very limited effect on investment.

However, the free rider problem which can arise from transfers, due to the different preferences of the receiving regions, can be prevented if the region is required to co-finance or maintain its tax effort (Zampelli, 1986). This could favour a "bandwagon effect" pulling resources towards investment (Sagbas & Tolga, 2008), leading the receiving government to make a greater investment effort than its available resources permit, taking resources from current expenditure which will be abandoned, or obtaining them from other sources, such as borrowing or taxes. On the other hand, an exclusionary distribution of spending functions between the donor and receiving governments, as in the Spanish case, makes such co-financing impossible, so that in this context there will be no substitution effect reinforcing the expansion of capital expenditure, making it more likely that spending will leak or be diverted towards other purposes.

Although a review of the extensive empirical literature on transfers and their incentives is outside the scope of this,[4] it is worth paying attention to studies which analyse certain distorting effects, such as the *flypaper effect* (Hines & Thaler, 1995); the *fungibility effect (*Islam, 1998;; González-Alegre, 2012); the *crowding out effect* on private investment (Xu & Yan, 2014); *displacement effects* on the composition of domestic public spending, from both a thematic and a geographical perspective (Del Bo & Sirtori, 2016); or the *gapfilling effect*, by which central government bails out local governments in fiscal distress, giving them incentives to spend beyond their revenues (Brun & El Khdari, 2016). Other papers analyse how fiscal equalization transfers distort the fiscal policies of recipient governments, because their taxes and expenditures can affect the parameters of the grant formula, thereby affecting the size of their grant (Buettner, 2006). The literature also studies the different effects of transfers according to the characteristics of the regions (Becker, Egger, Von Ehrlich, & Fenge, 2010). And recently, some authors have modelled the effect of sub-central tax autonomy on transfer efficiency (Volden, 2007; Kappeler, Solé-Ollé, Stephan, & Välilä, 2013; González-Alegre, 2015).

[4]The work of Bergvall, Charbit, Kraan, and Merk (2006), Boadway and Shah (2007), and Brun and El Khdari (2016) can be consulted for a deeper understanding of intergovernmental transfers in a federal context.

The theoretical model underlying our empirical exercise is based on the conventional mathematical development of budget balancing (Bahl & Bird, 2013; Buiter, 2001; Dabla-Norris, Brumby, Kyobe, Mills, & Papageorgiou, 2012; Pack & Rothenberg, 1993), to which we add the institutional, tax, and political incentives introduced by second-generation fiscal federalism (Weingast, 2014). This approach allows us to take into account the stimuli affecting regional governments, arising from use of borrowing and its institutional restrictions, transfers, and the demand for co-financing, which must come from current savings.

The starting point would thus be the expression [1], which reflects the budget restriction facing any government and connects its public investment (INV) with the financing sources for that investment; in other words, with income from capital transfers (TRANS), current savings (SAVE), and net borrowing (BORROW).

$$\mathrm{INV} = \mathrm{SAVE} + \mathrm{TRANS} + \mathrm{BORROW} \tag{1}$$

However, as this is merely an accounting expression, it cannot capture the stimuli or disincentives affecting the investment behaviour of regional governments, such as those relating to the functioning of the political market and vote-seeking, which are often left out of economic analysis. There are significant political benefits derived from using borrowing and getting aid from other levels of government, insofar as these are financing mechanisms which make it possible to enjoy the benefits associated with the availability of public assets while avoiding paying for them (moral hazard problem). This has led to the appearance of a set of tax rules, such as requiring budget stability, or that borrowing and capital transfers must only finance investment costs. These tax rules are intended to protect the solvency of the public sector, but they can distort the investment behaviour of regional governments, favouring or discouraging investment, altering its composition (a mix of current and capital expenditure), and even incentivising the use of a little "creative accounting" (Buiter, 2001; Milesi-Feretti, 2003; Dabla-Norris et al., 2012).

For this reason, in this paper we have considered that investment is the output of the regional governments' policy,[5] and we have connected it with the sources of financing using stochastic frontier analysis (SFA).[6] This methodology will allow us, first, to determine the maximum potential investment which regions can reach for financial resources and other factors (y_M), such as the stock of available capital,[7] and a set of institutional factors which enable us to adapt the theoretical model to the context of Spanish institutions and which may condition regional investment capacity.[8] Second, to compare the real capital expenditure by each region to their potential expenditure; in

[5]It includes both direct investment and transfers, insofar as the region can make the investment directly or transfer funds to the private sector for them to invest. This enables to avoid the risks arising from the possible substitutability and interdependence of different types of investment.

[6]SFA, suggested by Aigner, Lovell, and Schmidt (1977) and Meeusen and Van Den Broeck (1977) to examine producer behaviour, although it is an emerging methodology in the field of intergovernmental relations and incentives, has been implemented recently to analyse other aspects of public economics by Pessino and Fenochietto (2010), Alm and Duncan (2014), Karnik and Raju (2015), Garg et al (2017), Niaounakis and Blank (2017), and others.

[7]As shown in the traditional theoretical approach of Gramlich (1969), Bradford and Oates (1971), and Mehrotra and Välilä (2006).

[8]Non-frontier analyses only estimate the mean of the investment. If we were using methods based on the OLS technique, we would make the mistake of considering the random component of the residual as investment effort (Rao, 1993).

other words, to determine the region's investment gap (u). Including this investment gap in the equation (2), explaining the investment output, lets us correct the problem of the existing empirical literature, which assumes the total efficiency of the public sector, even when there is no empirical or theoretical basis for such a supposition (Dabla-Norris et al., 2012). And third, to identify and quantify the explanatory hypotheses (k) which enable us to understand this investment gap (u), shown in equation (3).

Thus, SFA facilitates the construction of a frontier within which the regions with the maximum investment level, given certain financial resources and characteristics, would be located. The distance from the real to the potential investment is the potential investment not achieved. If investment by local or central government increases the gap or distance from regional investment in terms of potential or frontier investment, this would be a disincentive effect of the central/local investment in that region (crowding out effect), or in other words, there would be a relationship of substitutability between investments by both levels of government. If, on the other hand, the distance to potential or frontier investment is reduced, this would demonstrate a relationship of complementarity between both investment policies, or the existence of a crowding in effect.

As far as we know, there is no literature analysing this phenomenon in the federal government context, so our proposal provides novel empirical evidence on the interdependence of` public investments by different levels of government.

For these calculations we use panel data for the 17 Spanish regions and for the 13 years for which we have information (2000–2012). The stochastic frontier technique is implemented with the following regression model with two error terms:

$$INV_{it} = \beta_0 + \beta_1 TRANS_{it} + \beta_2 SAVE_{it} + \beta_3 BORROW_{it} + \Sigma_M \varphi_M y_{Mit} + v_{it} - u_{it} \quad (2)$$

where the output INV_{it} is the capital expenditure of the region i in year t in terms of its income, with $i = 1, 2, \ldots, 17$ and $t = 2000, \ldots, 2012$; β_0 is the common constant for all the regions, and β_1, β_2, β_3 are the parameters of the three sources of funding for regional investment: TRANS, SAVE, and BORROW,[9] all of them measured in terms of regional income.[10] We expect they have a positive effect on regional investment. y_{Mit} identifies regions with special characteristics: the regions with the highest level of responsibility (RESPONS),[11] for which the expected effect is, a priori, undetermined because although these regions have assumed responsibility for education and healthcare, these responsibilities are labour-intensive; the single-province regions (SINGLE), which assumed the responsibilities and projects of their respective Provincial Governments, so we expect a positive effect for this variable; and the regions with the greatest tax autonomy, as a consequence of their

[9]Here it should be borne in mind that Spain conditioned the use of borrowing to fund regional investment, stimulating capital over current expenditures, as well as strengthening intergenerational equity.

[10]This lets us talk in terms of the capacity to obtain financial resources, and avoid the discrepancies the different dimensions of the regions would introduce. This is a regular practice in the conventional literature (i.e., Buiter, 2001) and even by the European Union when setting legal limits for debt and deficit.

[11]The CE discriminates between two types of regions: regions with a high level of responsibility (art. 151) and regions with a low level of responsibility (art. 143), depending on whether they assume responsibility for education and healthcare (which represent around 60–70% of total regional spending, according to *Las haciendas autonómicas en cifras,* Ministerio de Hacienda-Ministry of Finance and Civil Service (various years)). In practice, the regions with high levels of responsibility experienced a higher level of fiscal autonomy in the beginning, but the gap between both types of regions has been reduced as the decentralization process has been taking place (González-Alegre, 2015).

unique (foral) financing systems (FINAN). The expected sign for FINAN is, a priori, undetermined depending on the preferences of these foral regions. We also include a dummy variable (RULE) for the 2002's budget balancing rule to strengthen financial solvency, which removed the borrowing as a source of funding, as well as discouraged the political benefits associated with the use of borrowing; and the stock of regional public capital available in per capita terms (STOCK). To consider the stock of capital available at the start of the year, we have lagged this variable by one financial year. The expected sign for both variables is negative, because the obstacles to the use of borrowing (RULE) will probably hinder investment, and the regions with the largest supply of capital (STOCK) will have lower investment needs, and their potential investment will be less.

The definition and source of the variables can be seen in Table 1A of the Appendix. Table 2A shows the main descriptive statistics and Table 3A the correlation matrix.

The error term v_{it} is the statistical noise, and the error term u_{it} captures the investment gap or distance to the potential investment, so u_{it} is our key dependent variable, and depends on variables, k_{it}.

$$u_{it} = \delta k_{it} + \varepsilon_{it}, \tag{3}$$

where ε_{it} is the error term.

The variables, k_{it}, explaining the gap or unrealised potential investment, u, are the following. A first group of *budget variables*, including the two key variables of our study: investment in the region by the central government on one hand ($_{FEDERAL}$INV) and by local governments on the other ($_{LOCAL}$INV), which will enable us to measure the relationship of complementarity or substitutability between central or local and regional investments. As we have pointed above, if investment by central government ($_{FEDERAL}$ INV) increases the gap or unrealised potential investment, u, i.e., shows a positive sign, there would be a relationship of substitutability between investments by both levels of government. This is what can be expected from the exclusionary attribution of spending responsibilities between central and regional governments. If investment by local government ($_{LOCAL}$INV) reduces the distance to potential or frontier investment, i.e., shows a negative sign, this would demonstrate a relationship of complementarity between both investment policies, or the existence of a crowding in effect, as can be expected from the cooperation of local and regional governments. We have also included in this group of variables the regional tax revenues (TAX) and the interaction between regional income from capital transfers and tax revenues ($TRANS_{EFFICIENCY}$-TAX), in response to theoretical approaches which affirm that the efficiency of capital transfers, in terms of capacity to increase investment, depends on the degree of tax autonomy (González-Alegre, 2015; Kappeler et al., 2013). The expected sign for these two variables is negative, i.e., we expect that a larger fiscal autonomy makes intergovernmental grants more effective in raising public investment. Moreover, we have considered the financial expenditure (FEXP), which would be a measure of the capacity to co-finance new investments (negative expected effect); and the current expenditure (CEXP) to test whether the regions opting or obliged to prioritise the provision of current or personal goods and services are further from their potential investment (positive expected effect). All this group of variables are measured in terms of regional income.

A second group would include *socioeconomic variables*, such as per capita income (INCOME) and the population density of the region (DENSITY). The expected sign for INCOME is negative, as investment and income are directed related, so the gap will probably be minor. However, the sign of DENSITY is, a priori, undetermined because it is an indicator of the relative need for investment, but it can also reflect the economies of scale. We have also included a variable (CRISIS) to identify the years of economic recession (2008–2012), expecting a positive sign for its.

Third, we consider a variable relating to *management*, which measures the fungibility of finally executed capital expenditure compared to budgeted amounts (QGEST), intended to approximate the quality of the investment project managers. A positive sign for this variable means management quality is lower, so the investment gap is likely to be larger.

And finally, we have included such *political factors* as political ideology (*IDEOLOGY*), the percentage of votes obtained (*SUPPORT*), the electoral cycle (ELECT) and whether the central and regional governments are from the same party (ALIGNED). In the year before regional elections there should be a greater investment effort, i.e., the expected sign for ELECT would be negative. However, the expected sign of the other political variables would, a priori, be undetermined. The lower the competition and its control over the governing party, the greater the investment effort should be (the Leviathan hypothesis), although the opposite sign, indicating a slackening of investment effort, is also possible. And something similar occurs when the party in power in the regional government is the same as the national governing party.

The variables are in logarithms.[12]

3.2. Results

We have estimated with panel data (2000–2012) and in one step, the following stochastic frontier model with true random effects (Greene, 2005; Belotti, Daidone, Ilardi, & Atella, 2013),[13] in which the error term u excludes unobserved heterogeneity:

$$\mathrm{INV} = \mathrm{f}(\mathrm{TRANS}, \mathrm{BORROW}, \mathrm{SAVE}, \mathrm{RESPON}, \mathrm{SINGLE}, \mathrm{FINAN}, \mathrm{RULE}, \mathrm{STOCK}) + \mathrm{v} - \mathrm{u} \tag{4}$$

$$\mathrm{u} = \mathrm{g}(_{\mathrm{FEDERAL}}\mathrm{INV}, _{\mathrm{LOCAL}}\mathrm{INV}, \mathrm{TAX}, \mathrm{TRANS}_{\mathrm{EFFICIENCY}} - \mathrm{TAX}, \mathrm{FEXP}, \mathrm{CEXP}, \mathrm{INCOME}, \mathrm{DENSITY}, \mathrm{QGEST}, \mathrm{SUPPORT}, \mathrm{IDEOLOGY}, \mathrm{ELECT}, \mathrm{ALIGNED}, \mathrm{CRISIS}) \tag{5}$$

The results are shown in Model 1 of Table 2. Model 2 of Table 2, to which we refer later, takes into account the fact of differences in the volume of transfers received according to the region's income level. The significance of the estimator λ in Table 2

[12]The use of logarithms lets us obtain elasticities directly, as well as certain advantages in estimation, such as reducing heteroscedasticity and multicollinearity problems (Auci, Castelli, & Vignani, 2011)

[13]The Hausman test, shown at the end of Table 2, suggests that the True Random Effects model (TRE) is preferable to the True Fixed Effects model (TFE).

indicates the rejection of the null hypothesis that $\gamma = \sigma_u^2/\sigma^2 = 0$. This confirms the suitability of SFA as a study method in this case; in other words, the need to include unrealised potential investment, *u*, in the investment capacity function, which should not be estimated using a mean behaviour function (OLS). The significance of parameter θ of variance in unobserved heterogeneity, also shown in Table 2, suggests that unobserved heterogeneity of the regions must be separated from the investment gap, validating the approximation we use from Greene (2005).

To determine whether the endogeneity problems affect a series of variables (i.e., TRANS, BORROW, $_{FEDERAL}$INV, $_{LOCAL}$INV, TAX, FEXP and CEXP), we have applied the two-stage Hausman procedure and calculated the Durbin and Wu-Hausman statistics, which can be seen in Table 4A of the Appendix. For this, we take as instrumental variables the lagged variables themselves or their rate of variation, as well as regional income and the weight of the agricultural sector in regional income, checking their validity with the Sargan and Basmann tests (which can also be seen in the last columns of Table 4A). The output of Wu-Hausman and Durbin tests show that we cannot reject the null hypothesis of exogeneity of the variables. The Sargan and Basmann tests present strong evidence that we cannot reject the null hypothesis that the overidentifying restrictions are valid. The validity of the instruments used ratifies the Wu-Hausman and Durbin tests.

The top of model 1 in Table 2 indicates which variables explain the potential investment of regional governments (equation (4)). Specifically, income from capital transfers (*TRANS*) is the main financing source (12.1%), which is in line with the roles of these resources in the regional financing model. Moreover, the single-province regions (*SINGLE*) have greater potential investment capacity. However, the level of responsibility (*RESPON*) which, as we explained earlier, is associated with having assumed responsibility for education and healthcare, appears to reduce potential investment, probably because both responsibilities are labour-intensive (the salaries represent 56% of education and healthcare expenditure, while general government services represent only 20%). Also, while spending on salaries is committed, the same is not true of investment, so that spending cuts tend to reduce investment disproportionately, rather than current expenditure (Mintz & Smart, 2006).

The model also shows that the regions with the largest supply of capital stock per capita (STOCK) show less need for investment, leading to lower potential investment.

Spanish regions use 59% to 76% of their potential investment, depending on the model 1 or 2 considered (this can be seen at the bottom of Table 2, in the row "Average investment effort"). The distance to the frontier is the unrealised potential investment or investment gap. Many of the variables considered in the explanation of this gap (equation (4)) are significant and have the theoretically expected sign.[14] As for the basic hypotheses we want to test, there is some

[14]We have also tested other variables. We tested different definitions of the SING variable, which we include to explain the investment potential of the region. To explain the incentive effects on regional investment, we also tested the weight of the agricultural sector in regional income, and population, as alternative socioeconomic variables, as well as a variable identifying the regions governed by nationalist/separatist parties, and another which captures whether the party in the regional government is the same as the national governing party (Bugarin & Marciniuk, 2017; Garofalo, 2019), electoral years, and special treatment of the archipelagos in development policy, among others. However, they all produced less satisfactory results.

empirical evidence that capital expenditure by the central government acting directly in the regions ($_{\text{FEDERAL}}$INV) may act as a substitute for regional investment (at 10% significance), as the distance increases between effective and potential regional investment, i.e., the coefficient of $_{\text{FEDERAL}}$INV is positive. In contrast, capital expenditure by local governments ($_{\text{LOCAL}}$INV) seems to complement regional spending, insofar as it reduces the investment gap in the region. These results are in line with the regulations on the distribution of responsibilities between levels of government which we saw in the introduction. The allocation of functions between central and regional governments stated in the CE has in most cases enabled a relationship of substitutability between the capital expenditures of both levels of government. In general, responsibilities are assumed exclusively by the central government, and the central infrastructure articulates the regional territory, thus mitigating the need for regional investment. Meanwhile, the regions and their local governments have followed the criteria established in the LBRL regarding the need to complement and coordinate the main local policies on social services, environment, sport, healthcare, tourism, education, town planning and local development; the general tendency is to share activities relating to design and planning, and leave execution in the hands of Town Councils, who also usually receive grants or subsidies from the regional government for these functions.[15]

Despite the strict financial restrictions imposed on the regions, those which prioritise providing goods and services to their citizens (CEXP) do not seem to do so at the cost of lower capital expenditure, and so they are also closer to their potential investment levels, since its coefficient is negative. Regarding the variable relating to the management of capital projects, we can observe that if public managers are less skilled (*QGEST*), measured by the distance between executed and budgeted regional investment, there is a greater distance between potential and real investment. The results also indicate that the investment gap is inversely related to the region's income level (INCOME), and that according to the ideology of the governing party, left-wing governments are nearer the frontier (*IDEOLOGY*).

To take into account the fact of differences in the volume of transfers received according to the region's income level, we have interacted in model 2 of Table 2 each one of the variables $\text{TRANS}_{\text{EFFICIENCY}}$-TAX, $_{\text{FEDERAL}}$INV and $_{\text{LOCAL}}$INV, with a dummy which captures the main regions receiving transfers ($_{\text{POOR}}$REGION), which are those constituting the objective of the territorial rebalancing policy. Although the significance of some control variables may change with these interactions, the two variables we are interested in are found to be robust. Also, the significance and value of the coefficients of some variables of the model seem to improve considerably with these interactions. They especially accentuate the effect of capital expenditure by the central government ($_{\text{FEDERAL}}$INV) on the regional investment gap, which would indicate that the substitutability relationship between central and regional investment is more marked in the most disadvantaged regions, which are the ones receiving the most funds. The coefficient of the variable interacting transfers and tax revenues ($\text{TRANS}_{\text{EFFICIENCY}}$-TAX) is significant when interacted with the dummy $_{\text{POOR}}$REGION. Its positive sign means that a larger

[15]For this reason, occasionally there is considered to be a problem of duplication of responsibility for spending at the local level, where there may actually be a relationship of cooperation or complementarity of functions.

fiscal autonomy makes intergovernmental grants less effective – in raising public investment – in poor regions. This result, which seems to go against what we would expect in theory, is also obtained for the Spanish case in González-Alegre (2015).[16]

On the other hand, the most dynamic regions, where the population tends to concentrate with greater density (DENSITY), which is an indicator of the relative need for investment and differential costs (economies of scale), now show a significant and positive coefficient, indicating a greater investment gap. The variable which captures the electoral support of the governments (*SUPPORT*) is also significant now, and shows how governments with large majorities, or which are subject to less control due to the weakness of their political rivals, tend to move further away from their potential investment levels (Bahl & Bird, 2013). This result seems to prove that when pacts are necessary due to the precarious position of the ruling party, investment expenditure expands, getting closer to its potential level. The period of economic crisis or budget stress (CRISIS) increases the gap between potential and actual investment (Allain-Dupré, 2011).

4. Conclusions

This work presents the first empirical investigation of the relationship between investments by the different levels of government in a federal context. Specifically, we evaluate whether direct investments in the regions, by the central government on one hand and by local governments on the other, have a stimulating or a contracting effect on regional investment, with the ultimate purpose of seeing whether the relationships between these investments are complementary or substitutional. To do this, we use a technique which is increasingly popular in public economics studies, the Stochastic Frontier Approach, which lets us determine, on one hand, the potential or frontier investment each region could achieve with the resources available to it and its institutional situation, and the gap or distance from the real investment to that frontier; and on the other, the factors explaining that gap. This way, we will be able to measure the regions' investment response both to direct investment by central and local governments, and to other relevant variables.

For the Spanish case these estimates are made for two reasons. First, because fortunately we have data on the territorial distribution of investment by different levels of government over a long enough period for study. And second, because responsibilities are distributed between the three levels of government (central, regional and local) in Spain in a very interesting dual way, providing a particular scenario for analysis which can help to explain the different results obtained according to the level of government considered.

The results obtained clearly show that investments by local and regional governments are complementary, a reasonable result given that responsibilities are distributed between both levels of government based on a philosophy of cooperation. In contrast, there are signs that investments by the central government and by regions may be substitutional. This could explain the regions' interest in establishing a guaranteed minimum investment in their Statutes of Autonomy. This substitutability relationship

[16]Fernández-Leiceaga et al. (2013) also show how poor regions divert resources towards reducing debt or savings effort, or even towards non-productive capital expenditure (education and healthcare).

could suggest the need for a capital expenditure co-financing policy between the regions and the central government, which would probably require the absence of legislation which distributes expenditure functions in an exclusionary manner. This could counter the free rider effect to some extent, by introducing the right stimuli to strengthen regional investment policies and generate crowding-in effects in public investment, and reduce regional governments' incentives to demand higher central investment.

The connection observed between the distribution of responsibilities among levels of government and the results obtained could serve as a guide for other countries to preview the potential relationship between the investments of their levels of government (substitutional or complementary) and the distribution of responsibilities established in their regulations (exclusionary or cooperative).

A different approach to that taken in this paper could consist of analysing how investment by the central government (or by local governments) in the region is affected by the investments of other government levels, an aspect which we leave for future research.

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Notes on contributors

Anabel Zárate-Marco received her Ph. D. Degree in 1999. She is profesor of Public Economics at the University of Zaragoza (Spain). Her main research areas are taxation, tax planning and fiscal federalism. She has published numerous papers in different leading journals.

Jaime Vallés-Giménez received his Ph. D. Degree in 1999. He is profesor of Public Economics at the University of Zaragoza (Spain). His main research areas are fiscal federalism, taxation, and tax planning. He has published numerous papers in different leading journals and has headed several research projects.

ORCID

Anabel Zárate-Marco http://orcid.org/0000-0002-5525-4556
Jaime Vallés-Giménez http://orcid.org/0000-0002-2542-4956

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APPENDIX

Table 1A. Variables: definitions and sources.

Variables	Definition	Source
INV	Capital expenditure of the region/Regional income	Liquidación de presupuestos de las Comunidades Autónomas (Ministerio de Hacienda) and Instituto Nacional de Estadística- National Statistics Institute (INE)
TRANS	Income from capital transfers/Regional income	Liquidación de presupuestos de las Comunidades Autónomas (Ministerio de Hacienda) and Instituto nacional de Estadística (INE)
BORROW	Debt level/Regional income	
SAVE	Current primary savings/Regional income	
RESPON	=1 if the region has the responsibility for education and healthcare = 0 otherwise	Política autonómica (Ministerio de política territorial y función pública)
SINGLE	=1 if the region has only one province: Asturias, Cantabria, La Rioja, Madrid, Navarre, Balearic Islands and Murcia = 0 otherwise	Instituto Nacional de Estadística (INE)
FINAN	= 1 for the Basque Country & Navarre = 0 otherwise	Financiación autonómica (Ministerio de Hacienda)
RULE	= 1 in 2002–11 = 0 otherwise	Ley Orgánica 2/2012, de 27 de abril, de Estabilidad Presupuestaria y Sostenibilidad Financiera-Organic Law 2/2012, of 27 April, on Budget Stability and Financial Sustainability.
STOCK	Stock of regional public capital available in per capita terms	BD.Mores, Base de datos regionales de la economía española-Regional database of the Spanish economy (2017)
$_{FEDERAL}$INV	Investment by the upper levels of government in the region/Regional income	Fundación BBVA e Ivie (Instituto Valenciano de Investigaciones Económicas)-BBVA Foundation and Valencian institute of Economic Investigations (2015), and Uriel and Barberán (2007)
$_{LOCAL}$INV	Investment by local governments in the region/ Regional income	Liquidación de presupuestos de las entidades locales (Ministerio de Hacienda)
TAX	Tax revenue/Regional income	Liquidación de presupuestos de las Comunidades Autónomas (Ministerio de Hacienda).
$TRANS_{EFFICIENCY-TAX}$	TRANS * TAX	
FEXP	Financial expenditure/Regional income	
CEXP	Current spending/Regional income	
INCOME	Per capita income of the region	Instituto Nacional de Estadística (INE)
DENSITY	Population/km^2	
QGEST	(Regional capital expenditure planned – executed)/Capital expenditure	Liquidación de presupuestos de las Comunidades Autónomas (Ministerio de Hacienda) and Presupuestos de las Comunidades Autónomas (Ministerio de Hacienda)
IDEOLOGY	= 1 if the party is left-wing = 0 otherwise	Resultados electorales (Ministerio del Interior)
SUPPORT	% of votes obtained by the government party	
ELECT	= 1 the year before regional elections = 0 otherwise	
ALIGNED	= 1 if the party in the regional government is the same as the national governing party = 0 otherwise	
CRISIS	= 1 in 2008–2012 = 0 in other years	Instituto Nacional de Estadística (INE)
$_{POOR}$REGION	= 1 for the regions that have received most capital transfers: Andalucía, Extremadura, Castilla-La Mancha, Galicia, Murcia, Asturias, Canarias, Valencia and Castilla León, and Cantabria, until 2007. = 0 otherwise	La política regional y sus instrumentos (Ministerio de Hacienda)

Source: By the authors.

Table 2. Results of the stochastic frontier analysis of investment.

	Model 1				Model 2			
Variable	Coefficient	z- statistics	[95% Conf. Interval]		Coefficient	z-statistics	[95% Conf. Interval]	
Frontier model								
TRANS	0.121***	3.310	0.049	0.193	0.147***	6.120	0.100	0.194
BORROW	0.005	1.470	−0.002	0.012	0.006	1.510	−0.002	0.014
SAVE	0.009	0.770	−0.014	0.031	0.024*	1.870	−0.001	0.048
RESPON	−0.129***	−2.470	−0.231	−0.026	0.040	0.820	−0.056	0.137
SINGLE	0.136***	2.650	0.035	0.236	0.039	0.650	−0.079	0.157
FINAN	−0.126	−1.540	−0.285	0.034	−0.110	−1.390	−0.266	0.045
RULE	0.005	0.150	−0.062	0.072	0.061*	1.770	−0.007	0.129
STOCK_1	−0.438***	−4.050	−0.650	−0.226	0.092	0.830	−0.127	0.311
CONS	5.721***	10.5	4.653	6.789	2.510***	4.420	1.396	3.625
Gap to the investment frontier								
$_{FEDERAL}$INV$^{\alpha}$	0.036*	1.680	−0.006	0.079	0.088***	2.670	0.023	0.152
$_{LOCAL}$INV	−0.279***	−7.070	−0.357	−0.202	−0.265***	−6.020	−0.351	−0.179
TAX	−0.077	−1.390	−0.186	0.032	0.041*	1.880	−0.002	0.083
TRANS$_{EFFICIENCY}$-TAX$^{\alpha}$	0.028	0.650	−0.056	0.111	0.071***	3.650	0.033	0.110
FEXP	0.022	0.910	−0.026	0.070	0.186***	6.060	0.126	0.247
CEXP	−0.256***	−3.610	−0.395	−0.117	−0.052	−0.560	−0.234	0.129
INCOME	−1.128***	−6.560	−1.465	−0.791–0.791	0.194	0.950	−0.205	0.593
DENSITY	0.053*	1.730	−0.007	0.113	0.093***	3.430	0.040	0.146
QGEST	0.012***	18.300	0.011	0.013	0.014***	14.630	0.012	0.016
CRISIS	−0.025	−0.740	−0.092	0.041	0.074**	2.020	0.002	0.146
SUPPORT	0.001	0.730	−0.002	0.005	0.004*	1.900	0.000	0.008
IDEOLOGY	−0.141***	−3.990	−0.210	−0.072	−0.211***	−5.010	−0.293	−0.128
ELECT	0.030	1.330	−0.014	0.073	0.038	1.470	−0.013	0.089
ALIGNED	−0.011	−0.560	−0.048	0.027	0.049	1.440	−0.018	0.116
CONS	10.378	7.21	7.555	13.202	−0.244	−1.410	−5.835	0.943
λ (Ho: $\gamma = \sigma_u^2/\sigma_\varepsilon^2 = 0$)	1.457***	57.32	1.407	1.507	0.412***	11.53	0.342	0.483
σ_u^2	.0941***	7.51	.072	.122	0.047*	1.65	0.014	0.154
σ_v^2	.064***	4.56	.042	.099	0.114***	12.34	0.097	0.133
θ	.616***	17.1	.545	.686	0.34***	10.76	0.279	0.404
Average investment effort		0.594				0.7613		
Hausman test (TFE vs. TRE) (Prob>Chi^2)		2.67 (0.4453)				2.42 (0.4893)		

Variables with the superscript $^{\alpha}$ are interacting in the model 2 with the dummy $_{POOR}$*REGION* which captures the regions which have received the most capital transfers (poor regions)
(***) Significance at 1%, (**) at 5% and (*) at 10%.
Source: By the authors.

Table 2A. Descriptive statistics.

Variable	Obs	Mean	Std. Dev.	Min	Max
INV	221	23.82	12.14	3.24	58.59
TRANS	221	7.98	6.33	.34	36.06
BORROW	221	12.99	16.13	.000	138.41
SAVE	221	19.23	18.19	−24.69	133.00
RESPON	221	0.94	0.22	0	1
SINGLE	221	0.35	0.47	0	1
FINAN	221	0.84	0.36	0	1
RULE	221	0.84	0.36	0	1
STOCK	221	184.31	44.39	104.41	277.86
$_{\text{FEDERAL}}$**INV**	221	11.99	7.94	.41	38.79
$_{\text{LOCAL}}$**INV**	221	12.06	4.35	2.30	24.28
TAX	221	77.26	40.66	1.86	215.98
TRANS$_{\text{EFFICIENCY}}$**-TAX**	221	567.04	461.98	1.16	2653.11
FEXP	221	7.00	6.19	1.24	65.52
CEXP	221	123.298	37.39	38.36	239.47
INCOME	221	1,847.85	372.80	1,056.30	2,663.62
DENSITY	221	154.63	169.01	21.83	798.01
QGEST	221	26.21	24.74	−88.18	76.25
IDEOLOGY	221	0.36	0.48	0	1
SUPPORT	221	45.87	9.61	23.08	64.96
ELECT	221	0.23	0.42	0	1
ALIGNED	221	0.38	0.49	0	1
CRISIS	221	0.38	0.48	0	1

Source: By the author

Table 3A. Correlation matrix.

	TRANS	BORROW	SAVE	STOCK	$_{FEDERAL}$INV	$_{LOCAL}$INV	TAX	FEXP	CEXP	INCOME	DENSITY	QGEST	SUPPORT
TRANS	**10.000**												
BORROW	**−0.0964**	**10.000**											
SAVE	**0.0688**	**−0.4334**	**10.000**										
STOCK	**0.0073**	**0.1338**	**0.1366**	**10.000**									
$_{FEDERAL}$INV	**0.5596**	**−0.2703**	**0.2804**	**0.2875**	**10.000**								
$_{LOCAL}$INV	**0.0993**	**−0.2628**	**0.1321**	**0.1368**	**0.2119**	**10.000**							
TAX	**−0.1962**	**0.1841**	**0.212**	**0.2766**	**−0.1744**	**−0.3359**	**10.000**						
FEXP	**0.079**	**0.7599**	**−0.2177**	**−0.0659**	**−0.1582**	**−0.2915**	**0.0957**	**10.000**					
CEXP	**0.3768**	**0.188**	**0.046**	**0.3685**	**0.2616**	**0.2242**	**0.3488**	**0.1187**	**10.000**				
INCOME	**−0.6824**	**−0.2166**	**0.1811**	**0.1252**	**−0.4096**	**−0.0382**	**0.1846**	**−0.28**	**−0.4796**	**10.000**			
DENSITY	**−0.4575**	**−0.0414**	**−0.1638**	**−0.3535**	**−0.4413**	**−0.2147**	**−0.1386**	**−0.0277**	**−0.4899**	**0.5026**	**10.000**		
QGEST	**−0.2778**	**0.0979**	**−0.0509**	**0.4036**	**−0.0646**	**0.032**	**0.1723**	**−0.0483**	**0.2024**	**0.0164**	**0.0343**	**10.000**	
SUPPORT	**0.2485**	**0.0729**	**−0.1265**	**−0.1106**	**0.1203**	**−0.0002**	**0.0247**	**0.0024**	**0.2365**	**−0.3989**	**−0.0183**	**−0.0476**	**10.000**

Source: By the author

Table 4A. Analysis of potential endogeneity .

Variable	Durbin-X_i^2 (Prob>X_i^2)	Wu-Hausman-F (Prob>F)	Sargan-X_i^2 (Prob>X_i^2)	Basmann-X_i^2 (Prob>X_i^2)
TRANS	1.7614	1.69521	1.58171	1.51381
	(0.1845)	(0.1943)	(0.4535)	(0.4691)
BORROW	0.29395	0.280492	2.97962	2.87001
	(0.5881)	(0.5969	(0.2254)	(0.2381
$_{LOCAL}$INV	1.33053	1.22753	1.09655	1.01023
	(0.2487)	(0.2696)	(0.2950)	(0.3148)
$_{FEDERAL}$INV	3.28179	3.06428	2.57261	2.37578
	(0.0701)	(0.0821)	(0.2763)	(0.3049)
TAX	0.360756	0.33087	5.47218	5.14535
	(0.5481)	(0.5660)	(0.0648)	(0.0763)
FEXP	1.61679	1.49425	7.56698	7.06552
	(0.2035)	(0.2235)	(0.1818)	(0.2158)
CEXP	1.82195	1.68598	11.9882	11.3605
	(0.1771)	(0.1961)	(0.1009)	(0.1237)