Economics
The Open-Access, Open-Assessment E-Journal

Vol. 11, 2017-34 | November 27, 2017 | http://dx.doi.org/10.5018/economics-ejournal.ja.2017-34

Catalytic effect of capital transfers in a federal context: the case of Spanish regions

Jaime Vallés-Giménez and Anabel Zárate-Marco

Abstract

There is a broad theoretical consensus on the effects of transfers (desired incentive impacts and induced adverse effects). But, as the literature review shows, there is not an accepted methodology for the empirical evaluation of these effects. The authors suggest a simple but rigorous empirical approach to quantify the catalytic effect of conditioned transfers for investment and their asymmetric impact across regions in Spain. To identify this behaviour, they have applied different empirical approaches with frontier techniques that let them consider the frontier as a proxy for potential investment. The results show that the conditioned transfers received by the regions from higher levels of government have a stimulus effect for investments, especially in the poor regions. The authors identify several factors explaining this unbalanced catalytic effect: the political cost of tax collection, political factors, inadequate management of debt, and other variables such as the level of economic development, population density, and the economic cycle.

JEL H20 H54 H7

Keywords Catalytic effect; capital transfers; regional capital expenditure; frontier techniques.

Authors

Jaime Vallés-Giménez, University of Zaragoza, Spain

Anabel Zárate-Marco, ✉ University of Zaragoza, Spain, azarate@unizar.es

Citation Jaime Vallés-Giménez and Anabel Zárate-Marco (2017). Catalytic effect of capital transfers in a federal context: the case of Spanish regions. *Economics: The Open-Access, Open-Assessment E-Journal*, 11 (2017-34): 1–27 . http://dx.doi.org/10.5018/economics-ejournal.ja.2017-34

Received July 7, 2017 **Published as Economics Discussion Paper** July 24, 207
Revised November 3, 2017 **Accepted** November 7, 2017 **Published** November 27, 2017

1 Introduction

Collaboration between levels of government to achieve certain economic policy objectives, such as territorial development or rebalancing, is one of the essential arguments justifying the existence of intergovernmental transfers. The behavioural response of recipient governments remains a prevalent and prolific area of study, as there is empirical evidence that transfers induce adverse or undesirable effects on the policies of recipient governments. On the other hand, if the transfers are well-designed and act as a catalyst for public spending or investments intended to stimulate, their effects on spending, growth, and economic development are even greater. During the recent years of economic recession, we have in fact been able to see how several countries have started stimulus spending packages, in which the subcentral governments have played a very important role in implementing investment recovery strategies (Allain-Dupré, 2011 and Del Bo and Sirtori, 2016). However, it is also true that access to traditional sources of financing of capital expenditure for regional governments is usually restricted in periods of crisis, with public investment being possibly forced to play its traditional role of financial adjustment (Allain-Dupre et al., 2012).[1]

Donor governments want their transfers to stimulate investment in the recipient economies, with the ultimate aim of achieving the intended growth and convergence objectives. Therefore, in this paper, we evaluate whether transfers from higher levels of government have a catalytic effect on increasing investment spending in regions, to see whether the policies of donor governments have the desired effect. We also analyse whether the catalytic effect of transfers is asymmetric across regions. There is empirical evidence about the effects of transfers both on spending and on growth and convergence, but our approach and methodology differ totally from those previously used in the available literature. We suggest a simple but rigorous methodology based on frontier investment estimations. We calculate the divergence between actual and potential investment, identifying the frontier as the potential investment which could be achieved if the grants had a catalytic effect on it, since it is including both the obligatory investment of the regions, in the sense that many of their funding sources are conditional on the realization of capital expenditures, and the investments voluntarily made by each region, the outcome of the catalytic effect of the transfers on investment. This way, a small gap will mean that grants have a high catalytic effect on investment.

We do this for the 17 Spanish regions in the period 1991–2011, which includes economic booms and crises. This will let us analyse the regions' investment response to the transfers they receive through the changes of the economic cycle. Also, the case of Spain is very interesting for these analyses because of the great efforts made by the European Union and the Spanish state to promote regional development, above all by means of large capital grants, especially to backward regions. The results obtained clearly show that the transfers received by the Spanish regions have an important catalytic effect on investment, especially in the poor regions. The stimulus effects of the grants are lower in the richest regions, to the extent that their investment

[1] In budgetary austerity contexts the capital transfers are lower, access to public debt can be severely restricted, and the collection of tax revenues diminishes as economic activity stagnates. Therefore, each jurisdiction can react differently: raising the public deficit, increasing fiscal pressure, reducing public investment and other expenses, although it may also have tried to manage public capital expenditure more efficiently.

is further from the frontier. The explanatory factors we have found for this asymmetry in the investment behaviour of the regions include political aspects, management or planning associated with the accumulated debt, the political cost of tax collection, and other factors such as the level of economic development, population and population density, and the economic cycle.

The work is structured as follows. The second section discusses the goals of the study from a theoretical point of view and reviews the available literature. The third section describes the non-parametric frontier methodology, the sample, the variables used in the estimations, and the results obtained. These non-parametric techniques enable us to identify a significant asymmetry in the regions' investment behaviour, which is ratified in the fourth section by the parametric Stochastic Frontier Analysis. As well as checking the robustness of the previous results, the stochastic frontier approach lets us improve the explanation of the investment potential and identify the socioeconomic and political factors explaining the catalytic effect of the transfers. We end the work with our conclusions.

2 Problem statement and literature review

The fiscal federalism literature has shown that the effects of a transfer on expenditure depend on the amount and type of the transfer, the spending habits and preferences of the receiving government and on the characteristic of the receiver government. Thus, equalization transfers and other redistributive subsidies can influence the policies of recipient governments in the intended direction, i.e., resulting in the desired incentive effects, but may also induce adverse or undesirable incentive effects (Bird and Smart, 2002 and Rego, 2002).

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 (Bradford and Oates, 1971 and Gramlich et al., 1973). If the receiving governments are required to co-finance a percentage of the subsidised capital goods (compensatory transfers or 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. Therefore, according to the conventional analysis, we can predict that compared to a compensatory conditional transfer, *ceteris paribus* there will be a lower investment level with an unconditional transfer of the same amount or a conditional block grant, as these stimulate spending through an income effect, while the conditional transfer adds a substitution effect which reinforces the expansion of capital expenditure.

As Gramlich et al (1973) and Oates (1999) point out, standard theory leaves little room to explain the existence of both categorical block grants (i.e., flat-rate subsidies that have to be used for certain specific purposes), and closed-ended matching grants (i.e. transfers that subsidize the costs of specific goods with a fixed maximum amount). These types of subsidies are distorting and unfit for internalizing externalities (Bezdeck and Jonathan, 1988). Although Huber and Runkel (2006) theoretically justify the use of both transfers, when the upper level of

government desires to implement redistributive policies and there is asymmetric information on the costs of providing public goods and services facing jurisdictions. Other authors, such as Smart (2007), also argue that conditional transfers in which the higher governments do not require co-financing by the jurisdictions receiving the aid can also affect the expenditure of the subcentral governments significantly, although from the economic point of view they are analogous to lump-sum income transfers.

Another current of the literature analyses the different effects of transfers according to the characteristics of the regions. Beugelsdijk and Eijffinger (2005), Matheson (2005) and Becker et al (2010) find that the grants are more effective in less developed regions; and Kessing and Schneider (2014) theoretically conclude that the incentives can differ between rich and poor regions depending on the nature of the investment. Ederveen et al. (2006) and Brun and Khdari (2016) find that the results of transfers depend on the institutional design in the country. Furthermore, there is a great deal of literature analysing the effects of grants on regional economic performance (see among others, Rodriguez-Pose and Fratesi, 2004 or Bouvet, 2007).

There is also ample literature that analyses the distorting effects of grants: the *flypaper effect*, which refers to the assumption that increases in equalizing transfers tend to stimulate more spending than do comparable increases in local tax revenues (Gramlich, 1977; Hines and Thaler, 1995; Gamkhar and Shah, 2007; Faber and Koning, 2012; Pevcin, 2014; Dahlby and Ferede, 2016), and the *fungibility effect*, that occurs when a jurisdiction receives a conditional transfer and diverts resources to other purpose, i.e. reducing taxes (crowding-out effect), debt or the current deficit; increasing current spending; or even mismanagement of these resources (Bradford and Oates, 1971; McGuire, 1975; Zampelli, 1986; Islam, 1998; Ulbrich, 2011; and Alegre, 2012). If this fungibility effect is strong, a conditional grant will essentially be equivalent to an unconditional grant, and will therefore have a very limited effect on investment. Furthermore, grants may exercise *displacement effects* on the composition of domestic public spending, from both a thematic and a geographical perspective (Chalmers, 2013; and Del Bo and Sirtori, 2016). Another adverse effect is that transfers may be "gapfilling", meaning that central government bails out local governments in fiscal distress. Local governments with larger deficits receive larger transfers relaxing their budget constraint, giving them incentives to spend beyond their revenues (Brun and Khdari, 2016). Additionally, there are papers that analyse how fiscal equalization transfers may 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 (Dahlby, 2002; and Buettner, 2006).

This review of the literature allows us to conclude that although the principle of additionality is at the basis of both European Cohesion Policy and the regional development policy of many countries, and it guides the allocation mechanism of capital funds between regions, whose aim is stimulating convergence and growth by co-financing regional public investment,[2] the potential effects of the transfers can be diverse (inventive and adverse effects) and they are clearly identified from a theoretical point of view. However, from the point of view of empirical evidence, it is not clear how important these potential effects really are. Conditional grants have an indeterminate impact on capital expenditures, since they reduce the relative price

[2] Similarly, the purpose of regional policy is to provide additional resources to regional governments, without substituting or displacing subcentral public funds.

of the investment (incentive or complementarity effect), but can also lead to lower levels of taxation if the subsidy is above the preferences of the jurisdiction (impact of preferences or substitution effect). They may also have an asymmetric response in the jurisdictions, depending both on the relative importance of the stimulus involved in the transfer for each jurisdiction, and on their disparate socio-economic conditions and their changes in time, and provoke other effects, such as geographical and displacement effects. There is, therefore, a broad consensus on the need to reinforce empirical attempts to assess the effectiveness of these policies on the objectives pursued, and the existence of unintentional distorting impacts (Gramlich et al, 1973, Dahlby 2002, Buettner, 2006, Karkazis and Thanassoulis, 1998, Brun and Khdari, 2016, and Del Bo and Sirtori, 2016).

This paper proposes an empirical exercise to quantify the stimulus effect of conditional capital transfers from higher levels of government on investment in regions. We will also check the relationship between the reaction of the regions to the stimuli that introduce such transfers, and different characteristics of the regions (reaction behavior), e.g., the regional level of tax burden, importance of their financial expenditures, and political aspects.

As the literature review has shown, there is no single accepted methodology for empirical evaluation of the effects of transfers, so we suggest a simple but rigorous empirical methodology that can help us identify the catalytic effect of transfers on regional decisions of public capital spending. For this we will calculate, first, the potential investment that a region could achieve if the received grants have a stimulus effect on investment. The potential investment or capital expenditure of a region depends on its revenue available for that purpose (since they are conditional, i.e. they must be intended for investment), but not only on those, as different environmental factors also affect expenditure. Frontier techniques can be suitable for determining the potential investment of the region, i.e. the investment implying a catalytic effect of grants, as they are based on a comparative analysis of the best regional investment behaviour (rather than the average behaviour considered in other methodologies), given similar financial resources, and when possible, other environmental factors. We will then measure the distance from the real investment to that potential. The smaller the distance, the greater the catalytic effect of the transfers in that region. As far as we know, there is no literature that analyses this phenomenon.

3 Non-parametric frontiers of investment and the catalytic effect of transfers

3.1 Methodology

As we just explained, we use frontier techniques in our analysis. We consider the investment as the output of the donor government's policy, which will be the function of a series of inputs – basically the financing sources available to the regions receiving the grants for making these investments. As we saw, under the principle of additionality, donor governments are worried about the potential output (investment) which is unrealised, so that this gap will represent the unused or not achieved investment potential, and could be caused by several factors: because

the regional government wants to prioritise the provision of services to its citizens, the payment of financial costs, and/or a reduction in tax pressure or debt; because there may have been poor practices in the planning and management of investment projects due to corruption, managerial incompetence by the governments, or a lack of suitable human resources, all of which could be considered an "unproductive" diversion of resources, or literal inefficiency; it may also be that subsidies have not had a sufficient stimulus effect on investment. For all these reasons, the gap detected by any of the frontier techniques we are going to use, cannot be identified with a fungibility effect or with a displacement effect, nor should be qualified as a problem of inefficiency in the provision of public capital expenditure, because this inefficiency could be precisely the cause of an excessive capital expenditure. This gap will be only a measure of the lack of catalytic effect of the grants for the regional investment. The smaller the gap the greater the stimulus or catalytic effect caused by transfers.

In this work we use a non-convex version of Data Envelopment Analysis, the Free Disposal Hull (FDH) proposed by Deprins et al (1984). This is a non-parametric technique which facilitates the construction of a frontier, within which the regions with the maximum investment level given certain financial resources would be located, so that a region's distance from the frontier would measure the lack of *catalytic effect* of the grants for investment. When constructing the investment potential or frontier investment with all observations, the FDH will always offer results equal to 1 or less than 1; in other words, results identifying either behaviour in accordance with the potential, implying a strong catalytic effect of the grants (when the result or investment effort is 1), or a lower stimulus effect (when the result is less than 1). The problem is that stimulus effects will scarcely reach a value close to one, since regions have some room to manoeuvre to finance current spending or maintenance associated with the subsidised investment projects (Frank and Martínez-Vázquez, 2015). Therefore, with this technique, the catalytic effect can only be evaluated by considering whether the region is above or below the average result.

Besides, since this technique suffers from a series of problems (dimensionality problems, given its slow convergence rate; results are sensitive to outliers and measurement errors; and it does not let decision-making units be located beyond the frontier), we also use the recently developed partial frontier methods, which do not envelop all the data. This last feature of the partial frontier models is of particular interest to us, since this is what can be expected in the case at hand: as the design of capital transfers concentrates resources in the poorer regions, the asymmetric incentive effects have to be translated into locating these regions outside the frontier.

Specifically, these are two robust approaches: Order-m (Cazals et al., 2002) and Order-α (Aragon et al., 2005), which Simar and Wilson (2013) develop in great detail. Both are generalisations of the FDH, so they are still non-parametric techniques, but permit observations located beyond the estimated frontier of possible investments, making the results much less sensitive to measurement errors and outliers, and eliminating the well-known "curse of dimensionality". The jurisdictions located beyond the frontier will be outliers for the high volume of their investments, given the size of their financing sources and the behaviour of the other regions considered. Therefore, there will be no doubt that the *catalytic effect* will be produced when the jurisdictions are located beyond the frontier, i.e., when the result is greater than 1, in the sense that it invests more than the region with the best potential behaviour in the

considered cohort of jurisdictions with similar financial resources. In contrast, a result less than 1 will indicate that a region is investing less than the region with the best potential investment behaviour in the sample, although it may be also investing beyond the volume of conditional transfers it receives from the central level (lower investment stimulus according to the lower volume of conditional funds received).

3.2 Database and variables

For these calculations we use panel data for the 17 Spanish regions over 21 years (1991–2011). This allows us to capture the possible variations in public activity with the economic cycle, and thus, the oscillations of the financial restrictions that regional governments have to handle.

Our output is the region's capital expenditure in terms of its income, KE_{GDP}, including both direct investment and transfers, to avoid the risks arising from the possible substitutability and interdependence of different types of investment. This form of measuring output comes from adopting the point of view of the donor government and its concern about the potential capital expenditure not achieved. Table 1 shows the definition of each variable used, the source of the data, and the main descriptive statistics. Table 2 shows the correlation matrix for the variables considered.

Table 1: Definition of the variables used and their sources

Variables	Description of the variable	Information source	Mean	Std. Dev.	Min	Max
INDEPENDENT VARIABLE						
KE_{GDP}	Capital expenditure (direct investment and transfers) of the region / Regional income	General Secretariat of Regional and Local Coordination (SGCHL) and National Statistics Institute (INE)	24.35	12.49	3.31	71.87
EXPLANATORY VARIABLES OF THE STOCHASTIC FRONTIER ANALYSIS OF CAPITAL EXPENDITURE						
Sources of financing						
IKT_{GDP}	Income from capital transfers / Regional income	SGCHL (data on settlements) and INE	8.63	6.84	1.00 E-11	42.82
$DEBT_{GDP}$	Debt level / Regional income		8.75	8.91	1.00 E-11	63.13
$CSAVE_{GDP}$	Current primary savings / Regional income		16.85	12.41	1.00 E-10	108.46
Institutional variables						
CAP	=1 if the region has transferred the responsibility for education and healthcare = 0 otherwise	By the authors	0.71	0.45	0	1

Table 1 continued

Table 1 continued

Variables	Description of the variable	Information source	Mean	Std. Dev.	Min	Max
CAP	=1 if the region has transferred the responsibility for education and healthcare = 0 otherwise	By the authors	0.71	0.45	0	1
SPROV	=1 if the region comprises a single province: Asturias, Cantabria, La Rioja, Madrid, Balearic Islands and Murcia. = 0 otherwise		0.29	0.45	0	1
SING	= 0 for the Basque Country = 1 for Navarre = 2 otherwise		1.82	0.51	0	2
LIMIT	= 1 in 2002-11 = 0 otherwise		0.47	0.50	0	1
EXPLANATORY VARIABLES OF INEFFICIENCY						
Socioeconomic variables						
GDPpc	Per capita income of the region	INE	13348.08	7435.37	0	30987.01
DENSITY	Population / km2		142.91	153.78	17.60	808.38
Budget variables						
TAX_{KE}	Tax revenue / Volume of capital expenditure	General Secretariat of Regional and Local Coordination (SGCHL)	2.23	2.64	0.05	25.68
FINEXP	(Interest + amortisation of the debt) / Current income		0.06	0.06	0	0.611
Political variables						
VOTES	% of votes obtained in the last election by the party in government	Ministry of the Interior	44.33	9.32	20.47	64.96
POLCOLOUR	= 1 if the party is left-wing = 0 otherwise	Ministry of the Interior	0.42	0.49	0	1
ELEC	=1 in an election year and the year before = 0 otherwise		0.52	0.50	0	1
Other hypotheses						
CRISIS	= 1 in the periods 1993-95 and 2008-11 = 0 in other periods		0.33	0.47	0	1
INSULA	= 1 in the Balearic Islands and Canary Islands = 0 in other regions		0.11	0.32	0	1

Table 2: Correlation matrix of variables

	KE_{GDP}	IKT_{GDP}	$DEBT_{GDP}$	$CSAVE_{GDP}$	CAP	SPROV	SING	LIMIT	GDPpc	DENSITY	TAX_{KE}	FINEXP	POLCOLOUR	VOTES	CRISIS	ELEC	INSULA
KE_{GDP}	1.00																
IKT_{GDP}	0.74	1.00															
$DEBT_{GDP}$	0.12	0.08	1.00														
$CSAVE_{GDP}$	0.45	0.25	-0.28	1.00													
CAP	-0.04	-0.12	0.18	0.11	1.00												
SPROV	-0.18	-0.18	-0.17	-0.05	-0.15	1.00											
SING	-0.03	0.34	-0.13	-0.20	-0.18	0.16	1.00										
LIMIT	-0.21	-0.29	0.21	-0.10	0.24	-0.02	-0.21	1.00									
GDPpc	-0.54	-0.67	-0.17	-0.02	0.40	0.17	-0.16	0.26	1.00								
DENSITY	-0.64	-0.61	-0.08	-0.28	0.06	0.32	-0.15	0.15	0.42	1.00							
TAX_{KE}	-0.61	-0.50	0.01	-0.20	0.38	0.14	0.09	0.47	0.54	0.44	1.00						
FINEXP	-0.19	-0.03	0.14	-0.22	-0.50	0.15	0.08	-0.16	-0.24	0.08	-0.21	1.00					
POLCOLOUR	0.18	0.30	0.11	-0.01	-0.11	-0.17	0.15	-0.05	-0.28	-0.23	-0.12	0.02	1.00				
VOTES	0.07	0.18	-0.11	-0.06	-0.11	-0.02	0.33	0.05	-0.17	-0.03	0.04	0.00	-0.07	1.00			
CRISIS	-0.17	-0.28	0.27	-0.15	0.14	-0.04	-0.25	0.92	0.19	0.09	0.37	-0.07	-0.04	-0.02	1.00		
ELEC	-0.02	-0.05	-0.05	-0.04	0.05	0.00	-0.04	0.10	0.01	0.00	0.09	-0.03	-0.01	-0.03	0.13	1.00	
INSULA	-0.12	-0.13	-0.15	0.00	0.03	-0.22	0.10	-0.10	0.18	0.13	0.09	-0.11	-0.12	-0.25	-0.06	-0.01	1.00

In a similar way to Gramlich et al (1973), the inputs used correspond to the three strategies the regions use to fund their investments: first, income from capital transfers expressed in terms of regional income (IKTGDP), as the government providing transferred capital funding can incentivise regional investment and generate a stimulus or catalytic effect on them; although this can also produce the opposite effect, diverting funds towards current spending or lower taxes, or be lost along the way in unproductive practices, due to inefficiency. Second, the policies affecting current savings, as regions can practice austerity in their management of current spending, freeing up funds for investment, and make a higher tax effort enabling them to finance more investments, or the complete opposite. Therefore, we have taken as input current savings in relation to regional income (CSAVEGDP). And finally, annual income from borrowing, also measured in terms of regional income (DEBTGDP). Here it should be borne in mind that Spain limits the use of borrowing to fund capital expenditure, stimulating capital expenditures over current expenditures, as well as consolidating intergenerational equity. But to strengthen financial solvency, in 2002 regional net indebtedness was prohibited, indirectly discouraging investment, as well as reducing the political benefits associated with the use of borrowing.

Table 3 shows that in Spain, the existing model for the distribution of transfers tends to exclude, totally or partly, the territories with the highest levels of development, as it does not adequately consider the richest regions' need to finance new investment projects, nor the cost of replacement and obsolescence of their capital stock.[3] This has led them either to use current savings more intensively (as has happened in Murcia or regions such as Navarre, the Basque Country, Cantabria and the Balearic Islands, where income is usually above 75% of the European average), or to borrow more than the average (as in Aragon, Catalonia, and Valencia, with a notably low weight of current savings in the latter two regions). It also shows the increasing importance of transfers (Bahl and Bird, 2013), given the limited tax capacity of sub-central governments and the growing restrictions on regional borrowing. This is weakening the exercise of political and fiscal responsibility by receiving governments, which eventually respond to the incentives introduced in the design of the transfers. In the current context, when European grants are decreasing, a well-designed distribution of the transfers is even more necessary.

[3] In Spain these transfers basically come from European structural funds (60%), the Inter-territorial Compensation Fund (25%), and agreements between administrations (15%). The first two of these are strongly oriented to redistribution.

Table 3: Relative weight of the financing sources of regional capital expenditure
(Averages in terms of GDP for the period 1995–2011)

	Capital expenditure	Sources of investment funding			
		Total	Income from capital transfers	Current savings	Net debt
Andalusia	2.65	3.52	1.35	1.59	0.58
Aragon	1.95	2.32	0.59	1.15	0.58
Asturias	3.12	3.41	1.27	1.70	0.45
Balearic Islands	1.59	1.93	0.31	1.23	0.39
Canary Islands	2.16	2.95	1.00	1.42	0.53
Cantabria	2.45	3.23	0.73	2.03	0.47
Castilla-La Mancha	3.53	3.70	1.37	1.76	0.57
Castilla-León	2.71	2.59	1.20	0.79	0.60
Catalonia	1.27	2.11	0.50	0.71	0.90
Valencian C.	1.44	2.12	0.41	0.95	0.76
Extremadura	4.22	4.84	2.36	1.90	0.58
Galicia	3.49	4.29	1.55	2.05	0.69
La Rioja	0.87	1.21	0.23	0.61	0.37
Madrid	1.92	2.40	0.75	1.14	0.50
Murcia	4.13	4.87	0.32	3.97	0.58
Navarre	1.65	2.69	0.27	2.00	0.42
Basque Country	2.16	2.74	0.48	1.74	0.53
Total	2.43	3.00	0.86	1.57	0.56

Source: Based on data provided by the Ministry of Finance and Public Administrations.

3.3 Results

The first block of Table 4, "Non-parametric models", shows the relative stimulus effect of the transfers on the Spanish regions, measured as the ratio between the real and maximum investment, which incorporates the catalytic effect of transfers, calculated with *Stata*, for the total frontier (FDH) and for partial frontiers (Order-m and Order-α). The average stimulus effect ranges from 86% to 98%, depending on the technique used, and is closest to 100% with Order-α. This means that, in general terms, they are practically on the frontier, if we take into account that the regions must have some legal room to manoeuvre to finance current spending or maintenance associated with the subsidised investment projects. Little more can be said at the general level given the methodological differences between both types of techniques. However, a more disaggregated analysis allows us to draw more interesting conclusions.

Table 4: Situation of the regions in relation to their potential investment frontiers*

	Non-parametric models			Parametric model
	FDH	Order-α	Order-m	SFA
Andalucía (1)	0.78	0.93	0.74	0.93
Aragón (2)	0.78	0.86	0.78	0.71
Asturias (1)	0.93	1.07	0.92	0.92
Baleares (2)	0.91	0.93	0.94	0.49
Canarias (1)	0.79	0.92	0.76	0.67
Cantabria (1)	0.80	0.89	0.82	0.81
Castilla-León (1)	0.99	1.17	0.98	0.95
Castilla-La Mancha (1)	0.89	1.02	0.92	0.92
Catalonia (2)	0.66	0.69	0.66	0.79
C. Valenciana (1)	0.82	0.86	0.80	0.87
Extremadura (1)	0.96	1.25	0.94	0.95
Galicia (1)	0.87	1.09	0.89	0.95
Madrid (2)	1.00	1.00	1.00	0.97
Murcia (1)	0.74	0.81	0.72	0.91
Navarra (3)	0.99	1.25	0.98	0.95
Basque Country (3)	0.92	1.00	0.91	0.99
La Rioja (2)	0.81	0.88	0.83	0.77
AVERAGE	0.86	0.98	0.86	0.86
Poor regions (1)	0.86	1.00	0.85	0.89
Prosperous regions (2)	0.83	0.87	0.84	0.75
Foral regions (3)	0.95	1.13	0.94	0.97

(1), (2), and (3): classification of poor and prosperous regions (differentiating foral regions) based on European average income (Eurostat).

* Calculations for $\alpha = 0.95$ and $m = 300$, although the frontiers were calculated with different values for the parameters, in order to check the robustness of the results.

Table 4 also shows that in poor regions, such as Castilla-León, Castilla-La Mancha, Asturias, Galicia, and Extremadura, which receive large capital transfers (as seen in Table 3), the stimulus effect of the transfers is greater than in the richest. In fact, the Order-α technique give these regions a value >1, which could be an indication that resources are being dragged towards gross capital formation, given that the Order-α technique places them beyond the frontier. This *bandwagon effect* could be capturing a true catalytic effect of the transfers, in the sense that these regions add own resources for investment. This may be happening, for example, in Castilla-León, where the volume of capital expenditure exceeds the resources available for

investment, as shown in Table 3. And it may be the result of the greater concern and interest of these regions in encouraging this type of action and fostering economic development, given their relatively disadvantaged situation.

Madrid and the Foral regions (the Basque Country and Navarre)[4] behave in a similar way. All of these, as prosperous regions, have very high investment efforts, which may be due to the capital city effect in the case of Madrid, and the special financing system of the Foral regions.

An extrapolation to the FDH of the results obtained with the Order-α, would suggest that there is a catalytic effect of the grants in those regions whose investment effort in relation to the maximum potential calculated by FDH exceeds 87%, since regions located beyond the frontier with Order-α show investment efforts with FDH of at least 87%.

The other regions are below the frontier, regardless of how it is constructed, revealing an absence or at least a lower catalytic effect of transfers on regional investment, especially low in Murcia, Valencia, and Aragon, but above all in Catalonia, which given its available resources is the region showing the greatest improvement margin in its investment activity.

Thus, the results demonstrate a significant asymmetry in the behaviour of regional governments receiving conditional capital grants in terms of the investments made. This asymmetry is summarised in the last three rows of Table 4, which show how the investment ratios (actual/potential) are greater in poorer than in prosperous regions, regardless of the technique used, suggesting that the transfers have a greater catalytic effect in poor regions, which are the jurisdictions that concentrate the resources distributed through the system of conditioned transferences.

4 The catalytic effect of transfers and its explanatory factors

4.1 Methodology and variables

Our study is completed by implementing the Stochastic Frontier Approach (SFA), an alternative methodology based on the stochastic frontier production possibilities suggested by Aigner et al. (1977) and Meeusen and van den Broeck (1977). This parametric technique lets us check and adjust the results obtained with the previous approaches and determine the explanatory factors behind the asymmetric catalytic effects of transfers (an aspect which has not been analysed until now in the available literature), estimating them simultaneously with the frontier investment. This can also be done with procedures associated with non-parametric techniques (Daraio and Simar, 2007), but a parametric approach, such as SFA, will enrich our analysis of investment, while allowing us to leverage the advantages and minimise the limitations of each method (non-parametric and stochastic), and to check the robustness of our previously obtained results.

SFA is increasingly popular internationally in empirical studies of public economy, based on the idea that no economic agent can be located beyond the frontier, so that any deviation

[4] Although for $\alpha = 0.95$ only Navarre is beyond the frontier, and the other three regions (Basque Country, Madrid and Balearic Islands) are on the frontier, as α is reduced they are going beyond the frontier. Order-α is shown to be more sensitive than Order-m to the parameter value (α or *m)* used in each case, although the ranking of regions is found to be fairly robust, both to the technique and to the intrinsic parameter used.

from it can be considered as unused regional investment capacity, this is to say, the catalytic effect not achieved by transfers. Moreover, it does let us see whether the hypotheses on the relationship between input (financing sources of capital expenditure) and output (potential investment) are significant, something which is particularly interesting in a study like ours. It also lets us incorporate *dummies* which capture the unique features of the institutions of each region (observed heterogeneity), which can influence their investment potential, and which we cannot consider with non-parametric techniques. Also, with the SFA we can see the causes of the different catalytic effects of transfers by regions.

The stochastic frontier technique is implemented statistically through the specification of a regression model with two error terms, which for investment is represented as:

$$ln\ KE_{GDPit} = \beta_0 + \Sigma_R\ \beta_R\ ln\ x_{Rit} + \Sigma_H\ \beta_H\ ln\ y_{Hit} + v_{it} - u_{it} \quad [1]$$

where KE_{GDPit} is investment in terms of the region's income i in year t, with i = 1, 2, …, 17 and t = 1991, ... , 2011; β_0 is the common constant for all the regions in the year t; β_R and β_H are parameter vectors to be estimated; x_{Rit} would be the three sources of funding for investment in the region i in the year t: IKT_{GDP}, $CSAVE_{GDP}$ and $DEBT_{GDP}$, which are measured as explained above; and finally, y_{Hit} should capture the unique features of the institutions of each region, which can cause heterogeneity in the sample on the frontier. These last would be, first, a dummy variable (CAP) to reflect the uneven level of responsibility of the regions, according to whether they are responsible for education and healthcare, as these involve a greater volume of capital expenditure. Second, a dummy identifying the single-province regions (*SPROV*), as these absorbed their respective Provincial Governments, assuming their responsibilities, and therefore their obligations in terms of investment projects.[5] Third, a qualitative variable to capture the unique financing systems of the Basque Country and Navarre (*SING*), which give them greater autonomy in tax matters. And finally, a qualitative variable (*LIMIT*) for the budget balancing rule introduced in 2002, which reduced investment potential significantly by eliminating a source of self-financing: borrowing.

The error term v_{it} in equation [1] represents the usual statistical noise – in other words, everything outside regional control (such as stochastic disturbances and random shocks, measurement errors, etc.). The second error term, u_{it}, represents the distance to the investment potential or the lack of catalytic effect of transfers, given certain inputs (financial resources and institutional variables), and would be the function of variables, z_{it}, which may change over time.

$$u_{it} = \delta z_{it} + w_{it,} \quad [2]$$

where δ is a coefficient vector to be estimated and w_{it} is the error term.

The variables, z_{it}, which we have considered may influence the catalytic effect of resources, u, are grouped in five blocks. First, *socioeconomic variables* such as per capita income (*GDPpc*) and the population density of the region (DENSITY), although to capture decreasing returns or congestion costs we have also included density squared ($DENSITY^2$). Second, two *budget variables*. On one hand, the regional tax revenues in relation to the volume of capital

[5] In contrast, the regions with more than one province maintained the Provincial Governments, which are configured as an intermediate level of government between the region and its municipalities.

expenditure (TAX_{KE}), which could be an indicator of the greater tax effort made by the regions to allocate new resources to the investment. However, this variable could also capture the political costs of using tax as a source of funding, which could make the regional government want to meet its own spending targets, diverting resources to other purposes. On the other hand, the importance of financial expenditure in current income (*FINEXP*), insofar as it reflects the financial risk assigned by the credit market, being therefore an indicator of capacity to co-finance new capital expenditure (Herrero-Alcalde et al., 2011).

Third, we have taken into account various *political matters* which could affect the degree of control exercised by the regional government: the political colour of the governing party (*POLCOLOUR*), the existing level of political competition (*VOTES*),[6] and a variable identifying the election and pre-election year (*ELEC*) to test the electoral cycle thesis. Fourth, we incurporated a qualitative variable (CRISIS) identifying the periods of economic crisis (1993–95 and 2008–11), in order to see whether capital expenditure is significantly reduced in these years, given its non-mandatory nature. And finally, given the unique features of the two archipelagos, we have incorporated a qualitative variable (INSULA) to capture their potentially different behaviour.

4.2 Results

In light of the methodology and hypotheses discussed above, we have estimated with panel data (1991–2011), and in a single stage, equations [3] and [4] of the stochastic investment frontier model, with random effects, proposed by Greene (2005) and Belotti et al. (2012),[7] shown below:

$$KE_{GDP} = f(IKT_{GDP}, DEBT_{GDP}, CSAVE_{GDP}, CAP, SPROV, SING, LIMIT) + v - u \quad [3]$$

$$u = g(GDPpc, DENSITY, DENSITY^2, TAX_{KE}, FINEXP, VOTES, POLCOLOUR, ELEC, CRISIS, INSULA) \quad [4]$$

This estimation considers that the error term u may vary over time, and that it excludes unobserved heterogeneity which does not change over time. The results, shown in Table 5, indicate the suitability of the SFA as a method for estimating the *catalytic effect* of grants. Specifically, as the estimator λ is significant in the model, the null hypothesis that γ equals 0 is rejected, which confirms the suitability of the SFA as method of study in this case, i.e. the need to include the *catalytic effect*, u, in the investment capacity function, which should not be approximated using an estimated average behaviour function (OLS). Additionally, the

[6] We constructed the variable as a percentage of votes obtained, expecting that the lower the competition and its control over the governing party, the greater the investment effort (the Leviathan hypothesis).

[7] In the true random effects model (TRE), the regions share the constant term of the specification. Although Farsi et al. (2007) point out that TRE models yield the most plausible estimations, we also tested the fixed effects approach of Greene (2005), in which the constant term is different for each region, with the model giving similar results.

significant value of θ suggests that unobserved heterogeneity of the regions must be separated from the stimulus effect, which validates the Greene (2005) approaches we use.[8] Meanwhile, the significance of the variables explaining the degree to which the investment potential is not used or the lack of *catalytic effect*, validates the suggested equation.

Table 5: Results of the stochastic frontier analysis of investment

Variable	Coefficient	z-statistics
Frontier model		
$LIKT_{GDP}$	0.25661**	13.18
$LDEBT_{GDP}$	0.07476**	5.71
$LCSAVE_{GDP}$	0.06911**	4.01
SING	0.41162**	7.49
CAP	0.12736**	4.83
SPROV	0.11549**	2.57
LIMIT	–0.01684**	–5.16
CONS	1.590829**	15.25
Inefficiency		
GDPpc	0.001048*	2.00
DENSITY	–0.0041849**	–4.27
$DENSITY^2$	1.3e-06	1.10
TAX_{KE}	0.1307379**	11.18
FINEXP	2.076081**	6.56
POLCOLOUR	–0.922829*	–2.25
VOTES	–0.0105506**	–3.93
ELEC	–0.218227*	–2.15
CRISIS	–0.736958*	–2.35
INSULA	0.9672978**	7.82
CONS	0.424772*	2.19
λ (Ho: γ =0)	0.638746**	19.57
σ_u^2	0.0888998**	3.48
σ_v^2	0.1391785**	14.93
$\gamma = \sigma_u^2/\sigma_\varepsilon^2$	0.6387468**	19.57
θ	0.5411886**	14.09

(**) Significance at 1% and (*) at 5%.

[8] See Farsi et al (2006).

The estimation indicates that the explanation of the investment potential of regional governments rests on a combination of the theses discussed above. Specifically, the model suggests that income from capital transfers (IKT_{GDP}) is the financing source which makes most regional investment possible, with borrowing ($DEBT_{GDP}$) and current savings ($CSAVE_{GDP}$) being less important. We also observe that when a regional government resorts to citizens' income through borrowing or current savings, it presents a very low marginal propensity to invest (around 7%), compared to the result of financing with subsidies (25%), which may indicate the presence of a fiscal illusion problem connected to the *flypaper effect*. However, this question is not analysed in our paper.

The institutional variables are also key to explaining the investment potential, and as we expected, both the level of responsibility (*CAP*) and being a single-province region (*SPROV*) have a close and direct relationship with potential capital expenditure. Also, regions with a common financing regime may invest more than foral regions (*SING*), which probably responds to the design of the transfer system (based on the criteria of equity) and the quantitative importance of European structural funds, which exclude the foral territories due to their high per capita income. Alongside this, the incorporation of the budget balancing law from 2002 (LIMIT) had the effect of reducing investment potential, as expected.

All the factors considered in the estimation of the catalytic effect of grants are also significant and have the expected sign. On one hand, the results indicate that the stimulus effect of the transfers is inversely related with the region's income level (*GDPpc*), as the non-parametric techniques showed in the previous section. The reader will recall that these pointed out that the poorer regions are nearer from the frontier than the richest. This may mean that regional development policies are especially effective and facilitate investment in the least favoured regions, while the wealthiest regions opt to prioritise, for example, current spending in response to a growing demand for public services from their higher-income citizens. This result would also confirm the hypothesis that opportunity costs for citizens in the most prosperous regions involve less control over government spending. On the other hand, density (*DENSITY*), which is an indicator of relative need for investment and differential costs (scale economies), shows that in the most dynamic regions, where the population tends to concentrate, the catalytic effect of the transfers is greater, without any sign of decreasing returns in the management of capital public services or congestion costs ($DENSITY^2$). This aspect is considered in the design of Spanish regional development policy, as an element determining the distribution of transfers by the central government.

The two budget variables we have used increase the gap to the potential investment. Significance of the tax variable (TAX_{KE}) suggests that the political costs of tax collection outweigh the benefits of using them in investment and reduce incentives to increase investment. And greater financial expenditure (*FINEXP*), making it difficult to obtain financing due to higher credit risk, means less capacity to co-finance investment projects, some of which may remain unrealised, reducing the catalytic effect of grants.

The model also reveals that political factors explain the effect of the transfers. Specifically, it shows that majority governments (*VOTES*) are nearer the potential investments, as the absence of political competition facilitates the stimulation of and makes it possible to carry out the desired investments; and that in election and pre-election years (*ELEC*) the stimulus effect

of the grants is greater, as the government seeks the political benefits of the investments (Bahl and Bird, 2013). We have also found different investment behaviour according to the ideology of the governing party, with left-wing governments being nearer the frontier (*POLCOLOUR*).

The significance of the CRISIS variable reveals the anti-cyclical *effect* of the transfers. Despite the role of investment as an adjustment variable in times of austerity (Allain-Dupré, 2011), given that capital projects are a type of spending that is not committed to ahead of time (compared to current and financial expenditure), the model shows that during the periods of economic crisis or budget stress, the gap between potential and actual investment is smaller. This is probably due to the stabilising role of investments attributed to income transferred from the central government, but also to the shrinkage of potential investment in times of crisis, due to greater budget restrictions. They are also due to investment and stimulation plans of the economic activity which were done in during the socialist government (2004–11).

Finally, despite the special treatment of the archipelagos in development policy, the model shows that the geographical and economic disadvantages of being an island reduce the catalytic effect of the grants.[9]

Knowing the hypotheses determining the investment potential of a region and the factors influencing the catalytic effect of resources, we have calculated the degree to which each region really uses its potential investment capacity. The margin between each one and the frontier will therefore be the catalytic effect we want to measure, or rather the lack of catalytic effect. The results obtained with the stochastic frontier method, displayed in the right-hand column of Table 4, show a high degree of use of the investment potential of the regions, at an average of 86%. An extrapolation to the SFA, of the results obtained with the Order-α, would point out that there is a catalytic effect of the grants in those regions whose investment effort in relation to the maximum potential calculated by SFA exceeds 92%. Thus, the transfers received by the Spanish regions have a relevant catalytic effect for investment, especially in the poorest regions. This asymmetry in the effect of the transfers is in line with the results of non-parametric methods, contributing to the robustness of the results.

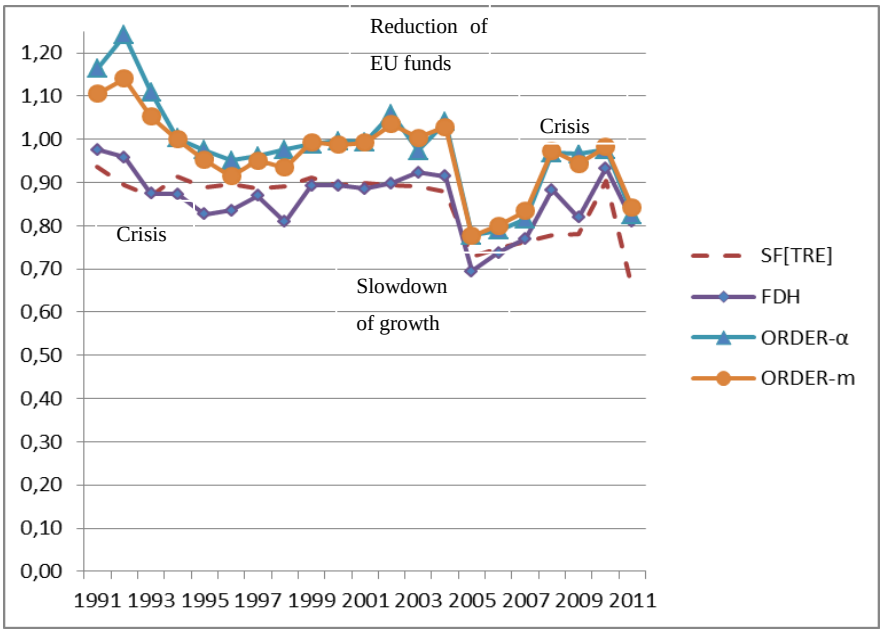
The evolution over time of the executed/potential investment ratio, displayed in Figure 1, also shows a very similar pattern, regardless of the estimation technique used. The high point of this evolution was the heavy investment effort made in the early 1990s, at the time of the Seville Expo and the Barcelona Olympics, at a level which has not been repeated. The intense budgetary adjustment which was necessary to undertake in the following years, to join the European Economic and Monetary Union, did reduce the transfers and possibilities of co-financing, resulting in a less incentivising impact of capital expenditure.

Another notable year is 2005, for the shock of the sudden drop in EU funds due to the Union's expansion to 25 member states, which led to a drastic reduction of its capacity to

[9] 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 catalytic effect of the grants, we also tested the weight of the agricultural sector in national 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. However, they all produced less satisfactory results.

stimulate investment.[10] Finally, it will be observed that the current crisis, the full scope and effective impact of which is still unknown, has obliged the Spanish regions to change their investment effort, increase their tax pressure or reduce the resources assigned to other budget items, but it is also true that it has probably incentivised improved management and a more efficient allocation of resources. Indeed, it has very possibly caused a combination of all these strategies.

Figure 1: Changes in regional investment over time



5 Conclusions

Donor governments design their programmes of conditional capital subsidies to stimulate investment in the region receiving the grants, while incentivising the incorporation of additional resources to capital formation by the receiving government. However, the empirical literature has shown that the effects of the transfers are diverse and are not always stimulating. For this reason, our work tries to quantify the catalytic or incentive effect caused by conditional capital transfers in the investment behaviour of the Spanish regions, using various frontier techniques. This empirical methodology can be seen as the basis for a reconsideration of the current

[10] There are several explanations to be found for this cyclical behaviour. On one hand, a smaller volume of transfers reduces the financial illusion, and therefore the costs of certain investment projects are not undervalued, so that a conservative outlook would lead to a rejection of investments of marginal importance in order to adapt to the new framework. On the other, a reduction in transfers reduces the *crowding in* effect or the attraction of private investment, which is co-financer along with public grants, so this was another way in which the least profitable investment projects were abandoned

verification mechanism adopted by the EU and Spanish government to evaluate the additionality of transfers.

Both the non-parametric techniques and the stochastic frontier analysis show that the stimulus effect of conditional grants for investment is lower in the most prosperous regions. However, only non-parametric partial frontier techniques, which let regions be located beyond the frontier, can technically identify a bandwagon effect which drags resources towards investment, which is localised in some poorer regions. This asymmetry in investment behaviour may reflect the pattern of redistribution incorporated in the design of capital transfers, and the interest or preference of poor regions for this type of activity as a factor of development and economic growth.

The results of our analysis also show that the catalytic effect depends inversely on regional income, the budget variables, and insularity; and it relates directly to population density, the number of votes, being involved in an election campaign, or a left-wing party being in power. In temporal terms, the model shows that for the Spanish regions, periods of economic crisis notably increase the catalytic effect.

To conclude, it should be noted that there are at least two worrying situations or challenges to be faced. On one hand, the gradual reduction in European funds and the reaction of the regions which depend on them most heavily (such as Extremadura, Castilla-La Mancha, Castilla and León, and Valencia), together with much tougher restrictions on borrowing. On the other, the situation in regions with congested capital goods or specific deficits hampering their long-term prospects for economic growth (such as the Balearic Islands, Catalonia, Madrid, and Aragon). Therefore, to ensure the continuity of the process of growth and internal convergence, it would be recommendable to consider a reform of the funding system which would guarantee a greater level of financial autonomy, enabling regions to obtain sufficient additional resources to co-finance the subsidised projects, and complementing the centralised development policy, adapting it to the different preferences of the territories (Petchey and MacDonald, 2007), without having to take resources from other purposes (*displacement effect*) nor divert them from their intended uses (*fungibility effect*). This would make it possible to attend to the needs both of lower-income regions, and of wealthier regions whose growth is limited by congestion or a scarcity of strategic capital goods, such as infrastructure, other public equipment, or spending on R&D.

Acknowledgments We gratefully acknowledge the funding support of the Regional Government of Aragón and the European Regional Development Fund (Public Economics Research Group). The usual disclaimer applies. This paper is not the result of a for-pay consulting relationship; neither we nor our employer have a financial interest in the topic of the paper which might constitute a conflict of interest.

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