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LOCAL GOVERNMENT EFFICIENCY: DETERMINANTS AND SPATIAL INTERDEPENDENCE*

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Abstract

We analyse the determinants of local government efficiency taking into account the presence of spatial interactions among neighbouring municipalities. To do so, first we estimate an efficiency index using the robust order-*m* methodology in Valencian municipalities (Spain). Second, we examine the socio-economic, political and budgetary factors that might influence efficiency levels. Finally, we analyse the spatial interactions present in our data. The results of estimating a spatial autoregressive model show that government efficiency in neighbouring municipalities positively affects the local government's own efficiency. This highlights the importance of considering spatial dependence structures in studies on efficiency in the public sector.

Keywords: local governments; efficiency; order-*m*; determinants; spatial interdependence; Valencian municipalities

JEL Classification: C14, C21, H21, R12

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1. Introduction

1.1. Motivation

The need for efficient management of resources in the public sector has become a crucial issue in recent times, leading to a corresponding increase in research analysing public performance measurement. The global financial crisis (GFC) has heightened society's interest in the sustainability of public finances (see, e.g. Seifert and Nieswand, 2014). This growing concern over public management is also due to the limitations on public incomes and indebtedness. During the crisis, fiscal discipline in the European Union increased the concern on reducing indebtedness in local governments (Ferraresi et al., 2018). Municipalities had to reduce their expenditures, making it difficult for them to meet the demands of standard levels of local public goods.

Within the European context, some analysts, economists, and the press pejoratively referred to Portugal, Italy, Greece, and Spain as the "PIGS" countries to highlight their similar macroeconomic characteristics and, more specifically, their high levels of public debt (Alamá-Sabater et al., 2016). In this macroeconomic situation, Spanish regions significantly reduced their expenditure on health, education and social services (see, e.g. IVIE, 2017 for the case of NUTS2, or Autonomous Communities). It is worth mentioning the case of the Valencian Region, where basic public services per capita were lower than the average of the Spanish regions during the period 2009-2015 (IVIE, 2017). For this reason our empirical analysis focuses on the Valencian Region.

The merger between municipalities could be one way to reduce costs and increase efficiency. In fact, mergers are one of the measures provided for in Law 27/2013 on the

Rationalisation and Sustainability of Local Administration[1], which allows municipalities with fewer than 5,000 inhabitants to merge in exchange for increases in financing or preferences in subsidies and cooperation plans. Although intermunicipal cooperation and municipal amalgamations are two strategies considered for improving municipal efficiency, they are very unusual.

The related literature shows that economies of scale increase municipal efficiency, thus defending the importance of amalgamation reforms (see, e.g. Reingewertz, 2012) and intermunicipal cooperation (see, e.g. Ferraresi et al., 2018). We aim to identify how a different channel, spatial interdependence, might influence municipal efficiency. To do so, we focus on the determinants of efficiency in municipalities of the Valencian Region, a region that has been heavily affected by an external shock, that is, the GFC.

1.2. Objectives and contribution of the study

In this paper, we analyse whether spatial interdependence plays a role in local government efficiency. In addition to other more “traditional” determinants (socio-economic, political, and budgetary), we analyse whether local governments’ efficiency in one municipality is influenced by neighbouring municipalities’ efficiency.

We use the cost efficiency concept, namely, the extent to which a municipality is able to provide a determined level of services with the minimum cost possible. In order to identify the main determinants of cost efficiency as well as whether spatial interdependence matters, first, we estimate the level of efficiency at municipal level. Next, we consider the determinants that affect the constructed local government efficiency scores, which we classify as socio-economic, political, and budgetary factors.

[1] Ley 27/2013, de 27 de diciembre, de Racionalización y Sostenibilidad de la Administración Local (BOE-A-2013-13756).

Finally, to analyse the importance of spatial interdependence for municipal efficiency, we consider various neighbourhood criteria that model different perspectives of spatial interdependence, which include geographical and ideological proximity, and size similarity across municipalities.

Our analysis is performed for local governments in the Valencian Region with a population of fewer than 50,000 inhabitants (for 524 municipalities). Our methodological approach relies on a regression analysis that is extended using techniques borrowed from the spatial econometrics literature. Our spatial approach consists of an autoregressive model that allows the analysis of spatial interdependence at municipal level. The tests performed reveal the presence of a positive spatial autocorrelation.

We demonstrate that spatial interdependence matters and, in doing so, the “traditional” determinants of efficiency are validated, as results obtained are robust in different specifications. Our main contribution is to show that what happens in terms of efficiency in one municipality influences neighbouring municipalities’ efficiency. Municipalities benefit from higher efficiency levels in neighbouring municipalities. A further contribution concerns the methodologies applied, as we demonstrate the usefulness of considering a spatial approach to analyse the determinants of efficiency in Spain.

The rest of the paper is organised as follows. The next section reviews the main empirical studies on efficiency and related studies considering spatial interdependence between neighbouring municipalities. This section also reviews the literature that leads to the selection of the “traditional” factors determining efficiency at municipal level. The third section describes data and variables, and the methodology followed for the construction of municipal efficiency scores. The fourth section presents the model specification and introduces the analysis of spatial patterns in efficiency of municipalities. Results regarding factors affecting municipal efficiency are reported in the fifth section. Finally, the main conclusions of the study are presented.

2. Literature Review

2.1. Efficiency and spatial interdependence

Studies on efficiency in the public sector have mainly focused on the local level (see Kalb et al., 2012; Cruz and Marques, 2014). Many of them assess the performance of municipalities as a whole, i.e. the overall local government performance. Evidence in the literature focusing on overall municipal efficiency is available for different countries. This is the case of Belgium (De Borger and Kerstens, 1996), Germany (Kalb et al., 2012), Greece (Doumpos and Cohen, 2014), Norway (Borge et al., 2008), Portugal (Afonso and Fernandes, 2008; Cruz and Marques, 2014), Spain (Balaguer-Coll et al., 2007, 2013; Bosch et al., 2012). Others focus on efficiency in the provision of a specific service such as refuse collection (Bosch et al., 2000), street lighting (Prado and García, 2007), and local road maintenance (Kalb, 2014). This study takes the global perspective, which is particularly important since citizens evaluate the activity of the government as a whole and do not simply concentrate on one particular service (Bosch et al., 2012).

Additionally, this literature has provided some insights into the determinants of efficiency in terms of the characteristics of the municipalities[2].

Other studies have tried to determine whether specific fiscal decisions are affected by those taken in nearby municipalities. This can be explained by the first law of geography, i.e. that everything is related to everything else, but near things are more related than distant things (Tobler, 1970). In fact, there are already theoretical models that justify the

[2] Cruz and Marques (2014) provide an extensive literature review with reference to the determinants of performance.

existence of spatial interdependence among governments. Brueckner (2003) and Revelli (2005) present an overview of the alternative theoretical explanations which can generate interdependence in this context.

Authors such as Bastida et al. (2013), Ermini and Santolini (2010), Foucault et al. (2008), López et al. (2017) and Rios et al. (2017) argue that spending levels in one municipality are affected by spending decisions in neighbouring municipalities. The same occurs for taxation decisions. For example, the studies of Cassette et al. (2012), Delgado and Mayor (2011) and Ndiaye (2018) study spatial patterns in the local tax system. Overall, there is consistent evidence of tax mimicking among municipalities. The work of Álvarez and Barbero (2016) highlights the importance of spatial effects of tax income on growth in Spanish regional economies, analysing at the same time competition among regions for public resources. Borck at al. (2015), Pan et al. (2017) and Kopczewska at al. (2016) study spatial patterns in debt. Likewise, Zhang and Gibson (2017) find spatial dependence in the outsourcing of local services, indicating that decisions to subcontract services to third parties are influenced by the outsourcing decisions taken by their nearest neighbouring local authorities.

The abovementioned studies show the importance of spatial interdependence for local governments. However, the analysis of interdependence between neighbouring local authorities in terms of efficiency levels is under-researched. Indeed, Allers and Elhorst (2011) suggest that focusing on either taxation or expenditure in isolation implies that the local government's budget constraint, which links spending to taxation, is ignored. For this reason, it is useful to focus on the analysis of efficiency.

The existence of spatial patterns in local government efficiency has been analysed by Geys (2006) and Revelli and Tovmo (2007). Geys (2006) confirmed the presence of neighbourhood effects in his analysis of efficiency in Flemish municipalities. A spatial analysis was also performed by Revelli and Tovmo (2007) for Norwegian municipalities, evidencing that comparative performance evaluation produces positive spatial autocorrelation in municipal efficiency ratings. Our study is focused, for the first time, on the spatial pattern in efficiency in Spanish municipalities. Specifically, our focus is on Valencian municipalities, located in a region heavily affected by an exogenous shock. As not all Valencian municipalities might have reacted to the GFC in the same way, our empirical choice facilitates identification of the effect of the determinants of government efficiency at municipal level, as well as of the role of spatial interdependences.

2.2. On the "traditional" determinants of local government efficiency

2.2.1. Socio-economic factors

The first of the socio-economic factors analysed as a determinant of the level of efficiency in local public service provision is population density (*dens_pop*). According to De Borger and Kerstens (1996), the degree of population concentration might influence the cost of providing certain public services, with cost inefficiency expected to increase where the population is more dispersed. Greater population concentration can make interrelated local services easier to manage and consume (Afonso and Fernandes, 2008) as they enjoy the cost advantages associated with agglomeration economies (Geys et al., 2010). Tang and Hewings (2017) observed that municipality mergers increase local economic development in China, although the magnitude of the effect depends on local endowments related to agglomeration forces. Therefore, the effects of mergers on local economic development may vary according to the initial density of cities.

The next socio-economic factor concerns citizens' incomes and wealth, which influence the incentives of both politicians and taxpayers to monitor expenditures (De Borger and Kerstens, 1996). We use two different determinants to measure the effect of citizens' wealth and the economic situation on local government performance: the unemployment rate (*unemp*) and per capita disposable income (*income*). Expected results for these two variables have been ambiguous in previous studies (Geys, 2006; Knack, 2002; Geys et al., 2010; Kalb et al., 2012).

Lastly, several studies have analysed how local government efficiency is affected by tourism (*tourism*). Seasonal population flows could affect the supply of local services. According to Seifert and Nieswand (2014), the extra costs of municipal services provided to non-residents may have a negative impact on budgets and expenditures. In this vein, Cruz and Marques (2014) suggest that larger populations in tourist seasons might require investment in additional infrastructure and services, which could negatively affect municipal budgets. It is also worth mentioning that there might be a greater demand for high-quality services in municipalities located in the most touristic regions (see, e.g. Kalb et al., 2012 and Kalb, 2014).

2.2.2. Political factors

The first political determinant analysed is the incumbent's ideology (*ideol*). The ideological effect on efficiency levels is not clearly defined in the previous literature and both predominant ideologies (right-wing and left-wing) have been associated with higher levels of efficiency depending on the context analysed (De Borger and Kerstens, 1996; Geys et al., 2010; Ashworth et al., 2014; Cruz and Marques, 2014). In addition, many studies have found insignificant or not highly robust relationships (Borge et al., 2008; Pérez-López et al., 2015).

Besides the political colour of the incumbent party, we analyse how the level of political competition in the council could affect local government performance, by using the Herfindahl index (*herf*). Note that the Herfindahl index takes values between 0 and 1, depending on the number of councillors from each party represented in the council, with higher values indicating a lower degree of political fragmentation and therefore a lower degree of competition or higher degree of political strength. On the one hand, according to Geys et al. (2010) and Kalb et al. (2012), electoral competition promotes efficiency or, put the other way, higher levels of political concentration reduce efficiency. On the other hand, the opposite relationship has been demonstrated by Revelli and Tovmo (2007), Borge et al. (2008), and Doumpos and Cohen (2014), who prove that political strength promotes municipal efficiency. A lower degree of political competition implies that resources are not wasted on negotiations that could weaken efficiency (Doumpos and Cohen, 2014) and it could be easier for a strong political leadership to impose strict budget constraint (Borge et al., 2008).

Finally, citizens' political participation might improve local government performance (De Borger et al., 1994). Active citizens who are socially and politically involved are expected to exert higher levels of supervision and pressure on government (Geys et al., 2010), thus giving politicians incentives to develop policies aimed at enhancing efficiency (Borge et al., 2008). Therefore, we use local voter turnout (*turnout*) as a measure of citizens' involvement and democratic participation, which is expected to reduce inefficiencies in the provision of local public services due to greater pressure on politicians to manage in a more efficient way (De Borger et al., 1994).

2.2.3. Budgetary factors

The group of budgetary variables begins with the level of tax revenues (*tax*). Previous evidence finds ambiguous results. For U.S. municipalities, Davis and Hayes (1993) found that higher taxes contribute positively to efficiency because taxpayers spend more time monitoring and controlling public management. However, when analysing other samples, evidence has also been found that the more easily local governments can obtain public revenues, the lower their efficiency levels. This is the case of Spanish municipalities (Balaguer-Coll et al., 2007), and Norwegian (Borge et al., 2008) and Belgian cities (Ashworth et al., 2014).

The effect of revenues from intergovernmental transfers (*grants*) on performance of local service provision has also been analysed, generally evidencing a direct relationship with inefficiency (De Borger and Kerstens, 1996; Balaguer-Coll and Prior, 2009; Kalb, 2014; Pérez-López et al., 2015). As in the case of tax revenues, there may be fewer incentives for efficient resource management when funds are generated more easily.

Debt levels (*debt*) are the last variable we study in relation to the budget balances. High debt levels could be representative of general bad management of resources (Revelli and Tovmo, 2007). Despite this, several studies have found that the provision of local public services does not significantly depend on debt levels (Revelli and Tovmo, 2007; Balaguer-Coll and Prior, 2009). On the one hand, local governments may be less able to perform efficiently because they have to channel more resources to interest and debt payments, which in turn may leave fewer funds available for providing municipal goods and services (Ashworth et al., 2014). On the other hand, it might be argued that high indebtedness can be the consequence of previous investments, which may contribute to better current performance.

Finally, we have included a variable that measures the number of presentation and execution mistakes in the budgetary statements (*mistake_budget*), as an indicator of a lack of or low quality of public resources (low-skilled staff, low technological resources, etc.). Balaguer-Coll and Prior (2009) observed that local authorities with a lack of resources have lower levels of efficiency. Thus, we expect that the higher the number of mistakes in the budgetary statements, the higher the levels of local inefficiency.

3. Data and variables

3.1. Sample selection

Our analysis is performed for a sample of Spanish local governments located in the Valencian Region. This region lies in the East of the country, and consists of 542 municipalities distributed in three provinces (Castellón, Valencia, Alicante). It is the eighth most extensive Spanish region and, with a population of 5,009,647 inhabitants[3], is the fourth most populous community in the country. The economy of the Valencian Region generates 9.5% of the Spanish GDP and is therefore the fourth of all the regions.

There are 15 cities with a population over 50,000 inhabitants for which data on the outputs required to measure efficiency are not available. Additionally, three municipalities did not present budgetary data in the year of the study (2011) and therefore it was not possible to obtain information about the inputs to estimate local performance. After removing those municipalities without information, our final database contains 524 municipalities.

3.2. Construction of the variable efficiency

In efficiency analysis, nonparametric approaches have been applied extensively in methods such as Data Envelopment Analysis (DEA) and the Free Disposable Hull (FDH)

[3] According to data from December 2011.

model, introduced by Charnes et al. (1978) and Deprins et al. (1984), respectively (Cazals et al., 2002). However, these techniques present two main disadvantages due to their deterministic nature (De Witte and Marques, 2010): they are highly sensitive to outliers and extreme values, since DEA and FDH estimators envelop all data points (Daouia and Simar, 2007) and they are also susceptible to measurement errors, because they assume the absence of statistical noise (De Witte and Marques, 2010). In response to these problems, the robust partial frontier deals with the presence of outliers by allowing the location of observations beyond the estimated efficiency frontier, as such a technique does not envelope all the data (creating the so-called super-efficiency estimation, see Simar and Wilson, 2008).

In comparison with the classic nonparametric methods (DEA and FDH), order-m estimations have two main advantages that signify a step forward: 1) the estimations are useful even in reduced samples (helping to overcome the problems caused by the curse of dimensionality, see Daraio and Simar, 2005); and 2) they serve to neutralise the impact of extreme observations or outliers.

The idea of order-m estimations is simple. Instead of considering the complete sample (as in DEA and FDH estimations), order-m generates a subsample of dimension m, which means that a specific unit can appear more efficient than the selected local frontier. As the efficiency scores will depend on the specific units that integrate the subsample m, a Monte Carlo process is followed to repeat the process a determined number of times (symbolised by the variable B, which usually takes the value of 2000). In sum, order-m models estimate 2000 efficiency scores by selecting B different subsamples to define the reference technology. Once concluded, the average of the efficiency scores is a representative approximation to the efficiency score, with a very limited influence of the potential outliers. Compared to the stochastic parametric approach, with order-m estimations there is no pre-requisite to define a specific mathematical form for the production function, and they are flexible to define a technology with several inputs used to produce several outputs.

For these reasons, we apply the robust order-*m* methodology, the partial or local approach that accepts the non-convex assumptions of FDH but without enveloping all the data (Cazals et al., 2002; Daouia and Simar, 2007), limiting the number of potential reference partners which constitute the frontier (De Witte and Marques, 2010). While FDH benchmarks a decision-making unit (DMU)[4] by the best performing unit in the whole sample, order-*m* obtains this benchmark by considering only a subsample of *m* peers.

The order-*m* approach can be oriented towards inputs, outputs, costs, revenues or profits. We chose the cost orientation, in a specific situation (when the input prices are unknown). The justification of this approach is based on the specific characteristics of local administration: it is appropriate to evaluate efficiency in terms of minimising costs, as outputs are either totally or partially determined externally. In addition, the assumption about cost minimisation behaviour is an acceptable choice, as the target to achieve on public sector organisms when output and input prices are unavailable (Cherchye et al., 2014). We can expect more demanding results from this orientation as three simultaneous conditions must be met to achieve cost efficient: input efficiency, allocative efficiency (operating with the optimal inputs mix), and price efficiency (having the capacity and/or ability to negotiate prices at their minimum levels).

Regarding output and cost indicators, we are aware of the difficulties in measuring the production process in the public sector (De Borger and Kerstens, 1996). Generally, limitations in the selection of outputs come from data restrictions and because we have to

[4] In the present study, local governments are the DMU.

adapt to publicly available information, we need to rely on proxy variables. To do that and in order to make comparison easier, we took into account previous studies based on other European local governments.

Hence, our selection of outputs reflects production variables (quantity) and we also introduce an indicator of quality, which is decisive in assessing municipal performance (Balaguer-Coll et al., 2007; Kalb, 2014). These data came from information gathered in the survey on local infrastructures and facilities (*Encuesta de Infraestucturas y Equipamientos Locales*-EIEL)[5] conducted by the Spanish Ministry of Finance and Public Administrations (*Ministerio de Finanzas y Administraciones Públicas*) [6] for municipalities with fewer than 50,000 inhabitants.

The outputs were selected based on the minimum services that local councils are required to provide. Spanish legislation[7] explicitly regulates these basic services based on population size. Table 1 gathers information on the minimum services that must be provided by each group of municipalities depending on their population size, as well as the output indicators to measure them.

[Insert Table 1]

When there was no clear output that allowed us to measure the service provided, we selected proxy variables. Consequently, while tons of waste collected is a clear direct output indicator for the waste collection service, there is no similar indicator in the case

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5 This survey has been used in previous related research (Balaguer-Coll et al. 2007, 2013; Benito, et al., 2014; Giménez and Prior, 2007; Zafra and Muñiz, 2010).

6 The information in the EIEL is prepared in accordance with the requirements of the harmonised methodology defined by the Ministry of Public Administrations. The acquisition and processing of data are carried out by technicians and experts, where there is strict control over the veracity of the data from each municipality so the EIEL reaches the required quality and fulfils the set objectives .

7 Law 7/1985 on the Foundations of the Local Government System (*Ley Reguladora de las Bases del Régimen Local*), article 26.

of, for instance, a public library; in this case, the total population was used as output.[8] Additionally, at least in the short term, local councils cannot directly influence the quantity of some outputs, but it might have a crucial impact on their quality (Balaguer-Coll et al., 2007). The survey on local infrastructures and facilities provides data on the quality of services, classified as "bad", "fair" or "good." Therefore, we constructed a weighted indicator of average quality and it was modelled as an additional output for each $i = 1, \ldots, n$ municipality as follows:

$$Quality\ (Y_i) = \frac{Y_{pi} \cdot Q_{ki}}{\sum_{i=1}^{n} Y_{pi}} \qquad (1)$$

where Y_i is the weighted total quality for the outputs of each municipality; Y_{pi} is the quantity of each output p, and Q_{ki} is the quality category, $k = 1, 2, 3$ (bad, fair or good, respectively)[9].

With reference to our cost indicators, following Balaguer-Coll et al. (2007, 2013), are based on budgetary variables reflecting municipality expenditures obtained from the Ministry of Finance and Public Administrations for the year of the study. Thus, our definition comprises current operating expenditures (wages and salaries, expenditures on goods and services, and current transfers) and capital expenditures (capital transfers and real investments). Table 2 reports descriptive statistics for the costs and output indicators selected to measure local government efficiency.

[Insert Table 2]

[8] Despite the possible controversy surrounding the use of number of inhabitants as an output of local production, it should be noted that it has been widely accepted in the literature, basically due to the lack of data on local services (Balaguer-Coll et al., 2013; De Borger and Kerstens, 1996).

[9] When we applied the proposal set out by Banker and Morey (1986), which involves breaking down the quality variable into two categorical variables, similar results were obtained.

The definition of efficiency (see the Appendix for a more detailed formalization of the methodological process), as well as that of the factors identified in section 2.2 as "traditional" determinants of efficiency, is presented in Table 3. In addition, the expected relationship of (in)efficiency levels with each variable (i.e. column "expected sign"), as well as the corresponding descriptive statistics (i.e. columns "mean" and "std. dev.") are presented.

[Insert Table 3]

4. Methodology

4.1. Model specification

In this paper, we run an Ordinary Least Squares (OLS) model in which our dependent variable, the index of (in)efficiency, takes lower values, the more efficient a local government is. Therefore, when we present the tables of results, we refer to it as efficiency index but, depending on the estimated coefficients obtained, we might provide the interpretation in terms of efficiency or inefficiency, depending on which one allows providing a higher intuition.[10] Our model specification can be expressed as follows:

$$\begin{aligned} efficiency_i = {} & \beta_0 + \beta_1\, dens\_pop_i + \beta_2\, unemp_i + \beta_3\, income_i + \beta_4\, tourism_i + \\ & +\beta_5\, ideol_i + \beta_6\, herf_i + \beta_7\, turnout_i + \\ & +\beta_8\, tax_i + \beta_9\, grants_i + \beta_{10}\, debt_i + \beta_{11}\, mistake\_budget_i + u_i \end{aligned} \quad (2)$$

where i denotes municipality; *efficiency* is the estimated local efficiency index, *dens_pop, unemp, income* and *tourism* are the socio-economic variables; *ideol*, *herf* and *turnout* are

[10] As we are working with the inverse of the Farrell-Debreu efficiency coefficient, positive signs of the estimated coefficients indicate higher inefficiency and negative signs higher efficiency.

the political variables; and *tax, grants, debt* and *mistake_budget* are the budgetary variables. Finally, u_i is the error term.

We introduce spatial interdependences in the econometric model of efficiency determinants specified above. The existence of spatial patterns in local government efficiency has been documented by Revelli and Tovmo (2007) and Geys (2006). While Revelli and Tovmo (2007) used Maximum Likelihood (ML) to estimate a model with spatial error autocorrelation, Geys (2006) estimated a spatial autoregressive model with both ML and Instrumental Variables (IV). As in Geys (2006), we will use IV in our spatial approach.

4.2. Modelling the spatial pattern

In Figure 1, we can see how municipalities shaded in darker orange, indicating higher levels of inefficiency, are generally near to those with similar colours. The same occurs with the lowest ratings of the efficiency score. This suggests the presence of a spatial pattern in our data.

[Insert Figure 1]

To detect the presence of spatial interactions between municipalities, we first need to specify our neighbourhood criteria, i.e. how neighbours are defined. The spatial weights matrix, generally referred as *W*, allows us to establish the degree of interdependence between each pair of municipalities (i, j) in our sample. In fact, Anselin (1988) pointed out that "the determination of the proper specification for the elements of this matrix, w_{ij}, is one of the more difficult and controversial methodological issues in spatial econometrics" (Anselin, 1988, p. 20). More recently, Plümper and Neumayer (2010) illustrate the importance of the specification of the weight matrix for the creation of the spatial effects.

In order to identify what the origin of the spatial interaction is, we use four different criteria for neighbourhood. First, we use geographical proximity, which is one of the most widely used definitions of neighbourhood in spatial interaction research. Examples in the field of expenditures or taxes include Solé-Ollé (2003), Šťastná (2009) and Delgado et al. (2015). In this study, we define neighbours as municipalities located within a distance of less than 20 km (W^{20km}). In this way, when the distance between municipalities i and j (d_{ij}) is less than 20 km, w_{ij} takes the value of 1 and 0 otherwise. Second, we introduce a scheme of inverse distance decay ($W^{invdist}$), so when d_{ij} is less than 20km, $w_{ij} = 1/d_{ij}$, (Cassette et al., 2012), and thus it gives more weight to those municipalities that are closer and that lie within the particular distance band (i.e. 20 km). Third, local authorities can be more influenced by the policies implemented by governments from the same political party (Revelli, 2006). Therefore, to control for party similarity we defined neighbourhood weighting by the ideology of incumbents (Solé-Ollé, 2003; Delgado et al., 2015), thereby giving more weight to municipalities located within a distance of 20 km and governed by the same ideology (W^{ideol}). In this way, w_{ij} equals 0 when d_{ij} is higher than 20 km; when d_{ij} is less than 20 km and municipalities i and j are controlled by parties from the same ideology, then w_{ij} equals 1, and if i and j are governed by different ideologies w_{ij} equals 0.5. Finally, in our last weight matrix (W^{pop}) we control for similarities in terms of population size (Solé-Ollé, 2003; Revelli and Tovmo, 2007) by giving stronger weights to neighbours that have more similarities in relation to their population size. To test the robustness of the results, we also constructed the same matrices changing the distance to 15, 25 and 30 km.[11] As usual, all spatial weight matrices are row-normalised, such that

[11] Results are not displayed since they were similar to those using the threshold of 20 km.

the elements of each row sum to one, thus facilitating the interpretation of the coefficients of the models (Anselin, 1988).

The next step is to determine the existence of spatial dependence in local efficiency levels in the Valencian Region. To this end, we use one of the most widely used tests, namely Moran's I statistic, to assess the correlation among neighbouring observations (Anselin, 1988; Boots and Getis, 1998). Specifically, we compute Moran's I test on municipal efficiency for the four previously defined specifications of the weight matrix. Our results show evidence in favour of rejecting the null hypothesis of no spatial autocorrelation (*p-value = 0.000*). Therefore, we empirically tested the need to include the spatial pattern and, more specifically, we detected the presence of a positive spatial autocorrelation (*I = 0.184; 0.209; 0.200; 0.276*). Nevertheless, because Moran's I statistic does not report where the spatial dependence is present, we ran additional tests that allow us to determine how the spatial pattern should be modelled. These tests, based on the Lagrange Multiplier (LM), are now explained and the results presented.

Spatial autocorrelation can be present in the endogenous variable (y) or in the error term (u), and even both kinds of spatial effects can be present. These models differ in how spatial dependence is included in the model. When the former occurs, we refer to the spatial autoregressive model (SAR or *spatial lag* model) and the spatially lagged dependent variable is included as an additional exogenous variable. It can be specified as follows:

$$y = \rho W y + X\beta + u \qquad (3)$$

$$u \sim N(0, \sigma^2 I)$$

where y is an $n \times 1$ vector of observations of the dependent variable; ρ is the spatial autoregressive parameter; W is a $n \times n$ spatial weight matrix; X is an $n \times k$ matrix of observations on the k exogenous variables with β being an associated $k \times 1$ regression coefficient vector; and u is a vector of error terms. Therefore, Wy is the spatial lag of the dependent variable and the spatial parameter ρ captures the spatial interactions among observations.

When the spatial effects are present in the error term, we refer to the spatial error model (SEM or *spatial error* model) as:

$$y = X\beta + u \qquad (4)$$

$$u = \lambda Wu + \varepsilon \qquad (5)$$

$$\varepsilon \sim N(0, \sigma^2 I)$$

where λ is the spatial error coefficient reflecting the intensity of interdependences, and ε is a vector of uncorrelated error terms.

Next, we select the specification that best incorporates the spatial pattern in our data. To select the spatial specification, we estimate our OLS model and then compute several tests based on the Lagrange Multiplier (LM). Specifically, *LM-lag* and *Robust LM-lag* detect the presence of spatial autocorrelation in the dependent variable, with ρ=0 being the null hypothesis and $\rho \neq 0$ is the alternative hypothesis. In addition to testing the presence of a spatially lagged dependent variable, the *LM-error* and *Robust LM-error* examine the existence of spatial error autocorrelation under the null hypothesis of λ=0, in contrast to the alternative $\lambda \neq 0$. Importantly, *Robust LM-lag* and *Robust LM-error* are so called because they are robust to the presence of the other sort of autocorrelation, i.e. to the existence of the alternative hypothesis of the other model.

Results obtained after computing the *LM* tests are similar for the four specifications of the spatial weight matrixes and reveal both a spatial pattern and the convenience of using a spatial lag model. [12] Specifically, the non-robust *LM* tests detect the presence of spatial autocorrelation both in the dependent variable (*spatial lag* model) and in the error term (*spatial error* model) since they are statistically significant. However, the robust test for spatial autocorrelation in the dependent variable (*Robust LM-lag*) remains highly significant, whereas that for spatial error dependence (*Robust LM-error*) is non-significant. Based on these findings, a SAR model (*spatial lag*) seems to be the most appropriate specification.[13]

5. Results

The first column of Table 4 shows the obtained results for the OLS specification, in which the goodness of fit, or R-squared, equals 39%.

[Insert Table 4]

We observe that none of the socio-economic variables shows a significant correlation with municipal efficiency. More specifically, results show that cost advantages associated with agglomeration economies are not exploited in this group of municipalities, as *dens_pop* is not statistically significant. The reason that this variable is not significant could be because the vast majority of municipalities are small and do not take advantage of economies of scale related to population size. These results are in line with Xu (2009), who finds that municipalities with a population between 3 and 4 million are more productive, suggesting that most cities are not big enough to exploit productivity advantages associated with agglomeration economies.

[12] Note that failure to include enough controls (or the right controls) in the right-hand side of the model is source of bias (see, e.g. Wooldridge, 2009; Angrist and Pischke, 2015). In the context of our research, an omitted variable bias (OVB) might exist if the spatial lag should be included in the model but is omitted in the OLS estimation.

[13] Our results reveal a spatial pattern when analysing the determinants of efficiency and the convenience of using a spatial lag model. To avoid a potential OVB, the SAR specification is preferred.

Additionally, non-significant results for unemployment (*unemp*) and income levels (*income*) are in line with the ambiguous results found in previous literature regarding wealth of citizens. And it also seems that seasonal population flows caused by tourism levels (*tourism*), which may affect the supply of municipal services, do not have a significant correlation with efficiency.

With reference to political variables, although incumbent ideology (*ideol*) does not correlate significantly with efficiency, the degree of political competition in the council (*herf*) presents a negative correlation with the efficiency index. This result coincides with those of Borge et al. (2008) and Doumpos and Cohen (2014), who find that political strength promotes municipal efficiency. According to these authors, the loss of resources in negotiations that could weaken efficiency is reduced due to the lower degree of political competition; additionally, a strict budget constraint can be easier to implement when political leadership is strong. However, not only political strength can be important; possible cooperation between political parties or the creation of coalitions[14] should also be considered as they may affect municipal management and therefore efficiency. In this line, Khrennikova (2016) analyses the conditions that favour cooperation over competition in political parties.

Finally, in this group of determinants, results show that a higher voter turnout rate in the municipal elections (*turnout*) implies higher inefficiencies. Although contrary to our expectations, this relationship has also been obtained recently by Cruz and Marques (2014) in their study of Portuguese municipalities.

[14] In this paper, we have not taken into account the possible coalitions between political parties due to lack of information.

Budgetary variables significantly correlate with local efficiency, with the exception of the variable of level of indebtedness (*debt*). We observe that efficiency decreases with tax (*tax*) and grants revenues (*grants*), as we find positive and significant estimated coefficients for these variables. According to our results, there may be fewer incentives for efficient resource management when funds are generated more easily. Our results for intergovernmental grants are similar to those of De Borger and Kerstens (1996), Balaguer-Coll et al. (2007), Kalb (2014) and Pérez-López et al. (2015). Following Silkman and Young (1982), grants might not only encourage local service provision, but also stimulate inefficiencies, as the cost of inefficient behaviour is increasingly shared by national or regional taxpayers. Additionally, and as occurs in Belgium, a large amount of the upper-level transfers are unconditional grants for current spending, implying little ex post control on actual spending (De Borger and Kerstens, 1996).

Regarding tax revenues, our results reveal that the higher voter awareness in monitoring public expenditure as tax levels increase worsens efficiency. An explanation for this result is that bureaucrats may prefer inputs that are more visible rather than less tangible ones, given that they are easier to justify in the production process (Lindsay, 1976). A classic example of this phenomenon is police cars, which are more visible than police training (Grosskopf and Hayes, 1993).

Finally, the estimated coefficient of the variable number of mistakes in the budgetary statements (*mistake_budget*) is positive and significant, showing that the higher the number of mistakes in the local budgetary statements, the higher the level of municipal inefficiency, in line with our expectations.

These results have been estimated using OLS. However, in the presence of a spatially lagged dependent variable (*Wy*), the OLS estimator is biased and inconsistent (Anselin, 1988). The presence of the spatial lag (*Wy*) is analogous to the existence of an endogenous variable on the right-hand side of the equation. To cope with this endogeneity, we use an IV approach.

In the IV framework, it is crucial the proper choice of the instruments. The set of instruments must satisfy two assumptions: they ($z_1, z_2, \ldots z_n$) are uncorrelated with the error term (u), i.e. $Cov(z, u) = 0$; and they are correlated with the endogenous independent variable (*Wy)*, i.e. $Cov(z, Wy) \neq 0$ (Wooldridge, 2009). As is usual in the related literature, to instrument *Wy* we take some of the spatially lagged explanatory variables (Kelejian and Robinson, 1993; Solé-Ollé, 2003, 2006; Geys, 2006; Foucault et al., 2008; Cassette et al., 2012; Goeminne and Smolders, 2014). Specifically, we introduce the spatially lagged exogenous variables that significantly affect municipal efficiency in the OLS regression, i.e. the level of political competition, voter turnout rate, taxes, grants, and reliability of budget statements. The *Hansen J* statistic shows the validity of the chosen instruments, as we are not able to reject the null hypothesis that the instruments are valid at 1% of significance (see last row of Table 4).

Columns 2-5 in Table 4 show the results after estimating the SAR model by applying IV. We report the results considering the four previously defined neighbourhood criteria, i.e. geographical, ideological, and size) in the four columns of this table (W^{20km}, $W^{invdist}$, W^{ideol}, W^{pop}). Results for socio-economic, political and budgetary variables that influence efficiency are similar to those previously reported when estimating by OLS. The coefficient of the spatial lag of the dependent variable (ρ), which specifically measures the degree of spatial interactions between neighbours and reflects the spatial dependence inherent in our data, is positive and statistically significant at the usual levels across the four columns. This direct relationship indicates that higher (in)efficiency scores in one local authority tend to be related to higher (in)efficiency levels in neighbouring municipalities. Additionally, we observe that the significance of the estimated coefficient for the spatial lag is lower when we control for similarities between the closest municipalities in terms of population size (W^{pop}), than in the case of W^{20km}, $W^{invdist}$, W^{ideol}. Interestingly, this analysis shows the importance of several channels of interdependence on local government efficiency: geographical and ideological proximity, as well as population similarity across municipalities.

Our results not only show that neighbouring local governments' efficiency influences municipalities' own local efficiency, but also identify several channels of interdependences. Finally, they confirm the robustness of the regression results obtained by OLS. Based on our findings, having efficient neighbours positively affects the municipality's own efficiency in local governments.

6. Conclusions

The present research studies the determinants of local government efficiency for the municipalities in the Valencian Region. At doing so, it considers whether spatial interdependence influences efficiency, that is, if efficiency in a municipality is influenced by neighbouring municipalities' efficiency. We focus on the Valencian Region because although it was heavily affected by the GFC, national legislation promoting municipal amalgamation or intermunicipal cooperation has not been substantially implemented in this region. The empirical analysis carried out is restricted to 524 Valencian municipalities with a population below 50,000 inhabitants. However, the findings could be extended to the rest of Spain because the competencies in the provision of services are the same. Further studies might analyse whether this conclusion holds for other countries. We learn that spatial interdependence matters for efficiency at municipal level, while the influence of "traditional" efficiency determinants is validated.

Results obtained in this paper show that the level of taxes and grant revenues negatively affect municipal efficiency. This indicates that there may be fewer incentives for efficient management when funds are easier to generate. Additionally, results report a direct relationship between municipal efficiency and the reliability of the budgetary statements. Political competition in the council promotes higher inefficiency. Finally, spatial interdependence is an important determinant of municipal efficiency levels. This is the most relevant insight: the level of efficiency of a municipality is positively affected by the efficiency of its neighbouring municipalities. With this finding, cooperation at municipal level acquires a new perspective that goes beyond merging neighbouring municipalities (municipal amalgamation) and reciprocal cooperation to provide service delivery between partners (intermunicipal cooperation). Municipalities might gain efficiency when a favourable network is created.

This study could help practitioners and policy makers to better understand those policy options that might work when external shocks affect the optimal delivery of public services. In addition to municipal amalgamation and intermunicipal cooperation, we have highlighted the existence of an additional channel for improving municipal efficiency scores, i.e. spatial interdependence. The convenience of considering spatial interdependences when analysing the determinants of municipal efficiency is a recommendation that could be extrapolated to other regions and countries.

References

Afonso, A. & Fernandes, S. (2008), 'Assessing and explaining the relative efficiency of local government', *The Journal of Socio-Economics,* 37(5), 1946-1979.

Alamá-Sabater, L.; Heid, B.; Jiménez-Fernández, E. & Márquez-Ramos, L. (2016), 'What drives interdependence of FDI among host countries? The role of geographic proximity and similarity in public debt'. *Economic Modelling,* 58, 466–474.

Álvarez, I. & Barbero, J. (2016), 'The public sector and convergence with spatial interdependence: empirical evidence from Spain', *Applied Economics*, 48(24), 2238-2252.

Allers, M. A. & Elhorst, J. P. (2011), 'A simultaneous equations model of fiscal policy interactions', *Journal of Regional Science,* 51(2), 271-291.

Angrist, J. D. & Pischke, J-S. (2015), *Mastering 'Metrics. The Path from Cause to Effect*. Princeton University Press.

Anselin, L. (1988), *Spatial Econometrics: Methods and Models*. Dordrecht: Kluwer Academic Publishers.

Ashworth, J.; Geys, B.; Heyndels, B. & Wille, F. (2014), 'Competition in the political arena and local government performance', *Applied Economics,* 46(19), 2264-2276.

Balaguer-Coll, M. T. & Prior, D. (2009), 'Short- and long-term evaluation of efficiency and quality. An application to Spanish municipalities', *Applied Economics,* 41(23), 2991-3002.

Balaguer-Coll, M. T.; Prior, D. & Tortosa-Ausina, E. (2007), 'On the determinants of local government performance: A two-stage nonparametric approach', *European Economic Review,* 51(2), 425-451.

Balaguer-Coll, M. T.; Prior, D. & Tortosa-Ausina, E. (2013), 'Output complexity, environmental conditions, and the efficiency of municipalities', *Journal of Productivity Analysis,* 39(3), 303-324.

Banker, R. D. & Morey, R. C. (1986), 'The use of categorical variables in Data Envelopment Analysis', *Management Science*, 32, 1613–1627.

Benito, B.; Solana, J. & Moreno, M.R. (2014), 'Explaining efficiency in municipal services providers', *Journal of Productivity Analysis*, 42 (3), 225–239.

Boots B. N. & Getis, A. (1998), *Point pattern analysis*. Scientific Geography Series. California, CA: Sage Publications.

Borge, L. -E.; Falch, T. & Tovmo, P. (2008), 'Public sector efficiency: The roles of political and budgetary institutions, fiscal capacity, and democratic participation', *Public Choice,* 136(3-4), 475-495.

Borck, R.; Fossen, F. M.; Freier, R. & Martin, T. (2015), 'Race to the debt trap?-Spatial econometric evidence on debt in German municipalities', *Regional Science and Urban Economics,* 53, 20-37.

Bosch, N.; Espasa, M. & Mora, T. (2012), 'Citizen control and the efficiency of local public services', *Environment and Planning C: Government and Policy,* 30(2), 248-266.

Bosch, N.; Pedraja, F. & Suárez-Pandiello, J. (2000), 'Measuring the efficiency of Spanish municipal refuse collection services', *Local Government Studies,* 26(3), 71-90.

Brueckner, J. K. (2003), 'Strategic interaction among governments: An overview of empirical studies', *International Regional Science Review,* 26(2), 175-188.

Cassette, A.; Di Porto, E. & Foremny, D. (2012), 'Strategic fiscal interaction across borders: Evidence from French and German local governments along the Rhine Valley', *Journal of Urban Economics,* 72(1), 17-30.

Cazals, C.; Florens, J.-P. & Simar, L. (2002), 'Nonparametric frontier estimation: A robust approach', *Journal of Econometrics,* 106(1), 1-25.

Charnes, A.; Cooper, W. W. & Rhodes, E. (1978), 'Measuring the efficiency of decision-making units', *European Journal of Operational Research,* 2(6), 429-444.

Cherchye, L.; Demuynck, T.; De Rock, B. & De Witte, K. (2014), 'Non-parametric analysis of multi-output production with joint inputs', *The Economic Journal,* 124(577), 735-775.

Cruz, N. F. & Marques, R. C. (2014), 'Revisiting the determinants of local government performance', *Omega,* 44, 91-103.

Daouia, A. & Simar, L. (2007), 'Nonparametric efficiency analysis: A multivariate conditional quantile approach', *Journal of Econometrics,* 140(2), 375-400.

Daraio, C. & Simar, L. (2005), 'Introducing environmental variables in nonparametric frontier models: A probabilistic approach', *Journal of Productivity Analysis,* 24(1), 93-121.

Bastida, F.; Guillamón, M. D. & Benito, B. (2013), 'Municipal spending in Spain: Spatial approach', *Journal of Urban Planning and Development*, 139(2), 79-93.

Davis, M. L. & Hayes, K. (1993), 'The demand for good government', *The Review of Economics and Statistics,* 75(1), 148-152.

De Borger, B. & Kerstens, K. (1996), 'Cost efficiency of Belgian local governments: A comparative analysis of FDH, DEA, and econometric approaches', *Regional Science and Urban Economics,* 26(2), 145-170.

De Borger, B.; Kerstens, K.; Moesen, W. & Vanneste, J. (1994), 'Explaining differences in productive efficiency: An application to Belgian municipalities', *Public Choice,* 80(3-4), 339-358.

De Witte, K. & Geys, B. (2013), 'Citizen coproduction and efficient public good provision: Theory and evidence from local public libraries', *European Journal of Operational Research,* 224(3), 592-602.

De Witte, K. & Marques, R. C. (2010), 'Influential observations in frontier models, a robust non-oriented approach to the water sector', *Annals of Operations Research,* 181(1), 377-392.

Delgado, F. J.; Lago-Peñas, S. & Mayor, M. (2015), 'On the determinants of local tax rates: New evidence from Spain', *Contemporary Economic Policy,* 33(2), 351-368.

Delgado, F. J. & Mayor, M. (2011), 'Tax mimicking among local governments: some evidence from Spanish municipalities', *Portuguese Economic Journal,* 10(2), 149-164.

Deprins, D.; Simar, L. & Tulkens, H. (1984), Measuring labor efficiency in post offices. In M. Marchand; P. Pestieau & H. Tulkens (Eds.), *The Performance of Public Enterprises: Concepts and Measurement* (pp. 243--267). Amsterdam: North-Holland.

Doumpos, M. & Cohen, S. (2014), 'Applying data envelopment analysis on accounting data to assess and optimize the efficiency of Greek local governments', *Omega,* 46, 74-85.

Ermini, B. & Santolini, R. (2010), 'Local expenditure interaction in Italian municipalities: ¿Do local council partnerships make a difference', *Local Government Studies*, 36(5), 655-677.

Ferraresi, M. Migali, G & Rizzo, L. (2018), 'Does intermunicipal cooperation promote efficiency gains? Evidence from Italian municipal unions'. *Journal of Regional Science.* DOI: 10.1111/jors.12388.

Foucault, M.; Madies, T. & Paty, S. (2008), 'Public spending interactions and local politics. Empirical evidence from French municipalities', *Public Choice,* 137(1-2), 57-80.

Geys, B. (2006), 'Looking across borders: A test of spatial policy interdependence using local government efficiency ratings', *Journal of Urban Economics,* 60(3), 443-462.

Geys, B.; Heinemann, F. & Kalb, A. (2010), 'Voter involvement, fiscal autonomy and public sector efficiency: Evidence from German municipalities', *European Journal of Political Economy,* 26(2), 265-278.

Giménez, V. & Prior, D. (2007), 'Long- and Short-Term Cost Efficiency Frontier Evaluation: Evidence from Spanish Local Governments', *Fiscal Studies*, 28 (1), 121–139.

Goeminne, S. & Smolders, C. (2014), 'Politics and public infrastructure investments in local governments: Empirical evidence from Flemish municipalities (1996–2009)', *Local Government Studies,* 40(2), 182--202.

Grosskopf, S. & Hayes, K. (1993), 'Local public sector bureaucrats and their input choices', *Journal of Urban Economics,* 33(2), 151-166.

IVIE- Instituto Valenciano de Investigaciones Económicas (2017), 'Insuficiencia de recursos para servicios públicos fundamentales'. *Papeles de Financiación Autonómica* n. 2, November 2017.

Kalb, A. (2014), 'What determines local governments' cost-efficiency? The case of road maintenance', *Regional Studies,* 48(9), 1483-1498.

Kalb, A.; Geys, B. & Heinemann, F. (2012), 'Value for money? German local government efficiency in a comparative perspective', *Applied Economics,* 44(2), 201-218.

Kelejian, H. H. & Robinson, D. P. (1993), 'A suggested method of estimation for spatial interdependent models with autocorrelated errors, and an application to a county expenditure model', *Papers in Regional Science,* 72(3), 297-312.

Knack, S. (2002), 'Social capital and the quality of government: Evidence from the States', *American Journal of Political Science,* 46(4), 772-785.

Khrennikova, P. (2016), 'Quantum dynamical modeling of competition and cooperation between political parties: The coalition and non-coalition equilibrium model'. *Journal of Mathematical Psychology,* 71, 39-50.

Kopczewska, K.; Kudła, J.; Walczyk, K.; Kruszewski, R. & Kocia, A. (2016), 'Spillover effects of taxes on government debt: a spatial panel approach', *Policy Studies,* 37(3), 274-293.

Lindsay, C. M. (1976), 'A theory of government enterprise', *Journal of Political Economy,* 84(5), 1061-1077.

López, F. A., Martínez-Ortiz, P. J. & Cegarra-Navarro, J. G. (2017), 'Spatial spillovers in public expenditure on a municipal level in Spain', *The Annals of Regional Science*, *58*(1), 39-65.

Ndiaye, Y. (2018), 'Road tax interactions among local governments: a spatial panel data analysis of the French case over the period 1984-2000', *Applied Economics*, DOI: 10.1080/00036846.2018.1441518

Pan, F., Zhang, F., Zhu, S. & Wójcik, D. (2017), 'Developing by borrowing? Inter-jurisdictional competition, land finance and local debt accumulation in China', *Urban Studies*, 54(4), 897-916.

Pérez-López, G.; Prior, D. & Zafra-Gómez, J. L. (2015), 'Rethinking new public management delivery forms and efficiency: Long-term effects in Spanish local government', *Journal of Public Administration Research and Theory*, 25 (4): 1157-1183.

Plümper, T. & Neumayer, E. (2010). 'Model specification in the analysis of spatial dependence', *European Journal of Political Research*, 49, 418-442.

Prado Lorenzo, J. M. & García Sánchez, I. M. (2007), 'Efficiency evaluation in municipal services: an application to the street lighting service in Spain', *Journal of Productivity Analysis,* 27(3), 149-162.

Reingewertz, Y. (2012), 'Do municipal amalgamations work? Evidence from municipalities in Israel', *Journal of Urban Economics*, 72, 240-251.

Revelli, F. (2005), 'On spatial public finance empirics', *International Tax and Public Finance,* 12(4), 475-492.

Revelli, F. (2006), 'Performance rating and yardstick competition in social service provision', *Journal of Public Economics,* 90(3), 459-475.

Revelli, F. & Tovmo, P. (2007), 'Revealed yardstick competition: Local government efficiency patterns in Norway', *Journal of Urban Economics,* 62(1), 121-134.

Rios, V., Pascual, P. & Cabases, F. (2017), 'What drives local government spending in Spain? A dynamic spatial panel approach', *Spatial Economic Analysis*, 12(2-3), 230-250.

Seifert, S. & Nieswand, M. (2014), 'What drives intermediate local governments' spending efficiency: The case of French Départements', *Local Government Studies,* 40(5), 766-790.

Silkman, R. & Young, D. R. (1982), 'X-efficiency and state formula grants', *National Tax Journal,* 35(3), 383-397.

Simar, L. & Wilson, P. W. (2008), Statistical inference in nonparametric frontier models: Recent developments and perspectives. In H. O. Fried; C. A. Knox Lovell & S. S. Schmidt (Eds.), *The Measurement of Productive Efficiency and Productivity Growth* (pp. 421--521). New York: Oxford University Press.

Solé-Ollé, A. (2003), 'Electoral accountability and tax mimicking: the effects of electoral margins, coalition government, and ideology', *European Journal of Political Economy,* 19(4), 685-713.

Solé-Ollé, A. (2006), 'Expenditure spillovers and fiscal interactions: Empirical evidence from local governments in Spain', *Journal of Urban Economics,* 59(1), 32-53.

Šťastná, L. (2009), 'Spatial interdependence of local public expenditures: Selected evidence from the Czech Republic', *Czech Economic Review,* 3(1), 7-25.

Tang, W. and Hewings, G.J.D. (2017),'Do city–county mergers in China promote local economic development?' *Economics of Transition*, 25(3), 439–469.

Tobler, W. R. (1970), 'A computer movie simulating urban growth in the Detroit region', *Economic Geography*, 46, 234-240.

Wooldridge, J. M. (2009), *Introductory Econometrics: A Modern Approach*. Mason, OH: Cengage Learning.

Zafra-Gómez, & Muñiz Perez, M.A. (2010), 'Overcoming cost-inefficiencies within small municipalities: improve financial condition or reduce the quality of public services? *Environment and Planning C: Government and Policy*,28, 609 -629.

APPENDIX. Robust Non-parametric Efficiency Estimations

The basic ideas of this estimation are taken from Daraio and Simar (2005). We therefore use the same notation in order to avoid potential confusion.

Let us define the variables we work with. We consider a production technology where the activity of the municipalities (the decision making units, DMUs) is characterised by a set of inputs $x \in R_+^p$ used to produce a set of outputs $y \in R_+^q$. In this framework, the production set is defined as:

$$\Psi = \{ (x, y) \in R_+^{p+q} \mid \text{x can produce y}\} \quad (1)$$

As Daraio and Simar (2005, p. 97) suggest "the order-m frontier corresponds to another definition of the benchmark against which units will be compared". Under the assumption of free disposability, for each observation (x, y) the Debreu-Farrell output efficiency score can be defined by:

$$\theta\,(x, y) = inf\ \{\theta \mid (\theta x \mid y) \in \Psi\} \quad (2)$$

where the efficient frontier corresponds to those DMUs where $\theta\,(x, y) = 1$.

Thus, for a given level of outputs $y \in Y$ consider *m* i.i.d. random variables X_i, $i = 1, \ldots, m$, and define the output set:

$$\Psi_m(y) = \left\{(x, y')\mathbb{R}_+^{p+q} \mid X_i \leq x, y' \leq y, i = 1, \ldots, m\right\} \quad (3)$$

Here we fix the value of *m* depending on the number of DMUs to be declared outliers. To do that, we apply the 5% rule (in other words, this implies that m should be chosen by considering that 5% of the DMUs have better performance than the reference technology).

Then, for any *y*, we can define:

$$\widetilde{\theta}_m(x, y) = min\ \{\theta \mid (\theta x \mid y) \in \ \Psi\} = \max_{i=1,\ldots,m} \{ \min_{j=1,\ldots,q} (\frac{x^j}{X_i^j})\}$$
(4)

For any $x \in R_+^p$, the order-*m* input efficiency score is defined as (Daraio and Simar, 2005, 99):

$$\theta_m(x, y) = E\left(\widetilde{\theta}_m\,(x, y) \mid Y \geq y\right) \quad (5)$$

In order to make this efficiency score robust, it is necessary to apply a Monte-Carlo algorithm (proposed in Cazals et al., 2002; and applied in Daraio and Simar, 2005). Thus, we redo the process *B* times. The algorithm will be as follows:

1. Compute equation (4) considering all the output and input variables of the chosen m DMUs to determine the cost efficiency score $\widetilde{\theta}_m$. This coefficient represents the radial –proportional– reduction that can be made in all the inputs (in our case the total cost) while maintaining the level of the observed outputs.
2. Redo step 1 for *b* = 1,…, *B* and estimate the *B* efficiency scores $\tilde{\theta}_m^b\,(x, y)$.
3. Finally, determine the average cost efficiency score $\hat{\theta}_m\,(x, y) \approx \frac{1}{B}\sum_{b=1}^{B} \tilde{\theta}_m^b\,(x, y)$

It is worth mentioning that for a big value of m or when $m \to \infty$ the order-*m* efficiency score will converge with FDH scores. Additionally, the following considerations should be taken into account: firstly, the quality of the approximation can be tuned by increasing *B*, and in most applications $B > 500$ seems to be a reasonable choice (Balaguer-Coll et al., 2013) although, depending on the sample size, B can be sufficiently large when $B = 2{,}000$ (De Witte and Geys, 2013). In the present study, the order-m methodology is applied considering $B = 2{,}000$. Secondly, according to Daraio and Simar (2005) the size of m is the value for which the percentage of superefficient DMUs decreases marginally with an increase in m. Concretely, to determine the value of m, the efficiency scores are computed for different values ($m = 50, 100, \ldots 300$). It was found that from $m = 200$ the results were very stable, as the percentage of superefficient observations declined only marginally with m. Thirdly, in the present study the application of the order-m methodology follows a distance function total cost or input orientation estimation (just the inverse of the Debreu-Farrell efficiency coefficient of equation 2) such that superefficient (inefficient) DMUs obtain efficiency scores below (above) 1.