



**HAL**  
open science

## **Municipal efficiency spillovers in France**

Juan Piedra-Peña, Marie-Laure Breuillé, Julie Le Gallo

► **To cite this version:**

Juan Piedra-Peña, Marie-Laure Breuillé, Julie Le Gallo. Municipal efficiency spillovers in France. *Annals of Regional Science*, 2024, 73 (4), pp.2143-2172. <10.1007/s00168-024-01326-6>. <hal-04849026>

**HAL Id: hal-04849026**

**<https://institut-agro-dijon.hal.science/hal-04849026v1>**

Submitted on 19 Dec 2024

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire HAL, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



Distributed under a Creative Commons CC BY 4.0 - Attribution - International License



# Municipal efficiency spillovers in France

Juan Piedra-Peña<sup>1,2</sup> · Marie-Laure Breuillé<sup>2</sup> · Julie Le Gallo<sup>2</sup>

Received: 4 April 2023 / Accepted: 29 September 2024 / Published online: 11 November 2024  
© The Author(s) 2024

## Abstract

This paper provides evidence of the role of efficiency spillovers between French municipalities assessed through four levels of municipal equipment. We investigate changes in municipal efficiency for both cities possessing a certain level of public goods and cities located closer to those hosting high-rank functions. Based on a cross-sectional database pertaining to French municipalities with over 3500 inhabitants in 2018, we develop a two-stage approach. In the first stage, we estimate municipal efficiency through a robust order- $m$  approach, while in the second stage, we run a truncated bootstrapped regression to disentangle the effect of the distance of an observed municipality to each of the four equipment levels. Our results provide evidence of efficiency spillovers where the less-endowed municipalities benefit the most from higher efficiency due to their geographical proximity to larger equipment centers.

**JEL Classification** C14 · C21 · H21 · R10

## 1 Introduction

The French government is currently planning to set a target limiting the increase of current sub-national expenditure to the forecast inflation rate minus 0.5 percentage points. This measure may affect around 500 French sub-national jurisdictions (regions, *départements*, municipalities, and their intermunicipal groups), whose expenditure amounted to some 40 million euros in 2021. “Agreements to return to

---

✉ Juan Piedra-Peña  
juanandres.piedra@uab.cat

Marie-Laure Breuillé  
marie.breuille@inrae.fr

Julie Le Gallo  
julie.le-gallo@institut-agro.fr

<sup>1</sup> Universitat Autònoma de Barcelona, Barcelona, Spain

<sup>2</sup> CESAER UMR1041, INRAE, Institut Agro, Université Bourgogne Franche-Comté, Dijon, France

the trajectory” could be signed between the prefect (i.e., the representative of the State at the *département* level) and non-compliant local jurisdictions to ensure financial recovery. With this measure, the French government would put increasing pressure on sub-national jurisdictions to improve efficiency in the provision of public goods and services. However, no tool currently exists in France to measure the cost and, even less, the efficiency of local public expenditure. After the “yellow vests” crisis in 2018–2019, which expressed the profound disillusionment of a cross section of taxpayers, a report written for the French government in early 2019 put forward the idea of sending a fictitious and personalized “bill” to every citizen detailing the cost of the public services and amenities from which they benefit, so that “everyone becomes aware of the way their taxes are used”. However, the conclusions of the report remained in the drawers of the ministry concerned. Today, the proposed “Agreements to return to the trajectory” once again place the efficiency of local public expenditure under the spotlight, which needs to be measured and explained given the large heterogeneity of profiles of sub-national jurisdictions in France and their unequal distribution over the territory.

In this paper, we define as efficient those municipalities that are able to minimize the use of their resources (or inputs) in order to provide a given set of services (or outputs). We exploit a cross-sectional database of the 2955 French municipalities with more than 3500 inhabitants in 2018, and we determine whether municipalities that are located closer to highly equipped centers (that is, groups of neighboring municipalities that host high-rank functions) present higher performance. In this sense, municipalities that belong to the less-equipped centers can ‘borrow functions’ from their high-rank neighbors, which can be translated into fewer expenditures for their localities and increase municipal efficiency.

We thus draw on the growing city network theory (Capello 1996, 2000) and consider externalities as the benefits derived from the agglomeration effects of bigger, more diverse cities that spill over to their closest neighbors (Fingleton 2003; McCann and Acs 2011).<sup>1</sup> Cities that interact with each other may benefit from horizontal functional relationships, which may, in turn, create synergies and complementarities between them. These interactions may come in the form of agglomeration externalities and network externalities. The concept of network externalities was proposed by Capello (1996, 2000) to understand the benefits associated with intercity interactions, where connections between cities go beyond physical distance, e.g., they may be channeled by transport costs and times, information networks, etc. The distinction between agglomeration and network externalities lies in the fact that the former attenuates with geographical distance (van Meeteren et al. 2016). In this paper, we specifically focus on the efficiency spillovers coming from agglomeration: we consider that agglomeration effects might not be limited to the boundaries of a city but can spill over to surrounding ones (Camagni et al. 2016) leading to an extended spatial extent of agglomeration externalities. Hence, through these externalities, the efficiency advantages stemming from the agglomeration effects of larger cities can also be shared by other neighboring small and medium-sized ones. The

<sup>1</sup> Hereinafter, we use spillovers and externalities in the same manner.

concept that helps to explain the mechanisms of this interaction is known in the literature as 'borrowed size' (Alonso 1973). The intuition behind this concept lies in the fact that smaller cities can 'borrow' some of the agglomeration benefits of their neighbors while avoiding agglomeration costs (Camagni et al. 2016; Burger et al. 2015). In the words of Alonso (1973, p. 200), "*people can use the shopping and entertainment facilities of other cities to complement their own, businessmen can share such facilities as warehousing and business services, and labor markets enjoy a wider and more flexible range of demand and supply*". Thus, given these interdependencies, smaller cities can 'borrow size' and host functions they could not have hosted otherwise (Burger et al. 2015).<sup>2</sup>

In this framework, Camagni et al. (2016) claim that it is necessary to distinguish the effects of population from the effects of functions, conflated in the concept of 'borrowed size'. On the one hand, 'borrowed size' may refer to the potential advantages to the population derived from a pooled and diversified labor supply, a larger market of final goods, and population spillovers from large cities. The effect of 'borrowed size' is expected to be bigger for larger cities which are more capable of exploiting large markets for their firms. On the other hand, 'borrowed function' comes with the accessibility of high-level functions yielding advantages that come from wider labor demand, more accessibility of services, and spatial spillovers of functions from larger cities. In this case, the effect is expected to be more beneficial for small cities, which have lower endowment of high-rank functions but can 'borrow' them from stronger neighboring cities.

Consequently, if particular functions can be 'borrowed' from other cities in the same regional context, then there is not necessarily a relationship between the size of a city and the function it fulfills (Meijers 2007). Therefore, the efficiency benefits derived from agglomeration do not necessarily have to be linked to urban size, but rather to the availability of higher-order functions and the physical proximity to the places that account for them (so as to benefit from spillovers). The importance of paying close attention to urban efficiency and potential spillovers is straightforward for policy-making: if such externalities are found, national or local authorities may enhance regional performance by concentrating their public resources in cities with a higher endowment of high-rank functions and exploit agglomeration economies that can spill over to their neighbors. As a result, this increase in efficiency may translate into higher growth with less use of resources, creating savings on the public budget. It is here where local governments play a key role as the main suppliers of goods and services in many developed economies, where the effective use of their resources can drive regional performance in the aforementioned way.

Unlike other economies, European countries follow a different pattern of urbanization with more than half of the population living in small and medium-sized municipalities which in many cases grow faster than large cities and show slow rates of urban growth (Meijers et al. 2016). These cities are also located in close

---

<sup>2</sup> We refer to the urban production functions, which in turn can be analyzed in the context of classical industrial production or the production of different services like education, health, etc. In this sense, we can expect large cities to be structurally different and host higher-rank functions than small ones.

proximity and well-connected through infrastructure, thus having the potential for further integration (Boussauw et al. 2018). In this context, it is valid to think that efficiency spillovers could arise from an effect of 'borrowed functions': If citizens are using public services provided by their neighbors, this entails less expenditure for their corresponding municipalities which can translate into more efficiency. Moreover, taking into consideration that these externalities attenuate with distance (van Meeteren et al. 2016; Burger and Meijers 2016), we can expect stronger efficiency gains for municipalities located closer to those where high-rank functions are concentrated. To capture the level of metropolitan functions, we follow an approach similar to that of Burger et al. (2015), which uses the level of amenities estimated in a country amenity index. Meijers et al. (2016) also follow a similar strategy by accounting for the domains of international, science, firms, culture, and sports institutions. In this paper, we leverage the novel work of Hilal et al. (2020) who classify French municipalities according to four levels of equipment (infrastructure and facilities) and service centers, with the highest one being the best-endowed. These centers are local, intermediate, structuring, and major equipment centers.<sup>3</sup> Following the intuition mentioned above, given the indivisibilities and synergies that give rise to agglomeration economies in more diverse municipalities, we can expect that major equipment centers show higher levels of efficiency and hence, through agglomeration externalities, this efficiency spills over to closer municipalities.

Clearly, this approach potentially affects the efficiency of any (public) production sector, which requires that we observe efficiency in an "overall" or "global" manner. In this sense, we can thus interpret municipal (urban) efficiency as how local governments use their resources (or expenditures) to provide a given set of services and infrastructures. In this context, there is a second strand of literature that relies on production theory to address municipal spending efficiency through the estimation of a single efficiency value that represents the evaluation of different services provided by the same municipality (Giménez and Prior 2007) as well as a general view of how local governments are managing and adapting to their multiple tasks (Kalb et al. 2012).

The methodologies commonly used to estimate efficiency can be differentiated depending on the methodology: parametric and non-parametric. Most studies analyzing efficiency from a global perspective make use of non-parametric techniques (Narbón-Perpiñá et al. 2018a), mainly Data Envelopment Analysis (DEA) and Free Disposal Hull (FDH).<sup>4</sup> Their main advantages over parametric methods are that they do not require an assumption of the functional form of the production function, and they can take multiple inputs and outputs to estimate the efficiency score based on optimization methods, which provides more simplicity and versatility (Balguer-Coll and Prior 2009). The main difference between DEA and FDH lies in the

<sup>3</sup> The infrastructure and facilities delivered in all equipment centers are almost integrally financed by the respective municipalities.

<sup>4</sup> However, parametric approaches mostly rely on Stochastic Frontier Analysis (SFA). Studies that evaluate the efficiency of local governments using SFA techniques include De Borger and Kerstens (1996); Geys et al. (2010); Kalb (2010) and Kalb et al. (2012).

technology assumption: DEA assumes a convex technology, and conversely, FDH assumes a non-convex one. The non-convexity assumption of FDH makes it particularly stringent with regard to inefficiency measurements and particularly suited for detecting the most obvious cases of inefficiency (Balaguer-Coll et al. 2013).<sup>5</sup>

However, these methods present a limitation in relation to their sensitivity to outliers and extreme values, given that they envelop all decision-making units (DMUs) in order to estimate the efficiency frontier.<sup>6</sup> To deal with the presence of outliers, Cazals et al. (2002) suggest the use of partial frontiers, which do not envelop all the data but only a subset and are more robust to extreme observations and outliers. More precisely, they introduce the so-called order- $m$  approach, which offers two main advantages over DEA and FDH: (1) estimations are robust, even in reduced samples, which helps to overcome the *curse of dimensionality* (Daraio and Simar 2005); and (2) they mitigate the impact of extreme observations and outliers.

Our paper's contribution to advancing research into these issues can be identified in three key areas.

Firstly, we aim to fill the gap in the literature and address municipal spending efficiency for French municipalities. Contrary to the wide range of studies that focus on the analysis of local government spending efficiency and its determinants for different European countries (see Narbón-Perpiñá et al. (2018a) and Narbón-Perpiñá and De Witte (2018b) for a review), the literature addressing these issues in the French case is scarce. To our knowledge, there is only one published paper that studies the determinants of the efficiency of French local government through a two-stage approach (Seifert and Nieswand 2014). More recently, Ayouba et al. (2023) also dealt with this question using a conditional efficiency measurement approach. However, both of these papers consider the case of French *départements*, a middle-tier local government, while French municipalities, the lowest tier, have not as yet been the focus of attention.

Secondly, while the literature focuses on the impact of agglomeration externalities on productivity or another related outcome, we focus on spending efficiency, thus providing a link between local public economics and urban economics.

Thirdly, from a methodological viewpoint, we provide empirical support to our environmental variables by means of a separability test. Local governments operate under heterogeneous contexts in terms of social, demographic, economic, political, and geographic characteristics, which creates the necessity to account for the effect of contextual (or environmental) variables and their impact on spending efficiency. Different ways to address this issue have been proposed in the literature. Within the non-parametric field, the most common approach is to carry out a two-stage analysis. In this approach, the first stage calculates the efficiency scores, which are regressed with a set of contextual variables in the second stage using Ordinary Least Squares (OLS), Tobit, or bootstrapped truncated models (e.g., Balaguer-Coll et al.

<sup>5</sup> In a convex technology, one observation can be determined as inefficient. Nonetheless, it may be the case that the inefficiency coefficient depends entirely on the assumption of convexity.

<sup>6</sup> We call a DMU any unit of analysis such as individuals, departments, firms, or in the case of our study, municipalities.

2007; Benito et al. 2010; Bosch et al. 2012; lo Storto 2016; Pérez-López et al. 2015). A number of other studies have applied alternative approaches such as meta-frontier (Balaguer-Coll et al. 2013), quantile regressions, (Narbón-Perpiñá et al. 2020) or conditional efficiency models (Cordero et al. 2017, 2020). Furthermore, the contextual variables included in the second stage are usually assumed to only influence the distribution of efficiency but not the production process itself. This assumption is commonly known as the separability condition (see Simar and Wilson 2007). However, the lack of proper empirical testing for this assumption has led studies to rely on alternative approaches or economic theory to assume this condition *a priori*. We contribute to the literature by applying recent separability tests introduced by Daraio et al. (2018) and Simar and Wilson (2020) to empirically support the introduction of contextual variables that comply with this assumption.

Our findings show that major equipment centers are in fact outperforming other municipalities, while externalities appear in the form of higher efficiency for those local centers that are located closer to major ones. Our results are consistent with the theory that less-endowed municipalities are 'borrowing functions' from stronger neighbors that allow them to host functions that they would not have been able to host in isolation. By 'borrowing' these functions, local governments are able to save on expenditure and increase their efficiency. However, this effect decays quickly with distance.

The remainder of this paper is organized as follows: Sect. 2 introduces the institutional context of French municipalities and equipment centers. Section 3 describes our two-stage strategy and Sect. 4 presents the data. The results and main conclusions are presented in Sect. 5 and Sect. 6, respectively.

## 2 French context

### 2.1 Institutional context

France is a relatively decentralized country with three constitutional levels of sub-national jurisdiction: regions, departments, and municipalities. There are almost 35,000 municipalities in France and 50% of them are relatively small in population size (i.e., less than 500 inhabitants). Given this acute territorial fragmentation, inter-municipal cooperation has become a key instrument of planning.

The evolution of intermunicipal cooperation can be identified in successive waves. The first wave dates back to the law of 22 March 1890, establishing single-purpose associations to manage single public services (such as water distribution or waste management). However, it became more widespread and more integrated since the "Chevènement Law" dated 12 July 1999 that strengthened and simplified intermunicipal cooperation by restructuring it into three types of Establishments for Inter-Municipal Cooperation (hereafter, EIMCs) with their own tax sources: urban communities, communities of agglomeration, and communities of municipalities (Breuillé et al. 2018; Breuillé and Duran-Vigneron 2023). The "RCT law" published on 16 December 2010 completed the intermunicipal map by requiring each municipality to join an EIMC by 2013 and created the status of metropole (reinforced by

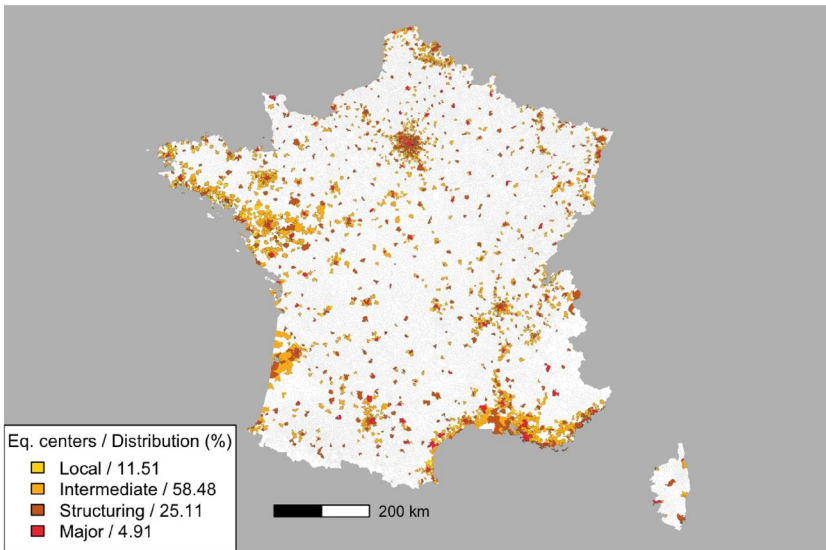
the “MAPTAM law” in 2014). The last component of this intermunicipal architecture was the “NOTRE law” which (unless exempted) requires a minimum threshold of 15,000 inhabitants.

Each EIMC is administrated by a delegated body comprised of councils of member municipalities (elected by universal suffrage). EIMCs must exercise compulsory competencies and choose from a list of optional competencies established by law. These lists of competencies depend on the legal status of the EIMC (i.e., *communauté de communes*, *communauté d’agglomération*, *communauté urbaine or métropole*). For instance, municipalities must transfer certain compulsory competencies (economic development, spatial planning, waste collection and treatment, social balance of housing, reception of traveling communities, and more recently management of aquatic environments and flood prevention). They can also choose to transfer other competencies: environmental protection, housing policy, road creation and maintenance, construction, operation, and maintenance of cultural and sports facilities and education infrastructure and amenities. These competencies are financed mainly by taxes out of the four main municipal direct taxes: residence tax, property tax on developed land, property tax on undeveloped land, and business taxes (i.e., business property tax (CFE) and contribution on the added value of companies (CVAE)).

## 2.2 Centers of equipment and services

The definition of equipment and service centers used throughout this paper is taken from Hilal et al. (2020), who propose a new classification of the central nature of municipalities based on the level of concentration of equipment frequented by its population and by the inhabitants of neighboring towns who do not have facilities on site. They identify four levels of centrality using the 185 facilities present in the permanent database of facilities of 2017 (INSEE, 2017), these are: (1) local equipment and service center, (2) intermediate center for equipment and services, (3) structuring center of equipment and services, and (4) major equipment and service center.

The provision of equipment varies greatly from one municipality to another. Some municipalities, populated with less than 3500 inhabitants and therefore excluded from our analysis, have no facilities, while others are very well equipped. The lowest-equipped centers (local centers) are characterized by the simultaneous presence of everyday services and facilities, which constitute the heart of the “equipment basket”. This mainly consists of particular services like hairdressing salons and restaurants, educational establishments (elementary schools), small business and general medical services. More highly equipped centers supply a more diverse palette of equipment and services, in addition to most of the services provided by the less-equipped ones. The final level of equipment center (major centers) thus offers almost all health services, large-scale retail outlets, or specialized food stores, in addition to several additional services for individuals, in particular legal administration services. The major centers are also characterized by services and facilities generally found in the biggest cities, such as tax administration, schools and universities, and sports, leisure, and cultural facilities.



**Fig. 1** Equipment and service centers

Figure 1 shows the distribution of the four levels of equipment centers for the sample of municipalities used in our study (described in section 4).

### 3 Method

Our approach evolves in two stages. In the first stage, we focus on the measurement of the municipal spending efficiency through the non-parametric order- $m$  model (Cazals et al. 2002). A bootstrapped truncated regression (Simar and Wilson 2007) is then used in the second stage to explain how contextual variables and distances to the equipment centers have an effect on the distribution of our calculated efficiency scores. We describe our two-stage strategy in the following sections.

#### 3.1 Order- $m$ efficiency

The first stage of our approach is based on the non-parametric order- $m$  methodology introduced by Cazals et al. (2002). Efficient municipalities are those that need fewer resources (inputs) to provide a certain level of services (outputs); thus, we use a cost-minimization approach to relate inputs (expenditure) and outputs (services and facilities). Introducing the notation used in this paper, we consider a set of  $n$  municipalities who provide  $y \in \mathbb{R}_+^p$  services produced by a set of  $x \in \mathbb{R}_+^q$  inputs. The production technology is the set of all input–output combinations.

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

Following Cazals et al. (2002) and Daraio and Simar (2005), under the free disposability assumption of inputs and outputs, the feasible set  $\Psi$  can be expressed as:

$$\Psi = \{(x, y) \in \mathbb{R}_+^{p+q} \mid H_{XY}(x, y) > 0\} \quad (2)$$

where  $H_{XY}(x, y) = \text{Prob}(X \leq x, Y \geq y)$  represents the probability of a unit operating at level  $(x, y)$  being dominated by another unit that produces as much output but with equal or less input. Then, from Farrell (1957), the input-oriented efficiency can be defined as:

$$\theta(x, y) = \inf \{\theta \mid (\theta x, y) \in \Psi\} = \inf \{\theta \mid S_{X|Y}(\theta x \mid y) > 0\} \quad (3)$$

where  $S_{X|Y}(X \mid y) = H_{XY}(x, y) / \text{Prob}(Y \geq y)$  is a nonstandard conditional survival function. The points where  $\theta(x, y) = 1$  are technically efficient ones and correspond to the efficiency frontier, while those with  $\theta(x, y) < 1$  are technically inefficient.

The FDH estimator of  $\theta$  ( $\hat{\theta}$ ) can then be obtained from an observed sample of production units  $X_n = \{(x_i, y_i) \mid i = 1, \dots, n\}$ . However,  $\hat{\theta}$  is sensitive to outliers, given that it includes the full observed sample. To mitigate the impact of outliers, Cazals et al. (2002) propose the use of a “partial frontier” that does not consider all units in one draw. Specifically, they propose the order- $m$  frontier, which benchmarks the expectations of the best practice among  $m$  peers randomly drawn from the DMU sample from which  $Y \geq y$ . Since outliers cannot be part of every subsample in every draw, the potential impact of these atypical observations on  $\hat{\theta}$  is mitigated. Thus, the estimated order- $m$  efficiency score has the following expression:

$$\hat{\theta}_m(x, y) = \int_0^\infty (1 - S_{X|Y}(ux \mid y))^m du \quad (4)$$

Daraio and Simar (2005) show how to approximate the integral in Eq. (4) using Monte Carlo simulations. Finally, note that the efficient frontier corresponds to the DMUs where  $\hat{\theta}_m(x, y) = 1$  but the efficiency scores can also take values higher than one. In this case, municipalities are known as *super-efficient*. When  $m$  converges to  $\infty$  the order- $m$  efficiency score will converge with FDH scores, therefore the number of  $m$  peers has to be selected by the researcher. According to Daraio and Simar (2005), the size of  $m$  can be determined by the value for which the percentage of super-efficient DMUs decreases smoothly with an increase of  $m$ .<sup>7</sup>

### 3.2 Order- $m$ directional distance efficiency

In addition to the order- $m$  (input-oriented) efficiency measure, we also employ its directional distance variation (Simar and Vanhems 2012) to identify which inputs contribute the most to the observed inefficiencies. The main difference between the two methods is that the (input-oriented) order- $m$  approach uses a radial measure,

<sup>7</sup> In our study, we have determined this value to be equal to 500.

which, in our case, assesses how much inputs need to be reduced to achieve a specified level of output. In contrast, the directional distance approach measures the distance of a DMU from the efficient frontier along a specified direction, offering greater flexibility in the implementation of the method. The efficiency is assessed by choosing a direction where inputs must be reduced and/or outputs expanded to reach the frontier. More precisely, we can define a vector  $d_x \in \mathbb{R}_+^q$  for the inputs and  $d_y \in \mathbb{R}_+^p$  for outputs. Under the free disposability assumption, the directional distance is formulated as:

$$\beta(x, y) = \sup\{\beta > 0 \mid H_{XY}(x - \beta d_x, y + \beta d_y) > 0\} \quad (5)$$

the directional distance  $\beta(x, y)$  is an inefficiency score, thus  $\beta = 0$  indicates that the point  $(x, y)$  is in the frontier and is efficient. Therefore, values of  $\beta > 0$  are interpreted as a level of inefficiency. Following Simar and Vanhems (2012) the order- $m$  directional distance can be defined as:

$$\beta_m(x, y) = \mathbb{E}\{\beta(x, y) \mid H_{XY}\} \quad (6)$$

as in Cazals et al. (2002),  $\beta_m$  benchmarks the unit  $(x, y)$  against the expectation of the “best” among  $m$  peers. It also allows the estimation of *super-efficient* values where  $\beta < 0$ . The flexibility of this approach comes from the possibility of choosing the direction  $(d_x, d_y)$  that measures the distance to the frontier. Input and output-oriented measures are included in this setting when  $d_x = 0$  and  $d_y = 0$ , respectively. In our case, we define  $(d_x = 1, d_y = 0)$ , allowing us to focus specifically on evaluating the optimal level of efficient expenditure among municipalities. This choice of a unit vector is widely adopted in empirical studies as it provides a straightforward method to assess DMUs in a consistent and proportional direction without an assumption and/or imposition on the selection of a directional vector (Wang et al. 2019). An additional advantage of this approach is that it enables the incorporation of specific scenarios into our specification, allowing us to assess the inefficiency of particular inputs. Finally, estimated directional distance efficiencies ( $\widehat{\beta}_m$ ) are obtained by computational methods introduced by Daraio et al. (2020).

### 3.3 Bootstrapped truncated regression

To investigate the potential effect that exogenous variables might have on efficiency, we follow Simar and Wilson (2007) and use bootstrapped truncated regression. According to the authors, two-stage approaches commonly used in the literature (OLS and Tobit models) to explain the effect of environmental variables on the efficiency distribution suffer from serial correlation, given that observations are empirically obtained and not independently distributed. Consequently, the inference of these standard approaches is invalid. Another potential problem is the correlation of contextual variables with the error term. Simar and Wilson (2007) show that bootstrapping methods can overcome these problems. Finally, the truncated distribution

of the error term is proposed to control for the interval of the efficiency score.<sup>8</sup> Thus, we define our econometric model as:

$$\theta_i = \beta_0 + \beta_1 d_{ij} + \beta_2 d_{ij}^2 + \beta_3 Z_i + EIMC_k + reg_r + reg_r * EIMC_k + \varepsilon_i \quad (7)$$

where  $\theta_i$  is the order- $m$  efficiency estimated in Eq. (4) for the municipality  $i$ ,  $d_{ij}$  is the distance from municipality  $i$  to the nearest equipment center  $j$ , while  $d_{ij}^2$  is the squared distance value,  $Z_i$  is the vector of contextual variables. We use dummies to control for the heterogeneity in the  $k^{\text{th}}$  EIMC ( $EIMC_k$ ) and the  $r^{\text{th}}$  region ( $reg_r$ ), as well as for the  $k^{\text{th}}$  EIMC within region  $r$  with the interaction term  $reg_r * EIMC_k$ .  $\varepsilon_i$  is the error term. As in Simar and Wilson (2007), this term is assumed to follow a truncated normal distribution with zero mean (before truncation) and unknown variance. The model is solved by Maximum Likelihood using bootstrapping methods with  $b$  replications. In our case, we use 1000 replications.

## 4 Data

Our study focuses on how the distance to a given equipment center may affect the spending efficiency of French municipalities for 2018.<sup>9</sup> For that purpose, we build and exploit a unique dataset that embeds financial, sociodemographic, political, and economic variables, along with our measures of distance to the four different levels of equipment centers. We limit our sample to those municipalities with more than 3500 inhabitants. We do this for several reasons. Firstly, many municipalities reported very low—or null—amount of municipal outputs (which we describe in the following paragraphs). This feature could have biased the estimation of the efficiency values in the first stage of our empirical strategy. Secondly, 3500 inhabitants is a key threshold in the “M14” nomenclature, from which municipalities must organize a budget orientation debate and provide a functional overview of their budget.<sup>10</sup> In accounting terms, they are required to depreciate their fixed assets (except for capital grants). In addition, the municipality that crosses the threshold of 3500 inhabitants moves into a new stratum (among the 15 existing ones), with an impact on the calculation of tax effort and the allocation of several grants including the most important one, i.e., the “dotation forfaitaire”. Finally, this threshold also has important consequences in terms of the composition of the deliberative assembly, local democracy and planning procedures. Excluding the twelve observations

<sup>8</sup> The truncated model proposed in Simar and Wilson (2007) assumes a first-stage efficiency estimation using classical DEA or FDH, therefore, they assume efficiency scores restricted to a certain interval, from 0 to 1. However, order- $m$  efficiencies are only truncated to the left (at point 0). Thus, in our application, this restriction is relaxed.

<sup>9</sup> We select this year of study due to the wider availability of data, especially for our selection of outputs and environmental variables (explained in the following sections). Furthermore, we select a year of study before the COVID-19 pandemic, so as to avoid its confounding effect.

<sup>10</sup> The 10 functions are: General services of local public administrations, Public health and safety, Education, Culture, Sports and youth, Social and health interventions, Family, Housing, Urban planning and services, Environment and Economic action.

with incomplete information, we gather a sample of 2955 municipalities in Metropolitan France. In addition, given the population threshold, all of our observations belong to a given equipment center.

#### 4.1 Input and output selection

The selection of inputs and outputs depends on the territorial and institutional organization of the given country as well as on the availability of data. In our case, we delimit our selection of input and output variables following previous literature in other European countries for various levels of local governments (e.g., Balaguer-Coll et al. 2007; Cordero et al. 2017; Kalb 2010; lo Storto 2016), as reviewed by Narbón-Perpiñá et al. (2018a). Input information was gathered from the *Direction Générale des Finances Publiques* (DGFIP), while output variables were obtained from different institutions: DGFIP, *Institut National de la Statistique et des Etudes Economiques* (INSEE), *Institut Géographique National* (IGN), *Direction générale des collectivités locales* (DGCL), and *Direction Générale de l'Aménagement, du Logement et de la Nature* (DGALN). A summary of the sources of the variables used throughout this paper is available in Online Appendix 1.

We select three inputs (expenditures): operating ( $X_1$ ), personnel ( $X_2$ ), and investment ( $X_3$ ) expenditure. To avoid potential bias in the efficiency estimations, particularly due to significant investment expenditures in 2018, we use the average expenditures from the period 2015–2019. This period was chosen to follow the 2014 elections and precede the 2020 COVID-19 pandemic. We link the construction of these variables to the institutional organization of French municipalities. As mentioned in the institutional context, EIMCs exercise both compulsory and optional competencies established by law. Therefore, we need to account for EIMC spending along with municipal expenditure. Hence, the expenditures used as inputs in our analysis are constructed as the addition of municipal spending plus the amount of EIMC spending affected at the pro rata of the municipal population, what we call the *cumulative spending*.<sup>11</sup>

The output selection is usually a more challenging matter and commonly depends on the minimum services and facilities that local governments are required to provide (Balaguer-Coll et al. 2013). In our context, these minimum services are dictated by the *Code Général des Collectivités Territoriales* (CGCT) and will depend on the type of EIMC: CA (communautés d'agglomération), CC (communautés de communes), CU (communautés urbaines), and METRO (métropoles). In our paper, we classify these competencies into two groups: (1) CA and CC; and, (2) CU and METRO, both supplying very similar compulsory services. Table 1 reports these minimum services classified by EIMC group and the corresponding outputs

<sup>11</sup> The EIMC spending of a given municipality is calculated by weighting the expenditure of its respective EIMC times the relative (population) size of that observed municipality to the total EIMC's population. In this way, we avoid the addition of an EIMC expenditure that is constant for all their respective municipalities.

**Table 1** Competencies per EIMC and output selection

EIMC	Competence	Output
Community of Municipalities and Communities of Agglomeration	Economic development	Urban surface area dedicated to economic activities; number of created business in 2018; number of non-public employees; tourist capacity
	Spatial planning	Street infrastructure surface area; urban surface area
	Management of aquatic environment and flood prevention	Total population; urban surface area
	Development and management of reception areas for travelling communities and family rental lands	Tourist capacity
	Collection and waste treatment	Total population
	Economic, social, and cultural development	Urban surface area dedicated to economic activities; number of created business in 2018; number of non-public employees; tourist capacity; education facilities; sports, culture and leisure facilities
	Spatial planning	Street infrastructure surface area; urban surface area
	Social balance	Residential urban surface area; social service facilities
	Management and balance of collective interest	Street infrastructure surface area; urban surface area; total population
	Environmental protection	Total surface area; green space surface area

Source: The authors

**Table 2** Output unit description

Output	Unit
Total population ( $Y_1$ )	Number of inhabitants
Urban surface area for economic activities ( $Y_2$ )	Hectare
Urban surface area ( $Y_3$ )	Hectare
Street infrastructure ( $Y_4$ )	Kilometers
Tourist capacity ( $Y_5$ )	Number of beds
Business ( $Y_6$ )	Number of created business
Non-public employees ( $Y_7$ )	Number of non-public employees
Residential urban surface area ( $Y_8$ )	Hectare
Social service facilities ( $Y_9$ )	Number of facilities
Sports, culture and leisure facilities ( $Y_{10}$ )	Number of facilities
Education facilities ( $Y_{11}$ )	Number of facilities
Green surface area ( $Y_{12}$ )	Kilometers squared

Source: The authors

proposed, while Table 2 describes the output's unit of measurement. When there was no clear output to measure a given service, we used the total population as a proxy.<sup>12</sup>

We, therefore, use two output specifications to distinguish between these two groups, which means that we run our order- $m$  model described in Eq. (4) twice. The first output specification includes total population ( $Y_1$ ), urban surface area dedicated to economic activities ( $Y_2$ ), urban surface area ( $Y_3$ ), street infrastructure ( $Y_4$ ), tourist capacity ( $Y_5$ ), business created ( $Y_6$ ), non-public employees ( $Y_7$ ). The second output specification embeds all outputs from  $Y_1$  to  $Y_7$ ; plus residential urban surface area ( $Y_8$ ), social service facilities ( $Y_9$ ), sports, culture, and leisure facilities ( $Y_{10}$ ), education facilities ( $Y_{11}$ ), and green surface area ( $Y_{12}$ ). Table 3 shows the descriptive statistics of all inputs and outputs used.

## 4.2 Contextual variables selection

To select potential determinants of municipal spending efficiency, aside from our variables of interest, we follow the previous literature as well as data availability. Firstly, we introduce our four variables of interest which measure the distance to the four levels of equipment centers (DIST): local (NV1), intermediate (NV2), structuring (NV3), and major centers (NV4). Then, we follow Narbón-Perpiñá and De Witte (2018b) and classify our external variables into 4 groups: geographic (which include our different distances to the equipment center), sociodemographic, political, and economic. Financial (or fiscal) variables like municipal taxes or debt are excluded to

<sup>12</sup> We acknowledge the clear limitations of the total population to proxy local production. However, this variable has been widely used and accepted in the literature to reflect basic administrative tasks provided by local governments when more direct outputs do not exist (Narbón-Perpiñá et al. 2018a).

**Table 3** Inputs and outputs descriptive statistics

Variable	Mean	sd	Min	Max
<b>Inputs</b>				
Operating expenditure ( $X_1$ )	202,194.37	417,289.06	5,088.45	5,455,026.21
Personnel expenditure ( $X_2$ )	50,326.48	93,667.76	1,218.66	2,159,660.27
Investment expenditure ( $X_3$ )	17,583.73	38,175.55	140.79	491,884.29
<b>Outputs</b>				
Total population ( $Y_1$ )	14,561.42	49,677.77	3,501.00	2,175,601.00
Urban surface area for economic activities ( $Y_2$ )	464.01	503.75	54.08	12,055.42
Urban surface area ( $Y_3$ )	830.54	894.99	101.14	22,419.60
Street infrastructure ( $Y_4$ )	63.21	73.71	3.62	1,625.00
Tourist capacity ( $Y_5$ )	3,414.43	17,871.06	0.00	782,831.00
Business ( $Y_6$ )	199.86	1499.38	8.00	76,084.00
Non-public employees ( $Y_7$ )	8,961.09	20,646.04	11.00	434,293.00
Residential urban surface area ( $Y_8$ )	366.53	396.10	39.99	10,364.18
Social service facilities ( $Y_9$ )	12.93	23.17	0.00	426.00
Sports, culture and leisure facilities ( $Y_{10}$ )	24.89	30.32	0.00	625.00
Education facilities ( $Y_{11}$ )	13.67	26.97	0.00	526.00
Green surface area ( $Y_{12}$ )	0.31	0.71	0.00	20.56

Expenditure expressed in thousands of euros.

Source: The authors

avoid potential endogeneity bias. Indeed, inefficiency could well affect tax collecting and debt given that inefficient municipalities could be increasing tax collection efforts and incurring higher levels of debt to provide the same level of services as efficient municipalities (Narbón-Perpiñá et al. 2020). The variables were retrieved from INSEE, DGALN, DGFIP, IGN, DGCL and governmental data on local elections. Please refer to the Online Appendix 2 for a detailed description of the contextual variables used in this paper and their expected impacts.

### 4.3 Separability condition test

The empirical literature seeking to understand how environmental variables affect inefficiency through two-stage approaches has implicitly assumed a condition of separability: these exogenous variables do not influence the input or output levels, but only efficiency (Narbón-Perpiñá and De Witte 2018b). This condition of separability was first described by Simar and Wilson (2007) and assumes that contextual variables only affect the distribution of efficiency and not the production process. If this assumption does not hold, then second-stage regressions would be difficult to interpret and perhaps rendered meaningless (Daraio et al. 2018). The lack of a proper empirical test of separability has led to municipal efficiency measurement studies to rely on previous literature to support this assumption *a priori* or apply

other conditional approaches (Badin et al. 2012) that avoid the problems related to the separability condition.

Recent studies by Kneip et al. (2016) and Daraio et al. (2018) have developed separability condition tests, which involve comparing a sample of the mean of efficiency estimates imposing the conditions of the null hypothesis. They ensure independence between two means by randomly splitting the original sample into two independent subsamples. However,  $p$ -values resulting from this test may vary across different random splits of the original sample (Simar and Wilson 2020). To eliminate this ambiguity, Simar and Wilson (2020) propose a method based on splitting the original sample many times, using a bootstrap algorithm to deal with dependence across multiple splits and provide valid inference.

Thus, we go one step beyond the municipal efficiency literature and apply both Daraio et al. (2018) and Simar and Wilson (2020) separability tests to ensure that all our environmental variables comply with the null hypothesis of separability. One important point that needs to be taken into consideration is the computational demand of these tests, which increases with the number of inputs and outputs used as well as with the number of observations. Simar and Wilson (2020) recommend as many splits as is computationally feasible. Our approach uses 3 splits. Table 4 presents  $p$ -values estimated for both Daraio et al. (2018) and Simar and Wilson (2020) separability tests. We observe that all the external variables of our second-stage analysis comply with the separability condition, allowing us to continue with our approach.

**Table 4** Separability tests

Variable	Daraio et al. (2018) $p$ -value	Simar and Wilson (2020) $p$ -value
DIST_NV1	0.67	0.69
DIST_NV2	0.67	0.48
DIST_NV3	0.66	0.74
DIST_NV4	0.63	0.23
NEIGH_N1	0.33	0.99
NEIGH_N2	0.54	0.99
NEIGH_N3	0.33	0.97
NEIGH_N4	0.99	0.15
DENS	1.00	0.21
HOUSE	0.67	0.69
FOREIGN	0.33	0.97
POP65P	0.18	0.27
TURNOUT	0.67	0.64
HHI	0.67	0.47
UNEMP	0.33	0.94
INCOME	1.00	0.21
TOURISM	1.00	0.26

Source: The authors

## 5 Results

In this section, we present the results obtained in the first and second stages of our strategy. We provide an overview of the average inefficiency of local governments and whether we find lower or higher values depending on the category of equipment center they belong to; we analyze whether the distance to these centers affects the efficiency of a given municipality.

### 5.1 Efficiency measurement

Table 5 presents the descriptive statistics of our order- $m$  specification as well as their desegregation by equipment center. We can observe that, on average, municipal expenditure efficiency is 0.63. This indicates that French municipalities could save 37% of their expenditures in order to be fully efficient. These results differ from those obtained for French départements by Seifert and Nieswand (2014) and Ayouba et al. (2023) who find an average efficiency of 0.88 and 0.86, respectively. However, these studies focus on a higher tier of French jurisdictions that exert very different competencies and essentially social benefits payments that are set by the central government. Our results are not so different from what has been found in recent similar approaches in the literature dedicated to estimating municipal efficiency, for example, in the case of Spain (Narbón-Perpiñá et al. 2020), Italy (Io Storto 2016), Greece (Doumpos and Cohen 2014) or Portugal (Cordero et al. 2017). In addition, when we disaggregate the results based on the four levels of equipment centers (local, intermediate, structuring, and major), we observe, as expected, an increase in the average efficiency as we move to the highest equipment centers, with major ones showing an average efficiency score of 0.94, 0.52 points higher than local centers.

To gain a clearer understanding of which expenditures are contributing to inefficiencies, we estimate the directional distance efficiencies using the approach outlined in Eq. (6). The absolute measures of technical inefficiencies are represented as the slacks in expenditures. To obtain relative measures, we divide these absolute inefficiencies by the corresponding amount of the related expenditure for each municipality under evaluation. The summary statistics by input use are

**Table 5** Order- $m$  efficiency descriptive statistics

	Order- $m$ efficiency					
	Mean	Median	sd	Min	Max	N
Total	0.6334	0.6568	0.3661	0.0223	1.8657	2,955
Local	0.4234	0.2946	0.3461	0.0313	1.5378	340
Intermediate	0.5731	0.4950	0.3715	0.0223	1.8658	1,728
Structuring	0.8101	0.9994	0.2762	0.0477	1.2466	742
Major	0.9403	1.0000	0.1309	0.3829	1.0049	145

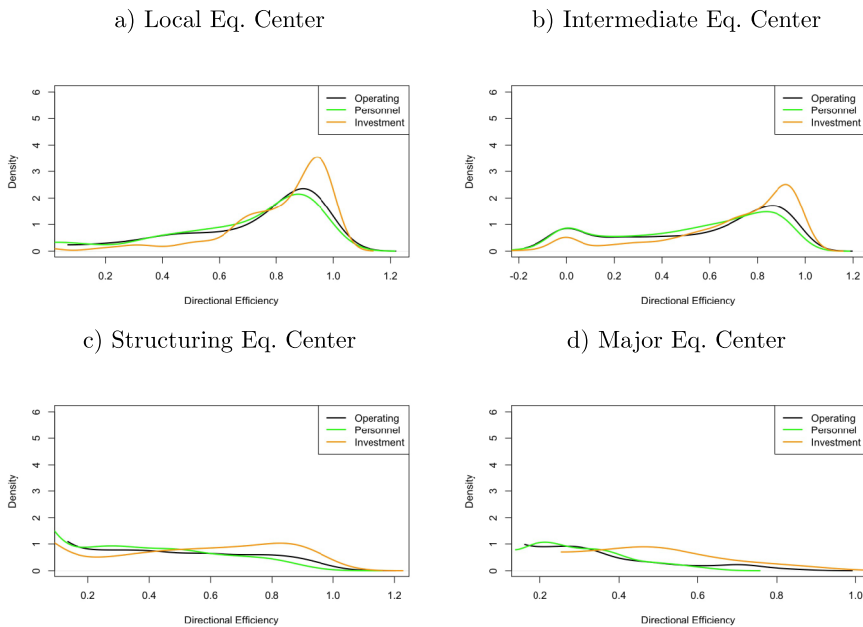
ANOVA test indicated that the differences between groups are statistically significant

Source: The authors

**Table 6** Order-*m* directional distance relative efficiencies by input use

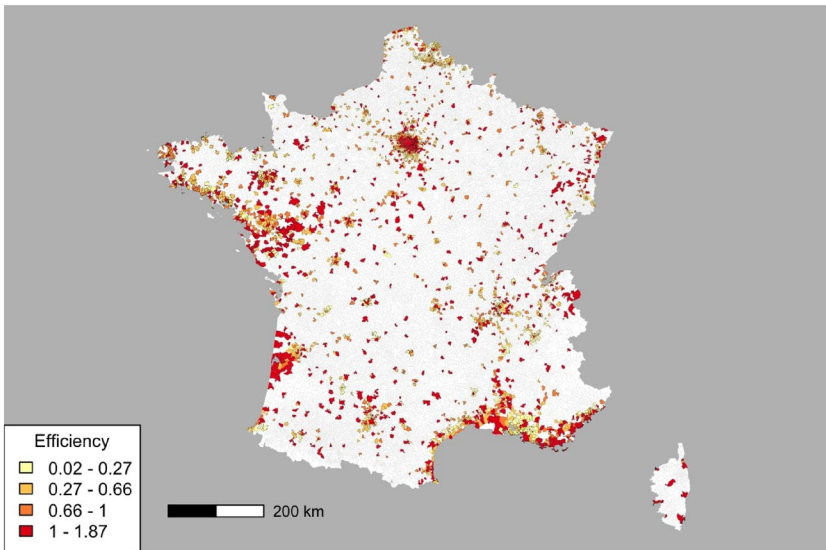
	Operating Exp	Personnel Exp	Investment Exp
Min	-0.3833	-0.5372	-0.5827
1st Qu	0.1086	0.1008	0.3786
Median	0.5401	0.4862	0.7157
Mean	0.4830	0.4508	0.6064
3rd Qu	0.8218	0.7707	0.8961
Max	0.9881	0.9879	0.9927

Source: The authors



**Fig. 2** Order-*m* directional distance efficiencies density plots

presented in Table 6, while the density plots by category of equipment centers are shown in Fig. 2, values higher than zero being intended as inefficient. Overall, our findings show a more inefficient use of investment expenditures. Contrary to operating and personnel expenditures, which are essentially recurrent, investment expenditures are generally more often subject to political influence (which can lead to prioritizing visible but inefficient projects), uncertainty (unforeseen challenges at different stages of an investment project), and coordination with various stakeholders. We find that municipalities belonging to local and intermediate centers are those that make more inefficient use of the different expenditures, particularly investment ones. Investment projects often require technical expertise



**Fig. 3** Order- $m$  efficiencies spatial distribution

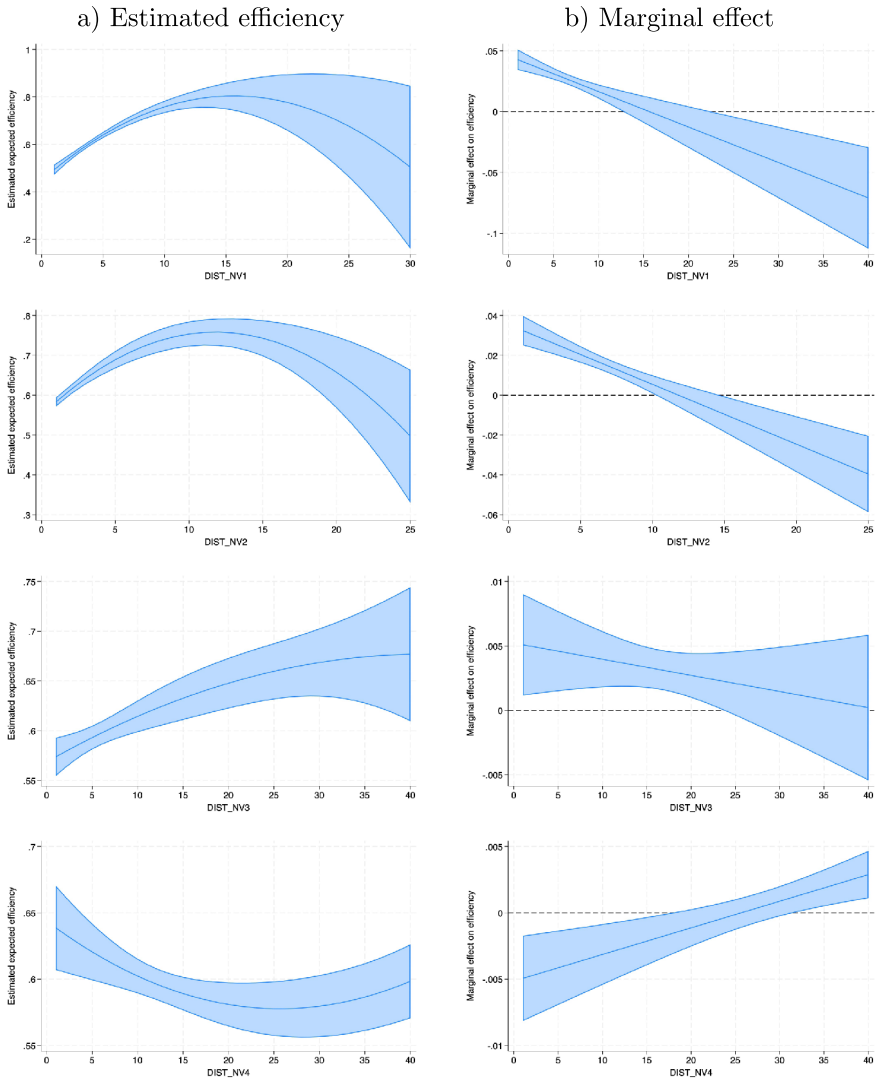
that local and intermediate centers are more likely to lack, which might lead to either bad project management or very costly consultant dependency.

Furthermore, we plot our results in Fig. 3. Municipalities with the highest efficiency scores (red color) are located in regions like Île-de-France, Bretagne, and the coastal areas of Nouvelle-Aquitaine, Occitanie, or Provence-Alpes-Côte d'Azur, whereas the lowest ones can be found in regions like Normandie or Hauts-de-France. Best-performing municipalities are mostly concentrated in structuring and major equipment centers. As expected, the results demonstrate that municipalities with a higher diversity of equipment and services are less inefficient, suggesting they enjoy the advantages of higher agglomeration economies as described by Jacobs (1969). Moreover, we can distinguish a pattern where municipalities become more inefficient as they move further away from the most efficient local governments,<sup>13</sup> noticeably stronger in nearby (less-equipped centers) municipalities who could be 'borrowing functions' from their neighbors, suggesting potential efficiency spillovers. Thus, we investigate in further detail how the distances to these centers may affect this distribution in the second stage of our approach.

## 5.2 Is there evidence of efficiency spillovers?

In Fig 4 we display the estimation results of our four variables of interest, controlling for the different geographic, sociodemographic, political, and economic variables

<sup>13</sup> This behavior is more evident when we observe the Île-de-France region.



**Fig. 4** Estimation results: effect of the distance to the nearest equipment center on spending efficiency with 95% confidence intervals

as introduced in previous sections.<sup>14,15</sup> Panel a) shows the expected estimated efficiency at different values of the four distance variables, while panel b) shows the

<sup>14</sup> In order to determine the robustness of the estimated parameters to the inclusion of new covariates, we run our model described in Eq. (7) with more or less controls. Our results for the baseline model are outlined in Online Appendix 3.

<sup>15</sup> Variance Inflation Factor (VIF) was calculated to check and ensure non-collinearity among the exogenous variables.

respective marginal effects. In this way, we can observe the nonlinear relationship between distance to a given equipment center and municipal spending efficiency. We observe a concave effect for the lowest equipment centers (local and intermediate), while a convex one is shown by the distance to the nearest major equipment center. As expected, the size of the marginal effect decreases (in absolute terms) as the geographical distance increases. These results reflect that local governments located closer to major equipment centers show higher efficiency levels that decrease as they locate further away from them. They also suggest that major centers act as the most reflective agglomeration economies, whose high efficiency levels spill over to their immediate neighbors and, specifically those with a lower endowment of equipment and services. This is reinforced by the concave effect found for DIST\_NV1 and DIST\_NV2 which demonstrate that municipalities that are located closer to a local center, for instance, present lower efficiency levels, while their efficiency levels increase as they move further away from these centers and get closer to major ones. The results are in line with the theory that smaller, and hence, less-endowed municipalities 'borrow functions' from their bigger neighboring municipalities: people from small municipalities benefit from greater accessibility of services and amenities of larger cities that share their location, which also implies that agglomeration is to their advantage as well (Camagni et al. 2016; Burger et al. 2015). Thus, less-endowed municipalities benefit the most from their geographical proximity to larger equipment centers, allowing their population to enjoy public goods and services without incurring additional expenditure, which translates into more efficiency. The effect of these externalities seems to rapidly decay with distance, with DIST\_NV4 becoming non-different from 0 after 20 km, results that are consistent with the empirical literature (van Soest et al. 2006; Baldwin et al. 2008).

Conversely, DIST\_N3 shows a somewhat positive linear relationship with municipal efficiency. The intuition behind this may come from the fact that, even when structuring centers possess a decent share of goods and services, people from neighboring municipalities may prefer to commute to their closest major center, which could be linked to savings of search and transaction costs associated with multi-purpose trips (Glaeser et al. 2001).

Another important feature that needs to be taken into account is the number of municipalities that are physically closer to each municipality. Municipalities closer to a bigger share of centers that account for higher-rank functions have more availability of functions to 'borrow' and hence, might benefit more from efficiency spillovers than those municipalities in isolation. To test this hypothesis, we split the sample into quartiles, according to the number of neighbors within 20 km. We select this threshold based on the catchment area of the spillovers found in our baseline results. Then, we run Eq. (7) on each quantile group, constraining our four distance variables to consider the nearest equipment center within 20 km. The results are presented in Table 7, where each column shows the marginal effects of our distance variables for each subsample. As expected, less connected municipalities i.e., those with a smaller number of neighbors within 20 km do not show evidence of efficiency spillovers (seen as the non-significant effects of DIST\_NV4 for Q1), while these are significant for Q2, Q3 and Q4. Another finding that is surprising, but not unexpected, is the negative and significant effect of DIST\_NV3. This finding

**Table 7** Marginal effects by quartiles: number of municipalities within 20 Km

Dependent variable: order- <i>m</i> efficiency				
	Q1 [0,7]	Q2 [8,16]	Q3 [17,32]	Q4 [33,193]
DIST_NV1	0.0550* (0.0325)	0.0394*** (0.0125)	0.0479*** (0.0088)	0.0313*** (0.0082)
DIST_NV2	0.0373 (0.0329)	0.0474** (0.0199)	0.0876*** (0.0145)	-0.0014 (0.0135)
DIST_NV3	0.0082 (0.0138)	0.0096* (0.0056)	0.0086 (0.0053)	-0.0440*** (0.0096)
DIST_NV4	-0.0061 (0.0172)	-0.0103** (0.0049)	-0.0113*** (0.0044)	-0.0133*** (0.0041)
Geographic variables	Yes	Yes	Yes	Yes
Sociodemographic variables	Yes	Yes	Yes	Yes
Political variables	Yes	Yes	Yes	Yes
Economic variables	Yes	Yes	Yes	Yes
<i>N</i>	90	323	600	703

Bootstrapped standard errors in parentheses. \*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

Source: The authors

provides evidence that in well-connected regions, less-equipped centers benefit from their high-equipped neighbors (structuring and major). Once again, this is consistent with the theory that municipalities that are less endowed with high-rank functions can 'borrow' them through easy accessibility to stronger neighbors in the same regional context. (Camagni et al. 2016).

### 5.3 Further insights into efficiency determinants

In addition to the analysis presented in previous sections, we assess the main determinants of municipal spending efficiency from our estimations. Table 8 shows the marginal effects of the sociodemographic, political, and economic variables estimated with Eq. (7).

Regarding sociodemographic determinants, urban population density (DENS) presents a positive and significant effect. This is consistent with the theory that economies of scale could exist when population concentration rises (Balaguer-Coll et al. 2007; Geys et al. 2010; Kalb et al. 2012; lo Storto 2016). However, the squared value of density is significant and its negative sign suggests a concave effect (see Online Appendix 3). In other words, the results suggest that economies of scale are present for less densely populated municipalities, and then, there is a negative effect coming from more concentration (Breuillé et al. 2019). The latter leads to thinking that larger population concentration derives in problems of equipment saturation, increasing costs, and higher complexity to manage public services (da Cruz and Marques 2014; Lampe et al. 2015) leading to a detrimental effect on the municipal

**Table 8** Estimation results: contextual variables' marginal effects

Dependent variable: order- <i>m</i> efficiency	
<b>Sociodemographic</b>	
DENS	0.0008** (0.0003)
HOUSE	-0.0047*** (0.0007)
FOREIGN	-0.0014 (0.0016)
POP65P	0.0044*** (0.0013)
<b>Political</b>	
TURNOUT	-0.0070*** (0.0010)
IDEOLOGY (ref: LEFT)	
CENT	-0.0018 (0.0319)
DTE	0.0530*** (0.0120)
HHI	-0.1487*** (0.0302)
<b>Economic</b>	
UNEMP	-0.0019 (0.0019)
TOURISM	0.0010 (0.0007)
INCOME	0.0000* (0.0000)
<i>N</i>	2955

Bootstrapped standard errors in parentheses.\*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

Source: The authors

performance. The share of house-owners (HOUSE) also presents a significant and negative effect on expenditure efficiency, while the elderly population (POP65P) shows a positive effect. Municipalities with a higher share of retired population, especially small ones, could be showing a higher control of retired people over the local council, as they could take part in local organizations (which in small communities can have a higher and positive impact on local authorities' decisions) (Bosch et al. 2000). In addition, retired people are a more captive electorate, whose threat of voting with their feet (Tiebout 1956) is less credible than other age groups.

Political variables are the biggest and most significant determinants. This effect is not surprising given that the historical evolution of intermunicipal cooperation has gone through a series of changes and reforms over the years, and has been an

important tool of state policy (West 2007). First, voter turnout (TURNOUT) is negative and significant. According to Asatryan and De Witte (2015), this effect could be signaling that a more inefficient performance of local governments might encourage higher citizen participation. We also observe that the municipalities with a right-wing incumbent party (DTE) are associated with higher efficiency levels. The results do not fall far from the common intuition in the literature: left-wing parties are usually linked with the public sector, which might be connected with lower efficiency levels (Ashworth et al. 2014). However, the negative sign of HHI suggests that the concentration of one political color has a negative effect on efficiency. This follows the idea that low political competition complicates other parties to have a decision over expenditures; therefore, efficiency might be reduced (Ashworth et al. 2014; Balaguer-Coll et al. 2007).

Before we draw any conclusions, we test the robustness of our results in the following section.

#### 5.4 Robustness analysis

One concern is linked to the influence of Paris on its neighbors. As the economic and political capital of the country and a major equipment center, being geographically closer to Paris might be advantageous for local governments.<sup>16</sup> Thus, our previous results could be mainly driven by the sole effect of the capital city and not by other major equipment centers in the sample.

We test this hypothesis and run Eq. (7) on those local governments outside the Île-de-France region. The results are comparable to those of our baseline model, although the marginal effect of DIST\_NV4 is now statistically significant for those municipalities located within a distance of under 15 km (rather than 20 km as in our baseline results). Results are shown in Online Appendix 4.

Another concern is related to whether the effects found so far are the same for all equipment centers or if they present certain asymmetries in their behavior. For example, is the relationship between DIST\_NV4 and efficiency the same for local and intermediate equipment centers? According to Camagni et al. (2016), a 'borrowed function' effect is mainly expected to yield more advantages to less-endowed cities, so we can expect to find different effects depending on the type of equipment center under analysis. To test for this, we split our sample according to the equipment center that each municipality belongs to. Then, we run our model specified in Eq. (7) on each subsample.<sup>17</sup> Table 9 shows the estimated parameters, while Table 10 presents the corresponding marginal effects.

The results demonstrate that the convex effect of DIST\_NV4 on spending efficiency remains only in the case of local equipment centers. As suggested by Camagni et al. (2016), less-endowed municipalities seem to be those that benefit

<sup>16</sup> This can also be partially observed by the clear distribution of efficient municipalities surrounding Paris in Fig. 3.

<sup>17</sup> We omit the interaction term  $reg_r * EIMC_k$  given that for some groups there were few observations that shared an EIMC within a given region.

**Table 9** Estimation results by equipment centers

Dependent variable: order- <i>m</i> efficiency				
	Local	Intermediate	Structuring	Major
DIST_NV1		0.0258*** (0.0093)	0.0266*** (0.0073)	0.0201 (0.0230)
DIST_NV1_SQ		-0.0008 (0.0005)	-0.0009*** (0.0003)	-0.0013 (0.0017)
DIST_NV2	0.0179 (0.0295)		0.0154** (0.0066)	0.0295* (0.0169)
DIST_NV2_SQ	-0.0004 (0.0017)		-0.0006** (0.0002)	-0.0013 (0.0008)
DIST_NV3	0.0141 (0.0128)	0.0064* (0.0039)		-0.0037 (0.0061)
DIST_NV3_SQ	-0.0003 (0.0003)	-0.0001 (0.0001)		0.0001 (0.0001)
DIST_NV4	-0.0164* (0.0085)	0.0034 (0.0029)	0.0050* (0.0030)	
DIST_NV4_SQ	0.0003* (0.0002)	-0.0000 (0.0000)	-0.0000 (0.0000)	
Geographic variables	Yes	Yes	Yes	Yes
Sociodemographic variables	Yes	Yes	Yes	Yes
Political variables	Yes	Yes	Yes	Yes
Economic variables	Yes	Yes	Yes	Yes
<i>N</i>	340	1,728	742	145

Bootstrapped standard errors in parentheses. \*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

Source: The authors

from agglomeration economies of nearby major centers. That is to say, residents can easily access the goods and services of well-endowed municipalities that are not available in their localities, while their respective local governments can save on such expenditures. Conversely, intermediate and structuring centers show lower efficiency levels as they approach major centers. A potential explanation could be linked to the concept of 'agglomeration shadows' (Fujita et al. 1999). As Burger et al. (2015) describes, a 'borrowed size/function' for one place means that other places are confronted with an 'agglomeration shadow' where municipalities located near higher-order ones will be limited due to competition effects. In our context, this would translate into underused goods and services supplied by intermediate and structuring centers, given that people may prefer to consume similar ones in major centers. This would entail more expenditure that could be saved by the former, hence translating into less spending efficiency.

**Table 10** Marginal effects by equipment centers

Dependent variable: order- <i>m</i> efficiency				
	local	Intermediate	Structuring	Major
DIST_NV1		0.0187*** (0.0053)	0.0160*** (0.0043)	0.0072 (0.0088)
DIST_NV2	0.0138 (0.0165)		0.0078** (0.0038)	0.0152* (0.0088)
DIST_NV3	0.0077 (0.0067)	0.0033 (0.0021)		-0.0012 (0.0023)
DIST_NV4	-0.0066* (0.0040)	0.0027* (0.0015)	0.0033** (0.0014)	
Geographic variables	Yes	Yes	Yes	Yes
Sociodemographic variables	Yes	Yes	Yes	Yes
Political variables	Yes	Yes	Yes	Yes
Economic variables	Yes	Yes	Yes	Yes
<i>N</i>	340	1728	742	145

Bootstrapped standard errors in parentheses. \*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

Source: The authors

## 6 Conclusions

This paper aims to provide empirical evidence of efficiency spillovers in French municipalities for 2018. Our theory builds upon the urban economics theory stating that more diversification (outside the industry) is the key source of agglomeration economies (Jacobs 1969). Hence, agglomeration effects would arise in more diverse municipalities and could be perceived as high efficiency. These municipalities are those that host high-rank functions that can be 'borrowed' by neighboring locations that are less endowed but benefit from easy access to their stronger neighbors. In this case, if externalities coming from 'borrowed functions' exist, it can be observed in the form of higher efficiency for these neighboring locations.

Our findings show that municipalities that host high-rank functions are indeed the best performers in the country, which is expressed by the high levels of municipal spending efficiency. Moreover, we find that neighboring municipalities with the lowest level of endowment (i.e., lowest functions) are those that benefit from their close location to the high-rank functions of their neighbors, as suggested by Camagni et al. (2016), providing evidence of the existence of efficiency spillovers. This effect rapidly decays with distance, which is in line with agglomeration externalities literature (van Soest et al. 2006; Baldwin et al. 2008).

The results have important policy implications. Considering the continual struggles of local governments in managing their public finances after the 2008 crisis, and more recently with the COVID crisis of 2020, the efficient management of their resources has become crucial. Our results highlight potential key players capable of boosting regional performance. By focusing their limited resources in well-endowed

municipalities, efficiency spillovers may be exploited to enhance the performance of their neighbors and, at the same time, save funds from the public budget. It is also important to distinguish those municipalities that are well-connected in a regional context from those that are more isolated, as externalities are found for the former but not for the latter. This has to be taken into consideration to design tailored policies and investment strategies.

Finally, we point out two main limitations of our study, linked to the availability of data at the municipal level in France.<sup>18</sup> Firstly, we limited our analysis to the year 2018, so that our interpretations only hold in the short-run. Future research will focus on extending the time period for a more complete and extensive analysis of the evolution of municipal spending efficiency and its determinants. The second point refers to the “global” approach taken to measure public spending efficiency. Although the overall performance assessment of local governments through a composite index becomes crucial in order to understand how they perform in a multitude of tasks, sometimes the estimation of such an index is difficult to implement due to the lack of data for direct outputs. Moreover, while the use of the total population as a proxy for local production has been accepted in the literature when direct outputs do not exist, future steps will seek to complement our approach as more data becomes available.

**Supplementary Information** The online version contains supplementary material available at <https://doi.org/10.1007/s00168-024-01326-6>.

**Acknowledgements** We would like to thank the participants of the GTI seminar (CESAER, Dijon), the Meeting in Public Economics (Spain), the ERSA congress, as well as Emili Tortosa, Rosella Nicolini, and the anonymous referees for their valuable comments. We also thank very much Camille Grivault for his work and contributions to the database. Juan Piedra-Peña wishes to acknowledge the support of the Margarita Salas Scholarship funded by the Ministerio de Universidades and the European Union (Unión Europea-NextGenerationEU). This research benefited from the financial support from Ministerio de Ciencia e Innovación PID2021-124713OB-I00.

**Funding** Open Access Funding provided by Universitat Autònoma de Barcelona.

## Declarations

**Conflict of interest** The authors report no potential conflict of interest.

**Open Access** This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if changes were made. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission

---

<sup>18</sup> For example, in the Base Permanente des Equipements, there are a number of modifications in the way equipment and infrastructure are recorded and classified, which complicates the construction of a consistent panel database. There have also been many institutional and territorial changes in French municipalities (e.g., mergers of municipalities and mergers of intermunicipal groups) that affect the way in which some environmental variables are recorded (e.g., political variables) and prevent a comparable analysis in the long-run.

directly from the copyright holder. To view a copy of this licence, visit <http://creativecommons.org/licenses/by/4.0/>.

## References

- Alonso W (1973) Urban zero population growth. *Daedalus* 102(4):191–206
- Asatryan Z, De Witte K (2015) Direct democracy and local government efficiency. *Eur J Polit Econ* 39:58–66. <https://doi.org/10.1016/j.ejpoleco.2015.04.005>
- Ashworth J, Geys B, Heyndels B, Wille F (2014) Competition in the political arena and local government performance. *Appl Econ* 46(19):2264–2276. <https://doi.org/10.1080/00036846.2014.899679>
- Ayoubia K, Duboz M-L, Le Gallo J (2023) Assessing French Departements spending efficiency over time. *Appl Econ*. <https://doi.org/10.1080/00036846.2023.2167925>
- Balaguer-Coll MT, Prior D (2009) Short- and long-term evaluation of efficiency and quality. An application to Spanish municipalities. *Appl Econ* 41(23):2991–3002. <https://doi.org/10.1080/00036840701351923>
- Balaguer-Coll MT, Prior D, Tortosa-Ausina E (2007) On the determinants of local government performance: a two-stage nonparametric approach. *Eur Econ Rev* 51(2):425–451. <https://doi.org/10.1016/j.euroecorev.2006.01.007>
- Balaguer-Coll MT, Prior D, Tortosa-Ausina E (2013) Output complexity, environmental conditions, and the efficiency of municipalities. *J Prod Anal* 39(3):303–324. <https://doi.org/10.1007/s11123-012-0307-x>
- Baldwin JR, Beckstead D, Mark Brown W, Rigby DL (2008) Agglomeration and the geography of localization economies in Canada. *Reg Stud* 42(1):117–132. <https://doi.org/10.1080/00343400701543199>
- Benito B, Bastida F, García JA (2010) Explaining differences in efficiency: an application to Spanish municipalities. *Appl Econ* 42(4):515–528. <https://doi.org/10.1080/00036840701675560>
- Bosch N, Espasa M, Mora T (2012) Citizen control and the efficiency of local public services. *Eviron Plann C Gov Policy* 30(2):248–266. <https://doi.org/10.1068/c1153r>
- Bosch N, Pedraja F, Suárez-Pandiello J (2000) Measuring the efficiency of Spanish municipal refuse collection services. *Local Gov Stud* 26(3):71–90. <https://doi.org/10.1080/03003930008434000>
- Boussauw K, van Meeteren M, Sansen J, Meijers E, Storme T, Louw E, Witlox F (2018) Planning for agglomeration economies in a polycentric region: envisioning an efficient metropolitan core area in Flanders. *Eur J Spat Dev* 69:1–26. <https://doi.org/10.30689/EJSD2018:69.1650-9544>
- Breuillé M-L, Duran-Vigeneron P (2023) Intermunicipal cooperation in France and related tax issues. NBER Chapters
- Breuillé M-L, Duran-Vigeneron P, Samson A-L (2018) Inter-municipal cooperation and local taxation. *J Urban Econ* 107:47–64. <https://doi.org/10.1016/j.jue.2018.08.001>
- Breuillé M-L, Grivault C, Le Gallo J, Le Goix R (2019) Impact de la densification sur les coûts des infrastructures et services publics. *Revue économique* 70(3):345–373. <https://doi.org/10.3917/reco.703.0345>
- Burger MJ, Meijers E (2016) Agglomerations and the rise of urban network externalities. *Pap Reg Sci* 95(1):5–15. <https://doi.org/10.1111/pirs.12223>
- Burger MJ, Meijers EJ, Hoogerbrugge MM, Tresserra JM (2015) Borrowed size, agglomeration shadows and cultural amenities in North-West Europe. *Eur Plan Stud* 23(6):1090–1109. <https://doi.org/10.1080/09654313.2014.905002>
- Badin L, Daraio C, Simar L (2012) How to measure the impact of environmental factors in a nonparametric production model. *Eur J Oper Res* 223(3):818–833. <https://doi.org/10.1016/j.ejor.2012.06.028>
- Camagni R, Capello R, Caragliu A (2016) Static vs. dynamic agglomeration economies. spatial context and structural evolution behind urban growth. *Pap Reg Sci* 95:133–158. <https://doi.org/10.1111/pirs.12182>
- Capello R (1996) Industrial enterprises and economic space: the Network Paradigm. *Eur Plan Stud* 4(4):198–485. <https://doi.org/10.1080/09654319608720360>
- Capello R (2000) The city network paradigm: measuring urban network externalities. *Urban Stud* 37(11):1925–1945. <https://doi.org/10.1080/713707232>

- Cazals C, Florens J-P, Simar L (2002) Nonparametric frontier estimation: a robust approach. *J Economet* 106(1):1–25. [https://doi.org/10.1016/S0304-4076\(01\)00080-X](https://doi.org/10.1016/S0304-4076(01)00080-X)
- Cordero JM, Pedraja-Chaparro F, Pisaflores EC, Polo C (2017) Efficiency assessment of Portuguese municipalities using a conditional nonparametric approach. *J Prod Anal* 48(1):1–24. <https://doi.org/10.1007/s11123-017-0500-z>
- Cordero JM, Polo C, Tzeremes NG (2020) Evaluating the efficiency of municipalities in the presence of unobserved heterogeneity. *J Prod Anal* 53(3):377–390. <https://doi.org/10.1007/s11123-020-00579-5>
- da Cruz NF, Marques RC (2014) Revisiting the determinants of local government performance. *Omega* 44:91–103. <https://doi.org/10.1016/j.omega.2013.09.002>
- Daraio C, Simar L (2005) Introducing environmental variables in nonparametric frontier models: a probabilistic approach. *J Prod Anal* 24(1):93–121. <https://doi.org/10.1007/s11123-005-3042-8>
- Daraio C, Simar L, Wilson PW (2018) Central limit theorems for conditional efficiency measures and tests of the ‘separability’ condition in non-parametric, two-stage models. *Economet J* 21(2):170–191. <https://doi.org/10.1111/ectj.12103>
- Daraio C, Simar L, Wilson PW (2020) Fast and efficient computation of directional distance estimators. *Ann Oper Res* 288:805–835. <https://doi.org/10.1007/s10479-019-03163-9>
- De Borger B, Kerstens K (1996) Cost efficiency of Belgian local governments: a comparative analysis of FDH, DEA, and econometric approaches. *Reg Sci Urban Econ* 26(2):145–170. [https://doi.org/10.1016/0166-0462\(95\)02127-2](https://doi.org/10.1016/0166-0462(95)02127-2)
- Doumpos M, Cohen S (2014) Applying data envelopment analysis on accounting data to assess and optimize the efficiency of Greek local governments. *Omega (United Kingdom)* 46:74–85. <https://doi.org/10.1016/j.omega.2014.02.004>
- Farrell MJ (1957) The measurement of productive efficiency. *J R Stat Soc Ser A (General)* 120(3):253–290. [https://doi.org/10.1016/S0377-2217\(01\)00022-4](https://doi.org/10.1016/S0377-2217(01)00022-4)
- Fingleton B (2003) Externalities, economic geography, and spatial econometrics: conceptual and modeling developments. *Int Reg Sci Rev* 26(2):197–207. <https://doi.org/10.1177/0160017602250976>
- Fujita M, Krugman P, Venables AJ (1999) *The spatial economy*. The MIT Press
- Geys B, Heinemann F, Kalb A (2010) Voter involvement, fiscal autonomy and public sector efficiency: evidence from German municipalities. *Eur J Polit Econ* 26(2):265–278. <https://doi.org/10.1016/j.ejpoleco.2009.11.002>
- Giménez VM, Prior D (2007) Long- and short-term cost efficiency frontier evaluation: evidence from Spanish local governments. *Fisc Stud* 28(1):121–139. <https://doi.org/10.1111/j.1475-5890.2007.00050.x>
- Glaeser EL, Kolko J, Saiz A (2001) Consumer city. *J Econ Geogr* 1(1):27–50. <https://doi.org/10.1093/jeg/1.1.27>
- Hilal M, Moret D, Piguët V, Bouscasse H, Cavailhes J, Diallo A, Legras S (2020) Centralités : comment les identifier et quels rôles dans les dynamiques locales et intercommunales (Tech Rep) Agence Nationale de la Cohésion des territoires. <https://hal.archives-ouvertes.fr/hal-03064655>
- Jacobs J (1969) *The economy of cities*. Vintage, New York
- Kalb A (2010) The impact of intergovernmental grants on cost efficiency: theory and evidence from German municipalities. *Econ Anal Policy* 40(1):23–48. [https://doi.org/10.1016/S0313-5926\(10\)50002-X](https://doi.org/10.1016/S0313-5926(10)50002-X)
- Kalb A, Geys B, Heinemann F (2012) Value for money? German local government efficiency in a comparative perspective. *Appl Econ* 44(2):201–218. <https://doi.org/10.1080/00036846.2010.502110>
- Kneip A, Simar L, Wilson PW (2016) Testing hypotheses in nonparametric models of production. *J Bus Econ Stat* 34(3):435–456
- Lampe HW, Hilgers D, Ihl C (2015) Does accrual accounting improve municipalities’ efficiency? Evidence from Germany. *Appl Econ* 47(41):4349–4363. <https://doi.org/10.1080/00036846.2015.1030562>
- Lo Storto C (2016) The trade-off between cost efficiency and public service quality: a non-parametric frontier analysis of Italian major municipalities. *Cities* 51:52–63. <https://doi.org/10.1016/j.cities.2015.11.028>
- McCann P, Acs ZJ (2011) Globalization: countries, cities and multinationals. *Reg Stud* 45(1):17–32. <https://doi.org/10.1080/00343404.2010.505915>
- Meijers E (2007) From central place to network model: theory and evidence of a paradigm change. *Tijdschr Econ Soc Geogr* 98(2):245–259. <https://doi.org/10.1111/j.1467-9663.2007.00394.x>

- Meijers E, Burger MJ, Hoogerbrugge MM (2016) Borrowing size in networks of cities: city size, network connectivity and metropolitan functions in Europe. *Pap Reg Sci* 95(1):181–198. <https://doi.org/10.1111/pirs.12181>
- Narbón-Perpiñá I, Arribas I, Balaguer-Coll MT, Tortosa-Ausina E (2020) Explaining local governments' cost efficiency: controllable and uncontrollable factors. *Cities*. <https://doi.org/10.1016/j.cities.2020.102665>
- Narbón-Perpiñá I, De Witte K (2018) Local governments' efficiency: a systematic literature review—part I. *Int Trans Oper Res* 25(2):431–468. <https://doi.org/10.1111/itor.12364>
- Narbón-Perpiñá I, De Witte K (2018) Local governments' efficiency: a systematic literature review—part II. *Int Trans Oper Res* 25(4):1107–1136. <https://doi.org/10.1111/itor.12389>
- Pérez-López G, Prior D, Zafra-Gómez JL (2015) Rethinking new public management delivery forms and efficiency: long-term effects in Spanish local government. *J Public Admin Res Theory* 25(4):1157–1183. <https://doi.org/10.1093/jopart/muu088>
- Seifert S, Nieswand M (2014) What drives intermediate local governments' spending efficiency: the case of French departements. *Local Gov Stud* 40(5):766–790. <https://doi.org/10.1080/03003930.2013.812962>
- Simar L, Vanhems A (2012) Probabilistic characterization of directional distances and their robust versions. *J Economet* 166:342–354. <https://doi.org/10.1016/j.jeconom.2011.10.002>
- Simar L, Wilson PW (2007) Estimation and inference in two-stage, semi-parametric models of production processes. *J Economet* 136(1):31–64. <https://doi.org/10.1016/j.jeconom.2005.07.009>
- Simar L, Wilson PW (2020) Hypothesis testing in nonparametric models of production using multiple sample splits. *J Prod Anal* 53(3):287–303. <https://doi.org/10.1007/s1123-020-00574-w>
- Tiebout CM (1956) A pure theory of local expenditures. *J Polit Econ* 64(5):416–424
- van Meeteren M, Neal Z, Derudder B (2016) Disentangling agglomeration and network externalities: a conceptual typology. *Pap Reg Sci* 95(1):61–80. <https://doi.org/10.1111/pirs.12214>
- van Soest DP, Gerking S, van Oort FG (2006) Spatial impacts of agglomeration externalities. *J Reg Sci* 46(5):881–899. <https://doi.org/10.1111/j.1467-9787.2006.00488.x>
- Wang K, Xian Y, Lee CY, Wei YM, Huang Z (2019) On selecting directions for directional distance functions in a non-parametric framework: a review, vol 278
- West K (2007) Inter-municipal cooperation in france: incentives, instrumentality and empty shells. *Inter-municipal Cooperation in Europe*. Springer, Dordrecht, pp 67–90

**Publisher's Note** Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.