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Local tax management in Spain: A study of the conditional efficiency of provincial tax agencies

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ABSTRACT

This paper reports an efficiency analysis of local tax management by provincial tax agencies in Spain based on supramunicipal delegation. To conduct this study, we used the robust order-*m* conditional model that directly accounts for some socioeconomic environmental variables to estimate the efficiency scores. This is a key issue, as tax agencies do not have control over the context in which they operate, and this may have a severe impact on their performance. Our results suggest that several of the provincial contextual variables accounted for (the net property tax base, population density and inhabitants of the municipalities that have delegated management to the provincial tier of government) have a negative impact on efficiency, especially at higher variable value levels. Considering that the provincial tier of government can opt to set up specific self-governing agencies to perform these tasks, we also applied metafrontier analysis to assess their share in inefficiency. We concluded that the establishment of such self-governing agencies does not lead to higher efficiency levels.

1. Introduction

The welfare state is a key support for democratic states that is based on a balance between public income and expenditures. This work focuses on the revenue side, in terms of analyzing the efficiency of its collection and management at the provincial level. Welfare state policies in Spain are structured on a quasi-federal state that is organized on three tiers: the national level (country), the regional level (autonomous regions) and the local level (municipalities and provinces).

The Spanish local system is characterized by a highly fragmented municipal scenario made up of a sizeable number of municipalities (more than 8 thousand municipalities of which 83.99% had a population lower than 5000 inhabitants) with limited economic resources and, therefore, with a diminished management and logistic capacity.

The economic resources of the municipalities come basically from their tax revenues (taxes, rates and special contributions), from their participation in the revenues of the state and the autonomous regions (transfers) and other non-tax revenues (those that come from the exploitation of their private patrimony, public prices, credit operations, fines and sanctions in the area of their competence and the subsidies that they could obtain).

It seems appropriate to propose a study that analyzes the performance of local tax management and collection bodies in these times of fiscal stress, since taxes are the main source of financing for municipalities (according to data from the Ministry of Finance and Public Function for Local Entities in Spain). Therefore, it will be essential to carry out tax management (and not only collection) in the most efficient and complete way that defends the economic range of local public services; particularly, taking into account the proximity character of local corporations for the provision of public goods and services that citizens demand [1].

According to the Spanish legal framework, municipalities may delegate the management of collection and inspection of their own taxes to other higher-level territorial entities.[1] In short, the management and collection tasks can be carried out by the local government itself, by delegation to the provincial council or to other higher-level public

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[1] In particular, the delegation of powers to other higher territorial entities is set out in Article 106.3 of Law 7/1985, of April 2, regulating the Bases of the Local Regime (LBRL) and in Article 7.1 of Royal Legislative Decree 2/2004, of March 5, which approves the revised text of the Law Regulating the Treasury (LHL). On the other hand, Article 36.1 LBRL expressly includes as the competence of the provincial councils, the assistance to the tax management and collection services of the municipalities with a population of less than 20,000 inhabitants; although, this competence can also be extrapolated to municipalities with a larger population.

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Table 1
Local tax management service provision options.

1. Direct management of taxation powers by the local government	a. Public service provided by the local council	Local council only
		With partner company
	b. Local self-governing agency	Self-governing agency only
		With partner company
2. Delegation of powers to provincial tier of government	a. Public service provided by the provincial government	Provincial government only
		With partner company
	b. Local self-governing agency	Local self-governing agency only
		With partner company
3. Delegation to regional government	As above, plus regional taxes	

Source: Own elaboration based on the Law on the Basis of Local Government and the Law on Local Tax Authorities.

entities such as the autonomous regions (in the case of single-province ones). It is quite common to combine several of these formulas.

Table 1 illustrates the different ways that municipalities can choose to carry out the management of their taxes. From this information, it can be deduced that there are two fundamental decisions for local leaders. The first is whether or not to delegate the management and collection of any of their taxes to their provincial council or to a specialized collaborating company. The second one is whether or not to constitute an autonomous body.

Although it is quite possible that political considerations are present in the final decision, the technical assessment must take into account the different appreciations. The model of delegation in the province to carry out tax management offers local governments a set of advantages to face several limitations: a) the lack of technical and human resources to efficiently and effectively manage their taxes, b) the complexity of existing regulations, c) the scarcity of human resources to update tax information, d) the intrinsic difficulty to adapt to ICT. Additionally, this management system shows a number of relevant benefits to the city councils, such as: being an alternative way of financing through advances on collection, by facilitating online payment, or even stimulating an environment of transparency in management and financial support. In fact, in this study it was observed that more than 90% of Spanish municipalities tend to delegate some aspect related to the management of their local taxes to the provincial institution (see Section 4 for details).

On the other hand, constituting a specific *ad hoc* autonomous body is motivated by the search for greater flexibility in the management and organization of the structures, while public control and ownership is maintained. It can either fully develop all the tasks or partially provide the service, together with collaborating companies [2]. Considering that the argument used to constitute an autonomous organism is based on maximizing management efficiency [3], it seems feasible to take this fact into account when trying to evaluate the efficiency of management and collection in provincial tax agencies.

Many papers have included this type of variables by using different extensions of the traditional non-parametric models like DEA (*Data Envelopment Analysis*) or FDH (*Free Disposal Hull*), given the higher flexibility to adapt better to the particularities of this type of public services and the possibility to account for several inputs and outputs [4]. These methods are supplemented by a second-stage analysis using methods ranging from conventional inference, like Tobit or ordinary least square models. Some works that apply these techniques in the field of tax agency efficiency analysis are, for example, Moesen and Persoon [5] and Barros [6]. In those models, the estimation of the parameters in the second stage regression is biased due to it using the estimation of the non-parametric efficiency obtained in the first stage as dependent variable, which is not observed. Simar and Wilson [7,8] offered an alternative that allowed solving these bias problems by introducing algorithms based on truncated regression and bootstrapping techniques, which provide more consistent results. This methodology has been widely used in different fields as, for example, in municipal management [9,10]. Nonetheless, the key limitation of these procedures is that the contextual variables are implicitly assumed to influence only the inefficiency levels and not the shape of the efficient production frontier (commonly known as the separability condition).[2]

In this paper, we use one of the most used techniques for properly processing exogenous variables without having to assume separability among variables [11]. This is the robust version of the non-parametric conditional model developed by Daraio and Simar [12–14] based on research by Cazals et al. [15]. To the best of our knowledge, this methodological approach has not as yet been used to evaluate local tax collection management, and hence this study is a clearly innovative line of research.

The impact of the choice to set up a specialized self-governing collection agency on office inefficiency is analyzed using the meta-frontier concept, developed by Battese and Rao [16], Battese et al. [17] and O'Donnell et al. [18]. Based on this methodology, inefficiency will be able to be decomposed into two factors: inefficiency due to there being a self-governing agency and intrinsic inefficiency of the provincial office.

In short, we aim to achieve two main objectives in this paper. First, we are interested in exploring how the efficiency estimation of the provincial tax agencies is affected when contextual variables are taken into account. To this end, an analysis of the efficiencies is carried out by using the robust conditional model. Secondly, we wish to analyze whether the fact of constituting an autonomous body for tax collection affects the performance of the provincial agency, for which a meta-frontier analysis is used.

This paper is structured as follows. Section 2 reviews studies on local tax collection and management agency efficiency and productivity. Sections 3, 4 and 5 report the methodology, the data and variables and the results, respectively. Finally, Section 6 outlines the main conclusions.

2. Literature review

Local governments in countries worldwide play a key role in public service provision, ranging from waste management and street cleaning services to the organization of state education and support for more vulnerable population groups through social services. Focusing on this circumstance, Walker and Andrews [19] review publications on local government management performance in specialized SSCI (Social Sciences Citation Index) journals. Based on 490 selected papers, they conclude that the biggest group of studies addresses performance measurement focusing mostly on the following fields of interest: organization size, underlying strategies, planning, staff quality, personnel stability, representative bureaucracy and networking. Hence, we deduce that the study of local tax revenue management efficiency is far from the top priority in studies focusing on local governments.

Based on the study by Cordero et al. [20] summarizing major research analyzing tax office efficiency both internationally and in Spain, we find that articles focusing on local taxation are scarce.

[2] This restrictive condition demands that exogenous variables should be fully independent of the input and output space, which is not usually the case. Several tests to check that this condition is met have been reported in the literature (see [Ref. 47]), although they are not often used in applied research.

Although it is true that research by Førsund et al. [21,22] and Barros [6], Mohammadi et al. [23] and the works of Shwu-Huei et al. [24] and Huang et al. [25] applying the Malmquist index, DEA and NDEA (network data envelopment analysis), respectively, address local office efficiency, they target nationwide taxes and how they are collected by diverse local offices, but neglect local taxes. Additionally, taxation relies - depending on each particular country - on different taxable transactions at a local and national level.

Lewis [26] published a paper on taxes collected by local governments, which applied a stochastic frontier parametric method to analyze the inefficiency costs of local government tax collection in Indonesia. He found that the more transfers and subsidies municipalities receive from the central government, the more inefficient tax collection management is.

Very recently, Nguyen et al. [27] have analyzed efficiency in tax administrations at a country-level study for 44 countries. They obtain efficiency measures in two different periods incorporating contextual variables in the estimation. To conduct it, the StoNEZD semi-parametric model is applied, and subsequently, the conditional order-m model is used as a robustness check.

Focusing on Spain, Fuentes and Lillo-Bañuls [28] applied the Malmquist index to analyze the efficiency and productivity change of the 30 Alicante Provincial Tax Management Agency (SUMA) regional offices responsible for collecting and managing local taxes for local councils in the province of Alicante over the period 2004–2006. Like us, they analyze a taxation model based on several taxes relying more on levies related to property and economic activity than to income and consumption.

Regarding the use of the robust conditional model used in this research, as far as we know, there is scarce literature that uses this methodological approach. We only find a recent work by Cordero et al. [29], in which a conditional model is applied to analyze the evolution of technical efficiency in tax offices in Spain at a regional level by using directional distance functions, which allows the incorporation of undesirable outputs in the production function. Neither are we aware of any paper that has used a metafrontier approach in this empirical framework, although it has been widely applied in other public economics contexts like education [30,31], healthcare [32] or public municipal services [33]. Consequently, the joint application of these two methodological approaches within a single analysis in this particular field is a clearly innovative feature of this research.

3. Methodology

3.1. The Free Disposal Hull (FDH) efficiency estimator

Let us assume that we have observed a set of n production units, called Decision Making Units - DMUs (provincial tax authorities in this paper). The DMU j consumes amounts of inputs $x_j = (x_{1j}, \ldots, x_{mj}) \in \mathscr{R}_+^m$ to produce amounts of outputs $y_j = (y_{1j}, \ldots, y_{sj}) \in \mathscr{R}_+^s$. The relative efficiency of each DMU in the sample is estimated with respect to what is known as the production possibility set. In general terms, the production possibility set T is mathematically characterized as follows:

$$T = \left\{(x,y) \in \mathscr{R}_+^m \cdot \mathscr{R}_+^s : x \text{ can produce } y\right\} \tag{1}$$

There are different non-parametric methods in the literature to estimate T. One of the most common methods is the Free Disposal Hull (FDH) estimator proposed by Deprins et al. [34], which is based on the assumption of free availability. It means that if $(x, y) \in T$, then $(x', y') \in T$ for all $x' \geq x$, $y' \leq y$:

$$T_{FDH} = \left\{(x,y) \in \mathscr{R}_+^m \cdot \mathscr{R}_+^s : \exists\, j = 1, \ldots, n \text{ such that } x \geq x_j,\ y \leq y_j\right\} \tag{2}$$

With respect to the measurement of technical efficiency, the two common approaches are linked to input and output orientations. Our research focuses on the output orientation, that is, we account for the maximization of the outputs at a constant input level.[3] Particularly, the output oriented radial model defines the efficiency score for an evaluated unit by proportionally increasing the outputs while the inputs remain constant:

$$\phi^{FDH}(x_j, y_j) = max\left\{\phi_j \in R : (x_j, \phi_j y_j) \in T_{FDH}\right\} \tag{3}$$

The estimation of the efficiency score can be obtained from the following mixed linear programming model:

$$\phi^{FDH}(x_0, y_0) = \max \phi_0 \quad \text{s.t}$$

$$\sum_{j=1}^{n} \lambda_{j0} x_{ij} \leq x_{i0}, \quad i = 1, \ldots, m$$

$$\sum_{j=1}^{n} \lambda_{j0} y_{rj} \leq \phi_0 y_{r0}, \quad r = 1, \ldots, s$$

$$\sum_{j=1}^{n} \lambda_{j0} = 1,$$

$$\lambda_{j0} \in \{0, 1\} \quad j = 1, \ldots, n \tag{4}$$

The optimal value ϕ_0^* of model (4), which is a linear programming model, is always equal to or greater than 1. ϕ_0^* denotes the DMU_0 efficiency score. On the one hand, if $\phi_0^* = 1$, then the DMU_0 is considered technically efficient. On the other hand, if $\phi_0^* > 1$, the DMU_0 is inefficient, and there is room for an equiproportional increase in its output levels, consuming the same amount of inputs.

Despite this technique being extensively used in wide-ranging fields of public economics to estimate efficiencies, it does have some major limitations. They include the fact that it is completely deterministic, whereby any deviation from optimal production is attributed to inefficiency, slow convergence rates (which lead to model dimensionality problems), and high sensitivity to sample outliers or extreme values.[4]

3.2. Probabilistic approach. Robust conditional model

In this subsection, the robust conditional model is described in terms of the probabilistic formulation developed by Cazals et al. [15]. The main advantage of that approach is that it does not require the fulfillment of the restrictive separability assumption [11]. This implies that it is not necessary to explicitly check if the exogenous factors are impacting only in the inputs-outputs space or also in the distribution of the inefficiencies.

In probabilistic terms, the joint probability function of inputs and outputs is characterized as follows:

$$H_{XY}(x, y) = \text{Prob}(X \leq x, Y \geq y) \tag{5}$$

This function represents the probability of a unit operating at level (x, y) being dominated. In the empirical context of this study, more or less efficient management of the tax collection offices can be affected by the action of non-controllable exogenous factors. Consequently, these contextual conditions have to be taken into account in the efficiency analysis in order to establish a fairer comparison between units. These factors can be included in the probabilistic formulation as an additional set of variables that will have an impact on the space (X,Y), as well as the

[3] We have used an output orientation due to the limited flexibility that tax agencies have to reduce their inputs. However, they do have a greater capacity to manage these resources in order to increase their revenues. There are many studies that analyze the efficiency of tax agencies where output orientation has been applied, as for example Barros [6] or Villar-Rubio et al. [48].

[4] See Simar and Wilson [7] for a detailed analysis of the major shortcomings of this methodological option.

on the efficiency distribution.[5] According to Daraio and Simar's proposal [12,14], the probability of a unit operating at level (x,y) being dominated by a unit operating under the same exogenous conditions $(Z=z)$ will be:

$$H_{X,Y|Z}(x,y|z) = Prob(X \leq x, Y \geq y|Z=z) \tag{6}$$

In an output-oriented model, the decomposition of this function will lead to two terms, the conditional survival function of outputs and the conditional distribution function of inputs, as follows (simplified notation):

$$H_{X,Y|Z}(x,y|z) = S_{Y|X,Z}\left(y|x,z\right)F_{X|Z}\left(x|z\right) \tag{7}$$

Accordingly, the conditional efficiency measure ϕ_0 can be rewritten as

$$\phi_0(x,y|z) = sup\left\{\phi_0 > 0 \middle| H_{X,Y|Z}(x,\phi_0 y|z) > 0\right\}$$

$$= sup\left\{\phi_0 > 0 \middle| S_{Y|X,Z}(\phi_0 y|x,z) > 0\right\} \tag{8}$$

A plug-in rule can be used to get different non-parametric efficiency estimators for total frontiers (like FDH or DEA) or partial (order-m or order-α) frontiers.[6] Partial frontiers can be considered as robust versions of the conventional FDH and DEA. They are much less sensitive to outliers since the efficient frontier is built with just a limited number of observations and not all DMUs.[7]

In particular, we use the robust conditional order-m estimator, developed by Daraio and Simar [12], whereby we can obtain efficiency measures for a unit compared exclusively with units that use either the same amount of or fewer inputs. This subset of observations is determined by the value of parameter m, which will always be greater than or equal to 1. With a large enough m (in practice, equal to the number of DMUs in the sample), the measure of efficiency would be equivalent to a full frontier like FDH. The choice of this parameter can be determined according to different criteria (see, for example [11,14]), although, for practical purposes, we will follow Tauchman [54].[8] Note that, as the frontier built with this estimator will not envelope all observations, there may be efficiency scores whose value is less than 1. This means that there are superefficient units that are above the frontier formed by the m units with which they were compared. Daraio and Simar [14] define the order-m output-oriented efficiency estimator as follows:

$$\phi_m(x,y|z) = \int_0^\infty \left[1 - \left(1 - S_{Y|X,Z}(uy|X \leq x, Z=z)\right)^m\right] du \tag{9}$$

The critical point of this technique is the non-parametric estimation of the conditional survival function ($S_{Y|X,Z}$), as it requires the use of smoothing techniques for the Z variables (due to the equality constraint $Z=z$). To accomplish it, we calculate the right bandwidth parameter (h) for the corresponding kernel functions involved in the estimation,[9] which leads to selecting the units that will be used as a benchmark in the comparison. In this paper, we use the methodology proposed by Badin et al. [35], based on a least square cross-validation (LSCV) process.[10] Thus, the empirical version of the survival function can be obtained from:

$$\widehat{S}_{Y|X,Z,n}(y|x,z) = \frac{\sum_{i=1}^n \boldsymbol{I}(x_i \leq x, y_i \geq y) K_{\widehat{h_z}}\left((z-z_i)\Big/h\right)}{\sum_{i=1}^n \boldsymbol{I}(x_i \leq x) K_{\widehat{h_z}}\left((z-z_i)\Big/h\right)} \tag{10}$$

This procedure has the ability of distinguishing the influential exogenous factors from the irrelevant ones. It can detect and smooth out irrelevant factors by providing sizable values to the related bandwidth parameters (see Ref. [36] for details).

Another advantage of using the robust conditional model is that it can determine whether or not the conditioning variables have a significant effect. According to De Witte and Kortelainen [38], the application of the bootstrap test proposed by Racine [39] can be regarded as the non-parametric equivalent of the t statistic used in the ordinary least squares linear regression model, where the p-value determines whether the variable has a significant influence.[11]

This conditional model also provides the possibility of analyzing and visualizing the possible impact (positive or negative) of exogenous variables on the production boundary, illustrated by frontier shifts. This can be done by evaluating a non-parametric regression, where the regressors represent the exogenous variables, and the ratio between the conditional efficiency and the original efficiency is the dependent variable[12]:

$$\widehat{R}_m(x,y|z) = \frac{\widehat{\phi}_m(x,y|z)}{\widehat{\phi}_m(x,y)} \tag{11}$$

According to Badin et al. [40], an upward trend of the ratio at high contextual variable values for an output oriented model would suggest that the effect on the frontier shift is positive (the conditional frontier moves closer to the original, which means that the exogenous variable is acting like a fully available input). However, a downward trend of the ratio at high contextual variable values denotes a negative effect (the conditional frontier moves away from the original, which means that the exogenous variable is acting like an undesirable output).

3.3. Decomposing inefficiency: the metafrontier approach

As the structure of our data is hierarchical (agencies operating under different collection management systems), we adapt the metafrontier concept developed by Battese and Rao [16], Battese et al. [17] and O'Donnell et al. [18]. This approach measures the efficiency of units with respect to best practice frontiers and can single out which part of inefficiency is attributable to the agencies themselves and which portion to the tax management system.

The metafrontier is defined as the unconstrained envelope set (that is, the efficient frontier considering all units). If we divide the sample according to the two management systems under study (provinces with and without a specific self-governing tax collection agency), each with its own distinctive features, we can build a separate frontier for each of the two groups (local frontiers). The metafrontier will envelop the local frontiers as shown in Fig. 1. The distance of one unit to the respective

[5] The contextual variables are directly included in the estimation via the production function in probabilistic terms as shown by equation (5). Therefore, the restrictive separability condition does not need to be checked because we are assuming that the Z factors could have an impact on both, the frontier and on the inefficiencies [47].

[6] See Daouia and Simar [37] for a detailed description of order-α frontiers.

[7] Daraio and Simar [13]; p.77 present a clear and concise exposition of the main advantages of the partial frontiers. It is detailed here that the main limitations (outliers or extreme data, efficiency slacks, dimensionality problems due to samples of moderate size, etc.) of traditional nonparametric total frontier models (DEA/FDH) are overcome by the "appealing" economic features and statistical properties of partial frontiers.

[8] The formula that this author suggests is $\sqrt[3]{n^2}$.

[9] We use the standard continuous kernels proposed by Racine and Li [49] and Li and Racine [50] to smooth all components of Z.

[10] See Li and Racine [50] and Badin et al. [35] for a detailed description of this procedure.

[11] As is noted in Daraio and Simar [51], this procedure is only acceptable when partial frontiers are used in the estimation, as is the case of this work.

[12] As is explained below, in this paper we focus on the impact of contextual factors on the frontier shifts, that is, which is derived from ratios estimated by extreme order-m measures. Nonetheless, it is possible to conduct a similar analysis by using ratios from median frontiers, i.e., obtained with small values of the parameter m (see Ref. [40]; for details).

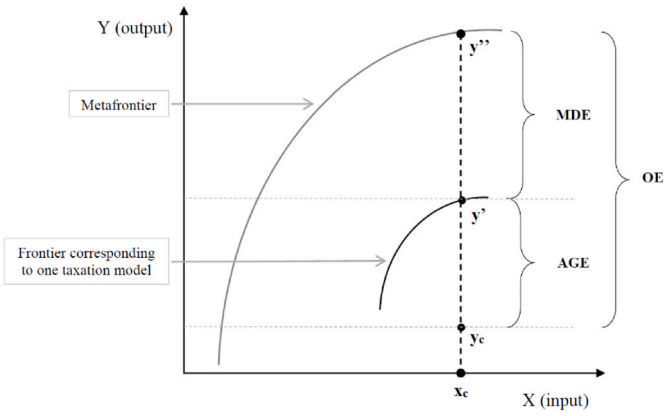

Fig. 1. Illustration of the metafrontier (inefficiency decomposition).

local frontier depends exclusively on agency efficiency (AGE -AGency Efficiency-), whereas the distance from the local frontier to the global frontier can be regarded as the "management model effect" (MDE -MoDel Efficiency-).

As shown in Fig. 1, the efficiency level of each office, c, depends on the resulting output level (y_c) using its respective input allocation (x_c). That agency is inefficient, as others operating under the same tax management model achieve better output levels (y') with the same amount of inputs (x_c).

The inefficiency of the local agency can be defined by the ratio of the potential output level to the real output level ($AGE = y'/y_c$). When this agency is compared to the metafrontier, the overall efficiency (OE -Overall Efficiency-) can be defined as $OE = y''/y_c$. Based on these two efficiency measures, the effect of the management model selected by the agency can be output directly from $MDE = y''/y' = OE/AGE$. In short, the overall efficiency of a unit can be decomposed into two effects: $OE = AGE \times MDE$.

4. Database and variables

4.1. A brief description of the organization of tax management in Spain

In this subsection, we briefly report the Spanish tax administration system following the excellent overview in Cordero et al. [29]. The structure of that system in Spain is organized at three levels: national, regional, and local (in both, municipal and provincial tiers). It is usually categorized as hybrid as opposed to the highly decentralized models applied in other countries.

At the national level, the national revenue service (*Agencia Estatal de Administración Tributaria* –AEAT) manages the major tax figures (personal income tax, corporate tax, value-added tax, and excise taxes). At the regional tier, autonomous regions are responsible for managing several regional low revenue-generating taxes and other taxes fully transferred by the state. Specifically, regional governments (since the latest reform of their financial system in 2017) mainly manage and collect numerous taxes related to patrimonial assets (real estate transfer tax and inheritance and donation tax).

Finally, local governments manage five kind of taxes and several tariffs, official fees, and levies. All of these tax figures represent 61.7% of total municipal revenue, of which property tax (*Impuesto sobre Bienes Inmuebles* - IBI), which is collected in collaboration with the central administration, is by far the most important financial source. It represents 62.1% of all tax revenues (according to 2017 Ministry of Finance and Public Administration for Local Corporations data which reflects 2015, year of our study). There are also other taxes for economical activities, vehicles and capital gains in the value of urban land and for construction, which figure to a lesser extent with regard to municipal income.

4.2. Data and variables

For our study, we used ordinary system provincial tax agency data for the year 2015. Note that some single-province regions,[13] foral system provinces[14] and any provinces with missing information on key variables were not taken into account, in order to guarantee that the data we were using were homogeneous and more or less reliable. Hence, the study was conducted with files from 36 provincial tax agencies (see Table A1 in the Appendix).

Based on the existing literature on local tax agency efficiency and productivity estimation [21,23,28], we considered three inputs, one output and four exogenous or environmental variables. The selected inputs are the total office workforce, including civil servants and employees under contract, the number of tax offices distributed throughout the province and the average availability of tax agency electronic office services. As regards the output used, we accounted for total revenue raised by the tax agencies. As already explained above, it is necessary to take into account the socioeconomic environment in which the provincial tax agencies operate in order to analyze their efficiency. To do this, we selected four contextual variables, namely: the total net tax base of the province,[15] province population density (pop. X km^2), the percentage of municipalities that delegated their tax affairs to the provincial authority, and, finally, the population whose municipalities have delegated their powers to the provincial tax agency.

Table 2 shows the key descriptive statistics for the variables used in the study for all 36 provincial authorities in the sample (a), for the 19 provinces that set up a self-governing body (b) and for the 17 provinces that did without a self-governing agency (c) (Table A2 in the Appendix shows the provinces in each group).

Note that the total sample is divided into provinces that have and have not set up a self-governing agency. We opted for this segmentation because the doctrine states that tax procedures are more expeditious and service provision is faster with self-governing agencies, basically because they reduce the number of associated decision-makers [2]. Additionally, in the case of local tax collection and management, local leaders and managers are both very keen to have a neutral body to take charge of the undesirable task of tax collection and relieve them of direct pressure from their citizens.

When analyzing the results of the sample segmentation of the provincial tax agencies depending on whether or not they set up a self-governing agency, we find that, in the first case, resource consumption (inputs) is greater for all items analyzed, which also results in substantially higher total revenue (output). Additionally, the environmental variables show that the provinces where a self-governing agency is responsible for tax collection are more complex in population terms (with a higher population density and a larger number of people requiring service provision) and have a higher net property tax base. Although the municipalities that they serve are also larger, the

[13] The single-province regions tend to either concentrate regional and local tax management or leave it to the municipalities to organize their own affairs without setting up any specialized service or management agency. Some provincial/regional tax agencies have not provided us with the data on local taxes or these were insufficient (Cantabria and Murcia). In the case of Madrid, as the most populated province, municipalities have not delegated their tax powers to their *comunidad autónoma* (autonomous region) and, therefore, all of them follow the so-called local model, i.e. each municipality carries out the tax management (see Table 1). Therefore, we have only considered Asturias, Baleares and La Rioja as single-province regions.

[14] Law 7/1985, of 2 April, on the Basis of Local Government and Royal Legislative Decree 2/2004, of 5 March, passing the consolidated text of Law 39/1988, of 28 December, regulating Local Government Tax Authorities, set forth the peculiarities of the historical regions of Álava, Guipúzcoa and Vizcaya and the foral system of Navarra.

[15] The total provincial net tax base including urban, rural property and special assessment tax according to Directorate General of Land Registry data.

Table 2
Descriptive statistics for Spanish tax agencies.

(a) Total sample

	Variables	Mean	SD	Min	Max
Inputs	Office workforce	133.33	147.06	3.00	680.00
	No. offices	15.28	17.93	1.00	102.00
	Internet	3.06	0.88	1.00	4.00
Output	Total revenue (M€)	221.52	318.72	13.11	1,709.43
Exogenous variables	Total net property tax base (M€)	37.25	50.51	5.21	291.43
	Population density	95.89	130.61	8.80	714.80
	% municipalities delegating to provincial authority	94.98	8.17	55.43	100.00
	Population served by provincial authority (thousands of people)	568.29	697.85	45.42	3,846.11

(b) With self-governing body

	Variables	Mean	SD
Inputs	Office workforce	183.00	177.70
	No. offices	21.26	22.60
	Internet	3.29	0.77
Output	Total revenue (M€)	309.65	401.80
Exogenous variables	Total net property tax base (M€)	45.94	64.73
	Population density	125.11	167.40
	% municipalities delegating to provincial authority	96.00	5.93
	Population served by provincial authority (thousands of people)	696.74	858.68

(c) Without self-governing body

	Variables	Mean	SD
Inputs	Office workforce	77.82	74.71
	No. offices	8.59	6.21
	Internet	2.81	0.94
Output	Total revenue (M€)	123.02	145.11
Exogenous variables	Total net property tax base (M€)	27.53	26.04
	Population density	63.24	60.37
	% municipalities delegating to provincial authority	93.84	10.19
	Population served by provincial authority (thousands of people)	424.73	440.81

difference is hardly significant, being over 90% in both cases.

In the following section, we detail each of the selected variables for this research. Within the inputs, the workforce has, in most cases, been found to be organized according to increasingly complex specialized tasks, generally accounting for: tax management, tax collection (before and after the due date), tax inspection and other roles. Additionally, the organizational framework of the workforce also has to take into account the intensity of task outsourcing and how large the taxpayer service office network is [41]. In any case, observed differences are that self-governing agencies are manned by employees under contract, whereas the provincial authority services are staffed by civil servants. Additionally, workforce roles vary depending on whether they are assigned to central or regional offices. On average, there are just over 133 people working in provincial offices managing and collecting local taxes on behalf of municipalities. Although workforce size is very wide-ranging (there are three people working at the smallest office in Soria compared to 680 at the largest, in Barcelona), we think that the fact that municipalities delegate most of the management to provincial agencies calls for a smaller and more specialized workforce than if the tasks were performed by local authorities directly, generating economies of scale.

As regards the network of offices distributed throughout provinces, we think that it is an indicator of better tax management service quality for citizens insofar as it provides service proximity and minimizes travel. The least populated provinces (Lugo, Palencia and Soria) are the ones that have only one central office, whereas the more populated provinces have more offices. Exceptions to this trend are Huelva and Pontevedra with 22 offices, whereas Valencia has only 17.

One of the key issues in the study of tax management is the increasing deployment of electronic processing systems with respect to payment, applications or claims (see Table A3 in the Appendix). In this respect, we have introduced four categories measuring the scope of the electronic procedures to gauge how virtual offices are, namely: a) face-to-face service, when there is some information about what the procedure or service is and/or how it can be performed on the agency portal. This category has been scored 1; b) basic service, taxpayers can download forms, that is, the above information is available and the taxpayer has the option of downloading the forms required for the procedure. This category has been scored 2; c) advanced service, when taxpayers can start a procedure online with the same legal guarantees as if it they had done so in person. This category has been scored 3; d) full service, when taxpayers can complete the entire procedure online with the same legal guarantees as if it they had done so in person. This category has been scored 4. Agencies that have not provided this information or do not even offer the basic service have been excluded from the study. Generally speaking, more and more local tax management services are being deployed electronically, as almost all the information is available on the web and procedures can be initiated online.

As regards the output, we have looked at the total amount of revenue collected following on from earlier international [42–44] and Spanish (e.g., Refs. [28,45,46]), research. According to the data breakdown for this study, we found that a high percentage of taxes are collected before the due date as a result of agency payment facilities: campaigns to promote tax payment by direct debit, active advertising of payment periods, more online payment channels, etc. Hence, citizens can be classified as having a civic and responsible attitude towards local tax payment.

On the other hand, we have the uncontrollable variables representing the context in which the collection agencies operate. First, we considered the total net property (urban, rural and special assessment) tax base, as it is the net tax base calculated based on the property land registry value that is taken into account to calculate the property tax bills to be paid by taxpayers. It is equated to an indicator of the economic conditions and is linked to contributive capacity. Additionally, according to the local tax agency report on figures for 2015 published by the Ministry of Finance and Public Administration (2017: 47) [55], 68% of

councils' tax income comes from direct taxes, of which property tax accounts for the largest amount, adding up to over half of all tax revenue (2017:53).

Population density, that is, the population size divided by province land area in km^2, provides general knowledge of the conditions of the people living in that province. Although the average population density of the provinces in our study (96/km^2) was close to the national average (92/km^2) in 2015, it is clear that the differences across the country are massive, the lowest being for the province of Soria with 8.8/km^2 and the highest for Barcelona with 714.8/km^2. Note that this variable is hugely asymmetric, and, therefore, there are few provinces with a very high population, whereas it is very low in quite a number of others. In particular, we found in our sample that 20% of the provinces, including Ávila, Cáceres, Guadalajara, Palencia, Soria, Teruel and Zamora, have a population density of under 22.8/km^2.

Finally, Table 2 compares the data on the percentage of municipalities that delegate to each of the provinces and the population that is covered by the respective authority. In almost all cases, we find that the percentage of delegating municipalities is greater than the percentage of the respective population that actually complete local tax administration procedures with the provincial authorities. These two figures do not match up, basically because neither the provincial capitals nor the large cities in almost all the provinces have delegated tax-related powers. This applies especially to provinces where a large part of the population is concentrated in a provincial capital and/or in a few large towns, although there is a significant institutional dispersion across very small municipalities.

Only in four provinces (Albacete, Alicante, Badajoz and Cáceres) have 100% of municipalities delegated powers, thus covering 100% of the population. A second tier includes provinces in which over 90% of municipalities have delegated powers, covering 90% of the population (Huelva and Teruel), from 50% to 90% of the population (A Coruña, Asturias, Ávila, Barcelona, Castellón, Ciudad Real, Córdoba, Cuenca, Granada, Jaén, León, Lérida, Lugo, Málaga, Segovia, Sevilla, Tarragona, Valencia and Zamora), and under 50% of the population (Burgos, Guadalajara, Palencia, La Rioja, Salamanca, Soria, Valladolid and Zaragoza, where there is a greater divergence between delegating municipalities and population covered). In Baleares, Ourense and Pontevedra less than 90% of their municipalities have delegated in the provincial tax agency.

Apart from this ratio of the percentage of delegating municipalities to the percentage of the population, highlighting that large cities are reluctant to delegate to higher-tier public authorities, the total population managed by provincial agencies has been regarded as a proxy of the potential number of taxpayers. Thus, we find there is a big gap between provinces with a population of just over 45,000 in Soria and Barcelona's population of 3.8 million.

5. Results

In this section, we report the main results of applying the methodology detailed in Section 3 for the 36 provincial tax agencies analyzed during the year 2015.

Fig. 2 shows the distributions of the estimated distributions of both efficiency estimates: the unconditional model (without including the exogenous variables) and the conditional model (accounting for the Z).[16] We find that the plots of both approaches are clearly different. This suggests that there is an exogenous effect on the production process analyzed that is significantly influencing the estimated efficiency scores. Looking at Fig. 2 in detail, we observe that the distribution of the conditional efficiencies is more concentrated around the value 1. This evidences that the units analyzed using this model are evaluated against a subsample of observations operating under the same context, which leads to a higher mean efficiency level. As in this study, we estimate the models by using a partial order-m frontier (with $m = 11$); each evaluated provincial tax agency is compared against another 11 randomly sampled offices that are operating in either under the same conditions or with with smaller or equal input values.

Table 3 shows the average output-oriented efficiency scores for both models. In view of the results, we find that, on average, the scores are higher for the model that does not consider the exogenous variables (unconditional), and, therefore, its efficiency levels are worse than for the conditional model. The mean efficiency of the conditional model improves substantially as it analyzes provinces that are operating in similar settings. Likewise, Spearman's correlation coefficient between the scores of the unconditional and conditional models (0.5507) reveals that both models arrive at different results, and, therefore, the addition of the environmental variables seems to have an impact on the performance of the evaluated units. Therefore, the fact that the minimum efficiency score values are below 1, indicates that the distribution contains superefficient units, that is, authorities that have higher output values than units with the same level of inputs located on the frontier.

Fig. 3 shows the differences detected in both models at a provincial level. This graph shows how the efficiency scores improve substantially when the model including the socioeconomic variables for each province is applied. Alicante, Asturias, Málaga and Barcelona are prominent examples, although each individual case can be appraised in more detail in Table 4. Table 4 lists the efficiency rankings of the provincial tax agencies according to the efficiency score estimated by both the unconditional (Table 4 (b)) and conditional (Table 4 (c)) models. Besides, Table 4 (a) includes the ranking by output achieved for each province (total revenue in million euros) in order to establish some interesting correspondences.

Looking at Table 4 (a), we find that the provincial tax agencies with above average total revenues are Barcelona, Alicante, Asturias, Málaga, Baleares, Tarragona, Sevilla, Huelva and Badajoz. However, these are not the tax agencies that turn out to be the most efficient when inputs are added to the efficiency model (Table 4 (b) and 4 (c)). This point is revealed by comparing the two estimated models (conditional and unconditional), as these agencies required a very high input of resources into the production process (a larger workforce, more virtual office resources and a larger number of tax collection offices) to achieve their output level. However, the efficiency level of these tax agencies changes when the socioeconomic context variables are taken into account in the estimation (Table 4 (c)), which leads us to think that the Z variables appear to have an impact on the performance of the evaluated units. The influence of these exogenous factors on tax agency management is reflected in the improved efficiency of the conditional model for some of these tax agencies, like, for example, Málaga, Asturias, Barcelona and Alicante.

A more detailed interpretation of the results of both models reveals that, according to the unconditional model, the superefficient provincial tax agencies are Salamanca, Palencia, Zamora, Ávila, Segovia, Lérida, Jaén, Castellón, Pontevedra and Valladolid, whereas the efficient provinces are Lugo, Ourense and Soria (note that the population density of most of the efficient and superefficient provinces is low). However, when the study is extended by adding the socioeconomic context, the provincial tax agencies considered efficient and superefficient change. According the conditional model, the superefficient tax authorities are Salamanca, Palencia, Ávila, Zamora, Pontevedra, Lérida and Almería (see Table 4 (c)). In particular, if we focus on the efficiency estimation of the Almería tax agency, we find that this agency swings from inefficient according to the unconditional model to superefficient when exogenous factors are taken into account. The same applies to the Teruel provincial tax agency, which is classified as an efficient authority by the conditional model after accounting for contextual variables, as opposed to

[16] We have selected the non-convex estimator for the order-m frontier after performing a test for convexity (see Ref. [52] for details). The statistic yields a value $\tau \cong$-3.4215 and the corresponding p-value after 1,000 bootstrap replications is 0.0003, thus the convexity assumption can be rejected.

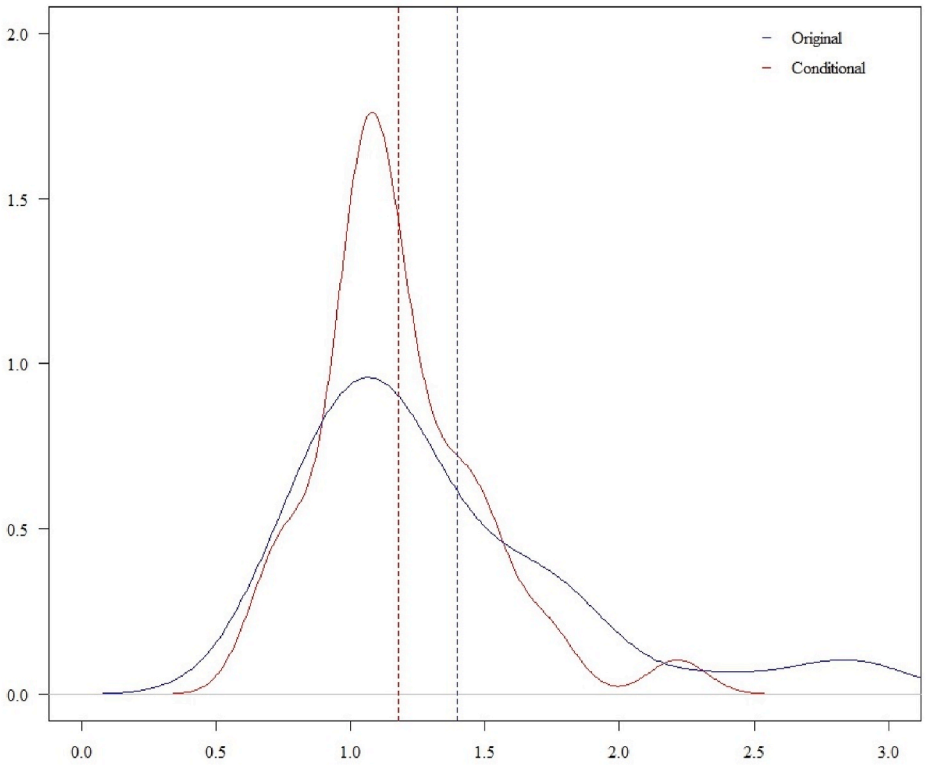

Fig. 2. Density plots of the unconditional (original) and conditional models.

Table 3
Descriptive statistics for efficiency scores.

	Unconditional model	Conditional model
Mean	1.4218	1.2377
Standard deviation	0.5595	0.2773
Minimum	0.7837	0.6930
Quartile 1	1.1437	1.1200
Median	1.2615	1.1749
Quartile 3	1.6644	1.3703
Maximum	3.4404	2.1398
ρ - Spearman	0.5507	

inefficient under the unconditional model. Additionally, we find that there is a sizable increase in the efficiency of some authorities when socioeconomic environment variables are added, an issue that is illustrated in both Fig. 3 and Table 4, where we find major improvements for Alicante, Asturias, Barcelona, Ciudad Real, Málaga, Tarragona and Toledo, among others.

On the other hand, note that some provincial tax agencies that were considered efficient by the unconditional model are rated as inefficient by the conditional model, for example, Castellón, Jaén, Segovia and Valladolid, whose efficiency scores dropped.

We now test the significance of the four environmental variables with respect to the efficiency values (see Table 5). The results suggest that three out of the four environmental variables have a significant influence on the resulting efficiency values: the total net property tax base, population density and population served by tax authority. On the other hand, the percentage of municipalities delegating powers is irrelevant in this study. This may be because the spread of this variable is very small, as, on average, 95% of municipalities have, as already mentioned, delegated tax management to their provincial authority (see Table 2).

Fig. 4 plots the non-parametric regression of the ratio of the conditional to the unconditional model with respect to each significant exogenous variable. As explained above, we focus the analysis to visualize the effects on the frontier shifts, obtained from robust estimations of the full frontiers.[17] In an output-oriented representation, an upward trend in the ratio as the value of the contextual variable increases is indicative of a positive effect on efficiency. Fig. 4 (a) shows that the exogenous variable for the total net property tax base has a negative influence (at high variable values) on the efficiency estimation of tax authorities, where the higher the value of the net property tax base (which is an indicator of the economic conditions linked to tax capacity) is, the lower the efficiency of the tax authority is. In fact, we find that this issue affects the provincial tax agencies of Barcelona, Málaga, Valencia and Alicante.

As regards the effect of population density, we again find that it exerts a negative influence on efficiency (Fig. 4 (b)). We detected that higher population density has an unfavorable effect on tax agency efficiency, which is much more pronounced at higher population density values. This applies to the Barcelona and Alicante tax authorities.

Finally, we find that the variable representing the total population managed by the provincial tax agency has a negative impact on efficiency (Fig. 4 (c)). Again, Barcelona, Alicante, Valencia and Sevilla are the tax agencies that manage a larger delegated population, and this issue has a negative influence on their efficiency scores. However, low population sizes improve the efficiency of tax collection authorities, as happens, for example, in Almería and Teruel.

Now that we have analyzed the importance of the contextual variables that condition the provincial tax agency production process and

[17] As mentioned above, we discard showing here the same analysis for partial frontiers ($m = 1$) because we did not find substantial differences among these two trends.

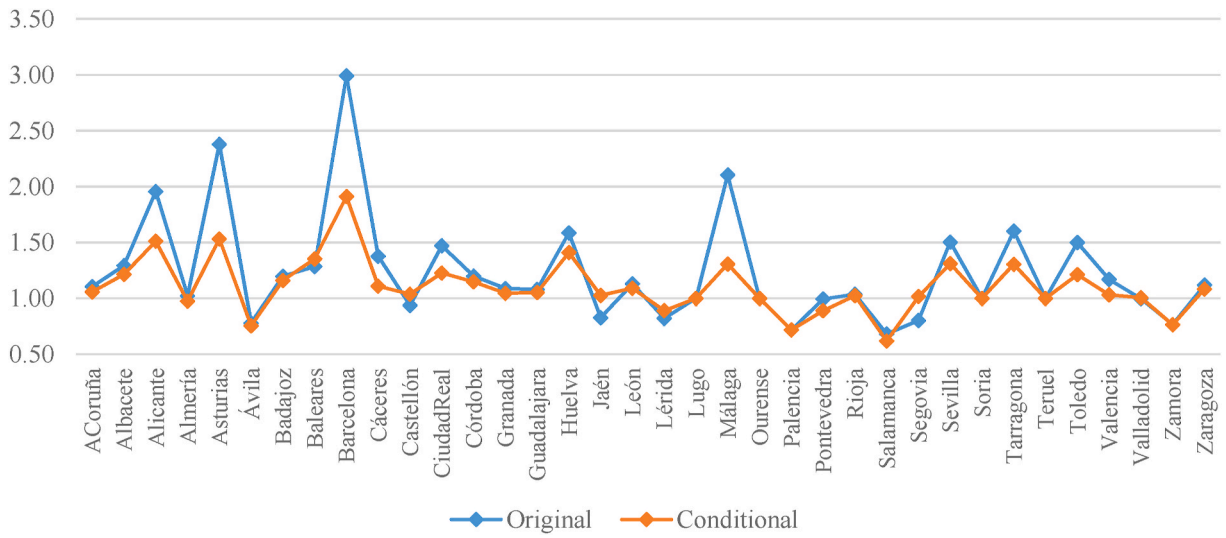

Fig. 3. Comparison by provinces between the original and conditional models.

Table 4
Provincial tax agency ranking by total revenue (a), efficiency according to the unconditional model (b) and efficiency according to the conditional model (c).

(a)		(b)		(c)	
Province	Revenue (M€)	Province	Unconditional	Province	Conditional
Barcelona	1,709.43	Salamanca	0.7837	Salamanca	0.6930
Alicante	904.69	Palencia	0.8243	Palencia	0.8026
Asturias	602.88	Zamora	0.8793	Ávila	0.8455
Málaga	563.93	Ávila	0.8957	Zamora	0.8556
Baleares	455.78	Segovia	0.9215	Pontevedra	0.9956
Tarragona	365.06	Lérida	0.9368	Lérida	0.9957
Sevilla	329.31	Jaén	0.9439	Almería	0.9982
Huelva	300.49	Castellón	0.9515	Lugo	1.0000
Badajoz	222.16	Pontevedra	0.9938	Ourense	1.0000
Mean	**221.52**	Valladolid	0.9966	Soria	1.0000
Córdoba	197.69	Lugo	1.0000	Teruel	1.0000
A Coruña	170.70	Ourense	1.0000	Valladolid	1.1259
Granada	166.57	Soria	1.0000	Segovia	1.1380
Toledo	159.98	Teruel	1.1501	Rioja	1.1468
Cáceres	148.92	Almería	1.1753	Jaén	1.1491
Valencia	145.85	Rioja	1.1916	Valencia	1.1550
Castellón	136.25	Guadalajara	1.2400	Castellón	1.1622
Albacete	131.56	Granada	1.2522	Granada	1.1714
Ciudad Real	129.70	A Coruña	1.2708	Guadalajara	1.1785
Pontevedra	121.08	Zaragoza	1.2867	A Coruña	1.1848
Jaén	120.66	León	1.2997	Zaragoza	1.2128
Lérida	120.41	Valencia	1.3442	León	1.2213
Almería	111.64	Badajoz	1.3771	**Mean**	**1.2377**
León	83.00	Córdoba	1.3785	Cáceres	1.2425
Zaragoza	80.27	**Mean**	**1.4218**	Córdoba	1.2860
Salamanca	66.01	Baleares	1.4783	Badajoz	1.2993
Rioja	63.24	Albacete	1.4871	Toledo	1.3572
Guadalajara	63.07	Cáceres	1.5832	Albacete	1.3603
Segovia	46.33	Ciudad Real	1.6914	Ciudad Real	1.3736
Ávila	44.18	Toledo	1.7234	Tarragona	1.4609
Lugo	40.57	Sevilla	1.7290	Málaga	1.4643
Valladolid	40.07	Huelva	1.8231	Sevilla	1.4685
Teruel	32.01	Tarragona	1.8424	Baleares	1.5146
Zamora	30.91	Alicante	2.2490	Huelva	1.5784
Palencia	29.07	Málaga	2.4200	Alicante	1.6922
Ourense	28.11	Asturias	2.7355	Asturias	1.7152
Soria	13.11	Barcelona	3.4404	Barcelona	2.1398

the effect that they have on their efficiency, we should look at whether or not the existence of a self-governing collection agency has an impact on office efficiency.

Applying the metafrontier approach proposed in Section 3, we subdivided the sample of 36 units described in Section 4 into two groups: (1) 19 authorities that do have a specialized self-governing tax collection agency, and (2) 17 tax authorities that opted not to set up such an agency. The methodology requires the construction of three frontiers

Table 5
Significance of exogenous variables in the conditional model.

Exogenous variable	*p*-value
Total property net tax base	0.00 ***
Population density	0.00 ***
% municipalities delegating to provincial authority	0.18
Population served by provincial authority	0.01 **

(***) 99% significance level.
(**) 95% significance level.

using the robust conditional order-m model. Two of these will be local frontiers for each group, and the other will be a frontier including all the units (metafrontier). We set the value for all frontiers at $m = 8$[18] in order to guarantee that each unit is compared with the same number of offices in all three cases.

Table 6 shows the mean efficiency scores for the metafrontier analysis. The results reported in column 1 show the total average inefficiency of the evaluated unit, which is composed of agency-induced inefficiency and management system-induced efficiency. As shown, the tax authorities that have a specialized self-governing tax collection agency are more inefficient than authorities that do not, when compared against the whole sample. This could be due to the fact that they use a lot more inputs in the production process than the units in the second group, that is, these agencies allocate a large amount of resources specifically to tax collection tasks.

On the other hand, the average efficiency for each group with respect to its local frontier (Table 6, column 2) suggests that authorities with specialized self-governing agencies are more efficient than those without. Unlike the above analysis, the comparison is confined to units operating under the same management model, and the resulting output levels are much higher in the first group than for authorities without self-governing agencies.

The proportion of inefficiency that can be attributed to the authority having or not having opted for a management system based on a self-governing agency can be derived from the decomposition of total inefficiency described in Section 3. Looking at the resulting percentages of inefficiency shown in Table 6, we find that almost half of the inefficiency of the group that set up a specialized self-governing agency can be attributed to operational issues (~45%), whereas the other half is due to it having opted for a self-governing agency model. However, the inefficiency due to the choice of management model in the second group is negligible (~4%), meaning that these units are not at a disadvantage even though their management environment is not specialized in the development of the activity. Any inefficiency will therefore be due almost entirely (~94%) to the performance of the tax office in question.

6. Conclusions

Local taxes are the key source of resources for municipalities. Therefore, we believe that it is of vital importance to analyze tax resource collection and management, taking into account that local corporations are the closest tier of government to citizens. Using the robust conditional order-m model that accounts for the estimation of the efficiency scores of variables representing the exogenous environment, we reached, based on information on 36 provincial-level tax agencies for the year 2015, the conclusions outlined below.

First, the fact that the context in which the units of study operate are taken into account (in this case the provincial tax collection agencies) is a key question in an efficiency analysis. We have found that both the efficiency scores and the rankings of the evaluated units vary substantially from a model that does not account for exogenous variables from another that does take into account these variables to build the efficient frontier and estimate inefficiency levels. This point has already been proven in the different areas where the robust conditional model used

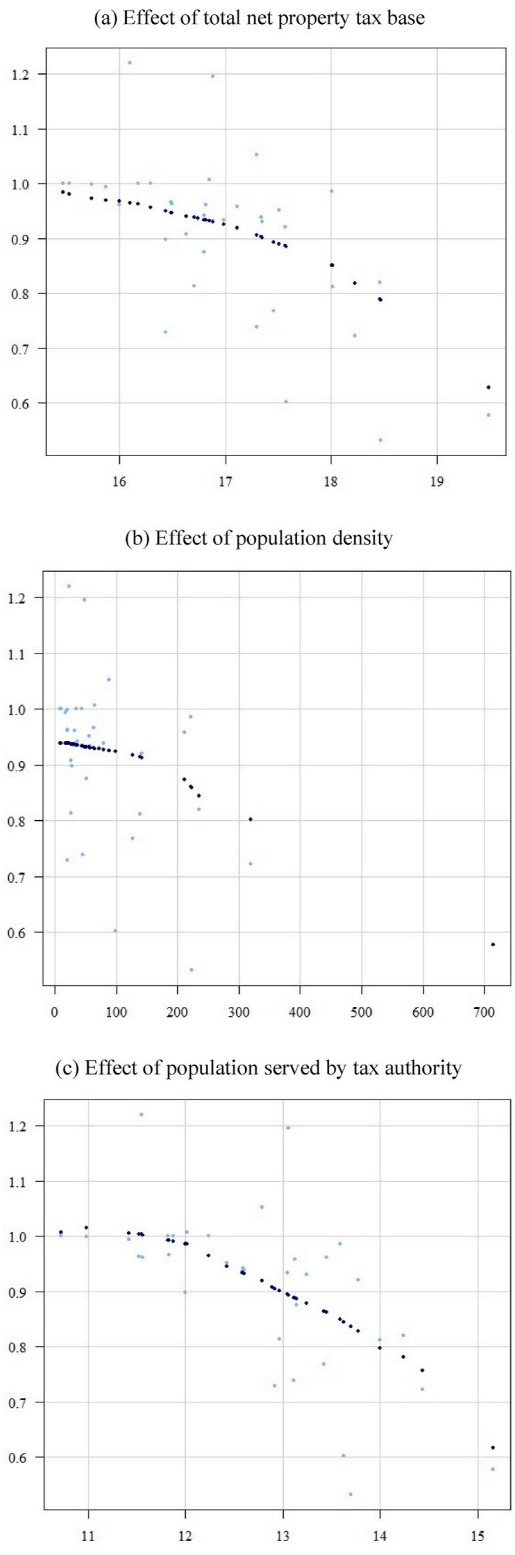

Fig. 4. Effect of exogenous variables on efficiency.

[18] This is a different policy to the one reported by De Witte and Marques [53] or Cordero et al. [20], who chose a value of m equal to or less than group size. If we were to have taken up this option, the local frontier of the smaller group would match up with the FDH frontier [14]. This would lead to a high number of units rated as efficient, and the comparison would not make empirical sense.

Table 6
Metafrontier analysis. Decomposition by inefficiency.

	Total mean efficiency	Local mean efficiency	Effect by model
Group 1: with self-governing agency	1.2319	1.1046 (45.11%)	1.1033 (44.55%)
Group 2: without self-governing agency	1.1221	1.1143 (93.61%)	1.0050 (4.01%)

here has already been applied. One of the major strengths of this model is that it avoids having to assume the restrictive separability condition (see Ref. [47] and references therein).

Second, we have found considerable differences between the estimated unconditional (not accounting for environmental variables) and conditional (accounting for exogenous factors) models. The tax agencies in the least populated provinces were found to be most efficient in the unconditional model. However, the introduction of the contextual variables complicates efficient tax agency management of authorities with high values for population density, total net property base and population served by the authority.

Third, the percentage of municipalities delegating to a provincial authority is the only exogenous variable taken into account that did not turn out to have a significant effect on the inefficiency of the evaluated units, whereas the total net property tax base, population density and population served by the tax authority did have a clearly negative effect.

Fourth, we analyzed the impact of having opted to set up a specialized self-governing tax collection agency on tax authority inefficiency. This option does not appear to have increased the inefficiency of agencies that did not set up such an agency. However, it did have a considerable effect on the group of provincial authorities that did set up such an agency. A possible future line of research is to determine the underlying cause behind the inefficiency of the self-governing body management model.

Finally, this is a synchronous study of local tax management efficiency, with the resulting limitations. Therefore, our future line of research is to conduct a diachronous analysis of the change in provincial tax agency productivity, using panel data to assess its performance over time.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.seps.2021.101057.

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