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Document de treball de l'IEB 2009/35

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Fiscal Federalism

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ABSTRACT: This paper proposes an approach to measure efficiency of a set of units operating in an administrative public service, namely real estate cadastral offices, which have not been analysed previously. This study has been made possible thanks to the database provided by the Directorate General of Real Estate Cadastral Assessment which includes information on the 52 local offices in Spain for the period between 2000 and 2005. Data Envelopment Analysis has been used to estimate the efficiency levels of these offices. Subsequently, a second stage model based on bootstrap techniques is applied in order to identify other potential factors (differences in management techniques, demographic and economic variables, etc.) that may affect the estimated efficiency measures.

JEL Codes: H3, H5, C6

Keywords: Efficiency, Data Envelopment Analysis, Cadastral

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1. INTRODUCTION

The increase in public expenditure in developed countries during the last decades together with current difficulties in rising tax resources have made actions aimed at improving efficiency in the public sector a priority of economic policy. As a result, multiple studies evaluating the efficiency of the organisations providing public services have come out in both research and policy-making activities. Even, some countries, including Spain, have established agencies or bodies specifically devoted to evaluating the effectiveness and efficiency of different public services.

Most of these studies have focused on two main policies of the Welfare State: health and education, although other areas such as court administration, social services or local activities have also been assessed. However, literature devoted to the efficiency evaluation of public producers with an administrative nature is still scarce. The sole exceptions to this have been the studies attempting to measure the efficiency of tax offices (González and Miles, 2000; Moesen and Persoon, 2002; Forsund *et al*., 2005; and, Barros, 2007).

This paper attempts to extend the literature about efficiency measurement in this specific field by focusing on the performance assessment of regional cadastral offices which had not been studied previously using this approach.

The main reason for the lack of previous studies in this area has been the difficulty in obtaining data on the productive process. However, the Spanish General Directorate of Real Estate Cadastral Assessment (General Directorate hereafter) clearly defines objectives and has made an effort to collect relevant information about the processes undertaken by the units, which enables us to construct a function that can model the production technology in this context.

In particular, we are able to perform our analysis because the General Directorate provided us with a high quality dataset containing information about the regional cadastral offices which operate in different regions for the period

2000-2005, which includes both indicators representing the results achieved and productive factors used in the process.

Furthermore, the analysis performed comprises an additional advantage that arises from the inclusion of information about activities carried out by external public sector agents that collaborate with the cadastral offices through technical assistance contracts, since it allows evaluating the effect of this cooperation process on efficiency.

The methodology used to analyse the performance of cadastral offices is Data Envelopment Analysis (DEA). This is one of the most widely used techniques in the public sector since it can be easily adapted to its particular characteristics of production such as the multiplicity of outputs, lack of information about production technology or the inexistence of prices. In particular, it is especially appropriate for measuring efficiency in relatively simple production processes where high quality data is available, a framework that takes place in our study. Moreover, multiple extensions have been developed within this technique in order to adapt it to different contexts and thus achieve high levels of accuracy in efficiency measures. These include the so-called second-stage models which are especially useful in our case, since they allow us to identify exogenous factors associated with demographic or economic aspects that, despite playing no role in the productive process, may have a significant effect on the results.

The study is structured as follows. The second section describes DEA and an extension to this method that makes possible to test the influence of external variables on results. The characteristics of the productive process in the cadastral offices are analysed in the third section and, subsequently, we describe the database used and the variables selected to perform the empirical analysis. The fourth section presents the results obtained by applying the techniques described in section two to the available sample. Finally, last section summarizes the main conclusions of the study.

2. METHODOLOGY

Efficiency evaluation models are usually based on frontier analysis, in which the maximum achievable output is estimated considering the use of certain inputs and a given technology. As a result, the frontier function represents the maximum production level which serves as a reference to calculate the inefficiency of the other observed units. Given that the frontier cannot be observed in practice, it is normally calculated using the best practices observed among all the assessed units.

The frontier function can be empirically estimated with alternative approaches which, in general, can be grouped into two categories: parametric and non-parametric techniques[1]. The former are characterised by the use of a predetermined functional form with constant parameters in order to construct the production function which is usually estimated using econometric methods. In contrast, the non-parametric approach does not require the imposition of a determined form on the production function. Instead, it is sufficient to define a set of formal properties which must satisfy the set of production factors.

In general terms, it makes little sense to consider one of the above methods as superior, since both of them present its own shortcomings. Consequently, the characteristics of the sector under examination, together with restrictions on available information, must determine the most adequate option in each case.

For the reasons explained in the introduction, non-parametric Data Envelopment Analysis (DEA) is particularly attractive for measuring efficiency in the public context and, specifically, for the subsector we are considering in this study. DEA was developed by Charnes, Copper and Rhodes (1978) from the basis of Farell's (1957) seminal work in order to obtain efficiency scores that represent the performance of different production units comprising an organisation considering input and output indicators. DEA offers relative

[1] See Lovell (1993) for an excellent discussion about the advantages and disadvantages of parametric and non-parametric techniques.

measures of efficiency, since each unit is compared to those with similar input and output values with the aim of determining whether it belongs to the frontier (if it is efficient) or not. In that case, the method allows identifying targets of production for each unit according to the values of its reference units.

Formally, Data Envelopment Analysis establishes a mathematical programming problem for each unit and the resolution of this problem allows it to be assigned an efficiency score. The standard formulation of this programme can be viewed as a problem of optimisation subject to certain restrictions reflecting the activity of the other producers. This formulation may take several forms depending on whether an approach minimising inputs or maximising outputs is adopted, according to whether units are being evaluated in terms of their ability to reduce resource input consumption or improve results. If we consider a set of units *n* consuming *m* inputs and producing *s* outputs, the efficiency of a unit can be measured as follows:

$$\text{Max.} \quad h_0(u,v) = \frac{\sum_{r=1}^{s} u_r y_{r0}}{\sum_{i=1}^{m} v_i x_{i0}}$$

$$\text{Subject to} \quad \frac{\sum_{r=1}^{s} u_r y_{rj}}{\sum_{i=1}^{m} v_i x_{ij}} \leq 1$$

$$v_i, u_r \geq 0 \qquad j = 1,\dots,n \qquad r = 1,\dots, s \qquad i = 1,\dots,m$$

where h_0 is the efficiency score (between 0 and 1); y_{r0} denotes the quantity of output *r* produced by the unit; x_{i0} is the quantity of input *i* consumed by the unit; y_{rj}, x_{ij} are the outputs and inputs of the unit *j*; and $v_i, u_r \geq 0$ are the weightings applied. The resolution of the programme allows obtaining the relevant weightings providing the best possible efficiency value for each producer. A unitary value implies that the observed and potential production are the same or, in other words, the producer is efficient. If the value is lower than one, the assessed unit is identified as inefficient since there are other units in the sample (those forming the reference group in the comparison) which perform better.

The DEA model described implicitly assumes constant returns to scale, which is a very restrictive assumption about the production technology. In other words, it assumes that any increase in inputs translates into a proportional increase in outputs, which excludes the possibility of inefficiency due to scale effects. This assumption can be relaxed with the inclusion of an additional restriction in the programme which allows variable returns to scale in production (Banker, Charnes and Cooper, 1984): $\sum_{j=1}^{n} \lambda_j = 1$. Thus, inefficient units are compared solely with others operating on the same scale. As a result, the technique admits greater flexibility by allowing an analysis to be performed in those (very common) cases where the units under evaluation operate on a similar scale.

Since 1978 a large literature on DEA has been developed in order to adapt it to different frameworks[2]. One of the fields in which there has been a significant evolution is referred to the treatment of factors beyond the control of the units under evaluation that can affect their performance - the so called environmental variables[3]. The option that has most widely been used in the literature for dealing with these variables is the second stage model[4]. This approach is based on calculating efficiency scores using an standard DEA in which the effect of environmental variables is not taken into account. This produces a first stage measure for production (θ_j) that captures not only technical inefficiency but also the influence of variables that have not been included in the analysis. Subsequently, those scores are regressed on environmental variables *(Z_j)*:

$$\theta_j = f(Z_j, \beta_j) + u_j .$$

[2] See Emrouznejad *et al* (2008) for an excellent review of the literature on DEA in the last thirty years.
[3] For a detailed review of the different methodological options for incorporating the impact of exogenous variables in efficiency analysis using non-parametric techniques, see Cordero *et al.* (2008).
[4] See Hoff (2007) for an excellent revision on this method.

The parameters of this regression are usually estimated using Tobit since the values of the dependent variable are censored (McCarty and Yaisawarng, 1993)[5]. Those estimates enables us to identify those variables that have influence on efficiency scores as well as the sign of that effect (positive or negative).

The main criticism of this approach has been that it does not comply with the assumption of the independency of errors, given that scores initially obtained using DEA include information on all units comprising the sample (Xue and Harker, 1999), with the result that the error term and vector *Z* are correlated. When the sample size is sufficiently large, the issue of error correlation disappears. However, the results obtained by drawing inferences from a small sample are invalid (Simar and Wilson, 2007).

This problem can be solved by using *bootstrap* methods. In this sense, there have been different proposals to address the problem[6], but the option that provides the most satisfactory solution is the methodology suggested by Simar and Wilson (2007). These authors describe a complete data generating process consistent with regression of non-parametric estimates in a second stage and develop two different algorithms based on the application of bootstrap methods to obtain consistent and unbiased estimates for the parameters of the regression independently of the sample size. This makes it possible to correctly identify the effect of those factors beyond the control of the units[7].

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[5] However, McDonald (2009) support that estimation through ordinary least squares provides consistent estimates given that the efficiency scores calculated in the initial stage are fractional instead of censored values.

[6] Xue and Harker (1999) and Hirschberg and Lloyd (2002) also suggest methods to avoid the problem of correlation among DEA scores, but they both use a *naive bootstrap* which is inconsistent in the context of non-parametric efficiency estimation (Simar and Wilson 1999a and 1999b).

[7] See Simar and Wilson (2007), pp. 41-43, for a detailed analysis of the content of these algorithms.

3. THE PRODUCTIVE PROCESS OF CADASTRAL OFFICES

This section introduces the main characteristics of the cadastral offices production process. Afterwards, it describes the variables used in the empirical analysis and the database.

3.1. Cadastral activity

The legislation regulating real estate evaluation in Spain is the Royal Legislative Decree 1/2004 which approves the Revised Text of the Law on Real Estate Evaluation. The first article of this regulation defines real estate cadastre as an administrative register in which rural and urban properties are described. More specifically, the third article establishes that this description must include their physical, economic and legal characteristics, i.e., the location, the cadastral reference, the cadastral value, the cadastral title-holder, the surface area, the construction quality and a graphical representation.

These activities are carried out through different procedures, notably applications or declarations for inscription, deregistration or modification proposed by property owners, communications from notaries and city councils and the property value and inspection reports achieved by the General Directorate itself.

The General Directorate is the office in charge of managing the Cadastre. The local nature of the Cadastre requires that the services have a clearly decentralised structure with management units located in every Spanish province. Despite the division of work between different administrative units, all of them are pursuing the same objectives which provides the rationale for our study.

In the context of an efficiency evaluation in this framework, the catalogue of functions assigned to the cadastral offices are identified as the outputs or results of the productive process. Thus, the level of success achieved by each unit will depend on the volume of declarations, applications and communications that it is able to address, the discrepancies it is able to resolve and the number of cadastral valuations and inspections completed. To be able to achieve these results, each unit has a set of productive factors or inputs, notably human resources and physical capital.

However, we should bear in mind that, in some cases, the activities assigned to cadastral officers are performed in collaboration with different public administrations, entities and/or corporations. This makes it essential to include information about those external processes in the evaluation in order to obtain measures that reflects appropriately the efficiency achieved by the cadastral offices.

3.2. Database and variables

Our dataset comprises information about 52 productive offices corresponding to regional administrative areas. Normally there is one office in each provincial capital although it is also possible for an office to be established in particular municipalities which have a sufficiently large population[8]. Although those units provide the cadastral services independently, they have a notable homogeneity both in the context of competences assigned and activities performed and also the tools used to accomplish them. This is essential for the analysis proposed.

The variables representing the outputs and inputs of the productive process have been obtained from data from the Task Management Plan (activities), the System of Indices of Efficiency, Quality and Effectiveness and each organisation's Planned Objectives for the years between 2000 and 2005 inclusively.

The selection of indicators representative of output is not a simple task given the diversity of functions performed by the regional offices. In addition, we

[8] Those municipalities are Cartagena, Gijón, Jerez de la Frontera and Vigo. The autonomous cities of Ceuta and Melilla also can be included within this category, whereas the offices operating in the foral regions of the Basque Country and Navarre are excluded of our analysis because there is not available information about their performance.

cannot include a high number of outputs, because it would imply the loss of discrimination power in DEA which may affect the results of the analysis. Therefore, we have opted for grouping the available information into a lower number of variables, following the guidelines established by the General Directorate. Following this principle, three output indicators were defined:

a) *CERENQ.* This indicator represents the relationship between the cadastral units and population. It encompasses certifications issued (cadastral, graphic, alphanumeric, etc.) as well as all enquiries addressed.

b) *ALTER:* The value includes the alterations to the cadastral database made directly by the offices themselves or indirectly by other (local) agents collaborating with cadastral offices to maintain and update the database.

c) *MODIF:* The variable Incorporates the modifications and rectifications made as a result of correcting discrepancies between the description of properties and their actual situation.

Regarding input factors, two variables were selected as representative of work and capital:

a) *EMPLOY:* This indicator represents the weighted number of employees, since it adjusts the number of employees in accordance with their professional category[9].

b) *CONTRACT:* This variable represents current costs arising fundamentally from technical assistance contracts to keep the cadastral database updated which can be interpreted as a proxy of capital resources. These costs may be attributable to the offices themselves or

[9] The employees working in each productive unit belong to different categories (senior management, middle management, administrative employees, etc.). In order to take into account those differences, the number of employees have been weighted according to the average remuneration of each group.

to central services. In the latter case, they have been attributed to the productive units benefitting from the relevant activities[10].

The production function derived from those variables involves a significant particularity that it is important to bear in mind and which is very useful in the evaluation of efficiency. If activities carried out on collaboration with local agents are included within the indicators representing the output of productive units, it is equally certain that the existence and extent of this collaboration favours those units in an efficiency evaluation by increasing the quantity of certain outputs. Consequently, in addition to considering the beneficial aspects of increases in output, we must take into account the cost of those collaborative activities. For this purpose, and following the guidelines of the General Directorate, we have considered collaboration between external agents and the productive units as a technical assistance contract with companies of the sector, thus increasing the amount of the relevant input (*CONTRACT*) at the market value of these activities. Moreover, this approach gives us the opportunity of evaluating in which extent that collaboration can affect the efficiency scores estimated.

The principal descriptive statistics of input and output indicators in each of the years considered in this study are showed in Table 1.

[10] The calculation is performed as if we are dealing with a technical assistance contract with companies from the sector, i.e., the value of the number of urban or rural units included in the cadastral databases is a result of new construction declarations and other modifications processed as part of the collaboration agreements. The average contract price was taken into account in determining the value.

Table 1. Descriptive statistics of outputs and inputs

	OUTPUTS			INPUTS	
	CERENQ	**ALTCAD**	**MODIF**	**EMPLOY**	**CONTRACT**
2000					
Average	64,092	52,497	35,303	88.92	735,869
Dev.	39,521	65,459	37,510	58.14	633,701
Max.	218,910	368,058	214,295	294.26	2,704,420
Min.	3,773	2,761	257	16.41	1,002
2001					
Average	60,957	61,689	48,639	86.15	600,212
Dev.	32,477	73,150	115,305	56.22	656,802
Max.	137,459	411,033	816,725	282.31	3,701,640
Min.	3,485	3,378	168	15.02	2,336
2002					
Average	57,736	61,368	31,020	85.03	530,213
Dev.	34,425	73,930	39,272	53.81	613,994
Max.	181,011	374,441	224,477	278.45	4,043,993
Min.	5,020	3,652	260	12.80	1,302
2003					
Average	54,652	64,002	29,217	81.66	649,490
Dev.	32,514	76,972	43,399	51.04	799,228
Max.	159,465	391,443	272,051	292.16	4,799,113
Min.	4,123	3,776	393	15.26	16,292
2004					
Average	57,885	72,934	37,113	83.22	789,260
Dev.	37,099	85,866	63,038	50.23	867,117
Max.	214,652	455,084	338,632	273.50	5,398,833
Min.	5,190	3,403	251	13.48	7,887
2005					
Average	49,382	79,342	24,052	84.25	833,856
Dev.	30,919	89,538	29,245	50.53	844,234
Max.	185,406	454,963	163,147	280.05	4,904,381
Min.	3,197	3,499	333	13.43	16,656

4. RESULTS

This section presents the results obtained using the models described in the previous section. First, we estimate efficiency scores for each unit by applying a standard DEA. The model used has an input orientation due to the fact that cadastral offices' results do not depend directly on their own efforts but rather the extent of real estate activity in the area and applications made by property owners. Thus, potential improvements in terms of efficiency only can be achieved with a reduction in the use of inputs. Likewise, variable returns to scale are assumed in order to avoid possible inefficiencies associated with the size of offices.

As we have available data about the units for a period, we have been able to perform different analysis for each year, which allow us to draw more reliable conclusions than those derived from specific estimates from a single year.

The procedure followed was to calculate the efficiency scores for each year and, subsequently, the average for the period, which provides a sound approximation of the relative position of each unit during the period. Table 2 summarises the average values of the efficiency scores and the number of efficient units for each year, together with the average values for the period. According to these data, the average efficiency during the period was around 80%, although the value in different years varies between 70 and 83%. In the case of the average number of efficient units, this varies significantly from year to year, although the average value of efficient units during the period represents around 30% of the total units.

Table 2. Average efficiency scores

	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2000-2005**
Average Scores	0.8102	0.8255	0.8227	0.7577	0.7038	0.8301	0.7917
Efficient units	18	16	16	13	12	17	15

But more interesting than the overall analysis of the units is the separate analysis of single units. Table 3 presents the efficiency scores for every unit in the sample in different years and the average for the period. Those values highlight the significant divergences among units. Thus, taking the average efficiency during the period as a reference point, we can notice that only four units achieved a unitary value on average (that is, only those that are efficient every year) while there are other units with average scores around 50%.

Table 3. Efficiency scores of units in the period

Unit	2000	2001	2002	2003	2004	2005	Average 2000-2005
Albacete	0.554	0.733	0.813	0.566	0.4612	0.640	0.628
Alicante	0.901	1.000	1.000	1.000	1.0000	1.000	0.984
Almería	0.725	0.801	0.760	0.825	0.656	0.864	0.772
Ávila	0.785	1.000	1.000	0.743	0.492	0.835	0.809
Badajoz	0.820	0.894	1.000	0.535	0.628	0.840	0.786
Baleares	0.657	0.786	0.760	1.000	0.474	0.871	0.758
Barcelona	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Burgos	0.516	0.679	0.659	0.481	0.455	0.740	0.588
Cáceres	1.000	1.000	0.846	0.468	0.511	0.657	0.747
Cádiz	0.737	0.904	0.772	1.000	0.770	0.750	0.822
Cantabria	0.795	1.000	0.979	0.758	0.783	1.000	0.886
Cartagena	1.000	1.000	1.000	1.000	1.000	0.891	0.982
Castellón	0.792	0.705	0.925	0.961	0.914	1.000	0.883
Ceuta	0.840	0.970	0.790	0.961	1.000	1.000	0.927
Ciudad Real	1.000	0.796	0.821	0.728	0.581	0.786	0.785
Córdoba	0.551	0.497	0.482	0.463	0.619	0.752	0.561
Coruña (La)	0.534	0.622	0.642	0.867	0.522	0.881	0.678
Cuenca	1.000	1.000	0.773	0.429	0.515	0.582	0.717
Gerona	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Gijón	0.824	1.000	1.000	1.000	1.000	1.000	0.971
Granada	0.477	0.609	0.602	0.561	0.625	0.778	0.609
Guadalajara	0.781	0.811	0.839	0.658	0.571	0.705	0.727
Huelva	0.858	0.771	0.681	0.636	0.522	0.875	0.724

Unit	2000	2001	2002	2003	2004	2005	Average 2000-2005
Huesca	0.602	0.488	0.501	0.430	0.393	0.478	0.482
Jaén	0.861	0.669	0.808	1.000	0.705	0.679	0.787
Jerez de la Frontera	0.618	0.552	0.517	0.550	1.000	1.000	0.706
León	0.653	0.823	1.000	0.711	0.829	1.000	0.836
Lérida	1.000	0.906	0.927	0.803	0.626	0.742	0.834
Lugo	1.000	1.000	0.677	0.660	0.678	0.865	0.813
Madrid	1.000	0.782	1.000	1.000	1.000	1.000	0.963
Málaga	1.000	0.778	1.000	0.921	1.000	0.987	0.947
Melilla	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Murcia	1.000	1.000	0.997	0.847	0.946	0.835	0.937
Orense	0.580	0.836	0.782	0.536	0.501	0.715	0.658
Oviedo	0.630	0.868	0.560	0.533	0.438	1.000	0.672
Palencia	0.779	1.000	0.741	0.869	0.429	0.719	0.756
Palmas (Las)	0.761	0.787	0.822	0.952	0.783	1.000	0.851
Pontevedra	1.000	0.868	0.832	0.718	0.747	1.000	0.861
Rioja (La)	0.741	0.789	0.896	0.688	0.552	0.800	0.744
S. C. Tenerife	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Salamanca	0.795	0.663	0.747	0.580	0.686	0.787	0.710
Segovia	0.709	0.624	0.660	0.676	0.582	0.717	0.661
Sevilla	0.651	0.785	0.618	0.568	0.463	0.532	0.603
Soria	1.000	0.734	0.751	0.588	0.520	0.665	0.709
Tarragona	1.000	0.917	1.000	0.931	0.922	0.887	0.943
Teruel	0.772	0.702	0.853	0.715	0.602	0.646	0.715
Toledo	0.743	0.792	0.854	0.763	0.597	0.757	0.751
Valencia	1.000	1.000	1.000	1.000	0.932	0.792	0.954
Valladolid	1.000	1.000	1.000	0.855	0.548	1.000	0.901
Vigo	0.895	0.982	1.000	1.000	1.000	1.000	0.979
Zamora	0.644	0.527	0.609	0.486	0.450	0.643	0.560
Zaragoza	0.546	0.472	0.483	0.370	0.561	0.467	0.483

The examination of specific cases enables us to identify units which have performed better or worse in different years. Notable amongst the former is the group composed of units classified as efficient in every single year (Barcelona, Gerona, Melilla and Santa Cruz de Tenerife) and other ones with average scores very close to one as they have been classified as efficient almost every year (Alicante, Cartagena, Gijón, Madrid, Málaga, Murcia, Tarragona, Valencia, Valladolid and Vigo). In contrast, Burgos, Córdoba, Huesca, Zamora and Zaragoza present values below 60% in almost every year.

Most of units are placed between these two extremes, as they are considered as efficient some years while others they are placed below the frontier. Likewise, we can also observe that some offices have clearly improved their performance relative to others over the time period considered, since they present high levels of inefficiency during the first years and become efficient at the end of the period. This is the case with Ceuta or Jerez de la Frontera. In contrast, other units, such as Cáceres o Cuenca, have become inefficient after some years of being efficient.

An exploratory analysis of the individual results of separate units reveals that, in general, offices sited in seaside provinces and those in provinces with higher levels of population are much more efficient than those in provinces with a lower population with the sole exception of Zaragoza. In order to test whether this perception has a statistical basis we perform a second stage analysis on the results of the efficiency analysis so that we can examine the possible impact of external variables not included in the initial evaluation.

For that purpose, we have considered three environmental variables that provide information about different aspects of the province where each cadastral office is situated and we consider that may be related to their volume of activities[11]. In addition, as we are interested in determining whether the collaboration with other public sector agents can affect the levels of efficiency achieved by cadastral offices, we have also considered another variable that

[11] The information on these variables was obtained from different databases compiled by the National Institute of Statistics.

represent the proportion of activities carried out by those agents[12]. Therefore, we have considered the following external variables:

- Population: *Total population*.
- *GVA:* Gross Value Added as an indicator of economic activity.
- *Construction:* Percentage of GVA represented by construction activities.
- *External Agents:* Percentage of activities carried out by collaborating agents.

The first three variables are associated with higher levels of demand in the sense that it could be expected that cadastral units sited in provinces with a higher population, higher levels of economic activity and, specifically, in the construction sector, require more cadastral services which could lead to higher efficiency scores[13]. Regarding the variable that represents the level of collaboration with other public sector units, its potential effect on improving efficiency (even if the cost of "purchasing" the service is charged as an external cost) come from the fact that decentralized units (councils and notaries) have at their disposal more detailed information about properties[14].

In the estimation of the Tobit regressions we have used panel data (Maddala, 1987) with the aim of modelling appropriately the heterogeneity detected in the initial evaluation, both across units and over the six years studied[15]. Subsequently, in order to avoid possible problems of bias in the results, Algorithm 1 developed by Simar and Wilson (2007) is applied with an

[12] Data about these activities were provided by the General Directorate.
[13] In fact, all these variables present significant and positive correlation coefficients with different output indicators.
[14] There is a profuse literature about external contracting or outsourcing in the public sector (either with private companies or with other public sector organisations) and its effect on efficiency assessment, since that collaboration can lead to reduce costs. See, for example, Jensen and Stonecash (2004) or Jensen (2005).
[15] Using panel data implies that there is a transversal dimension, which is observed for a specific period of time (2000-2005 in our study), which also bestows a temporal dimension to the dataset.

adaptation for the particular context of panel data[16]. Tables 4 and 5 show the results of the different estimations.

Table 4. Tobit regression results

Dependent variable: Initial efficiency scores				
Estimation Method: Panel Tobit				
Sample: 2000 2005				
Periods included: 6				
Cross Section Units: 52				
Total Observations in Panel: 312				
Variable	**Coefficient**	**St. Error**	**t**	**p-value**
Population	0.004472	0.001013	4.413568	0.0000
Construction	0.000031	0.000006	5.478987	0.0000
Gross Value Added	0.000024	0.000005	5.030307	0.0000
External Agents (%)	0.130349	0.047247	2.758869	0.0058

Table 5. Results obtained with model proposed by Simar and Wilson (2007)[17]

Dependent variable: Initial efficiency scores				
Estimation Method: Panel Tobit				
Sample: 2000 2005				
Periods included: 6				
Cross Section Units: 52				
Total Observations in Panel: 312				
Variable	**Coefficient**	**St. Error**	**t**	**p-value**
Population	0.004193	0.000923	4.542795	0.0000
Construction	0.000028	0.000005	5.723837	0.0000
Gross Value Added	0.000022	0.000006	4.763123	0.0000
External Agents (%)	0.118512	0.045392	2.610856	0.0055

[16] According to the authors, Algorithm 1 offers better results than Algorithm 2 when the sample size is relatively small as in our case.
[17] The results shown in this Table represent the average values obtained after estimating 2,000 iterations using the Algorithm 1 proposed by Simar and Wilson (2007).

These results, in addition to confirming our perception, highlight some interesting issues. Firstly, the estimated parameters do not vary significantly between the standard Tobit and the application of the Simar and Wilson (2007) model as is usually the case when their Algorithm 1 is used[18]. Secondly, although all the variables related to demand side pressure (population and the general and specific added value of construction) have a positive and significant effect on efficiency, the low values of their parameters denote that the effect is extremely limited. In contrast, the variable representing the percentage of activities managed by collaborating agents present higher values of parameters, which are also significant and positive. This result seems to confirm that sharing responsibilities in the management of cadastral services (at current levels of collaboration) has a positive effect on the performance of units.

5. CONCLUSIONS

This study examines the performance of units providing cadastral services in Spain using an approach based on efficiency. For this purpose, we have used Data Envelopment Analysis since this technique can easily be adapted to this context. The dataset used in this application, provided by the General Directorate of Real Estate Evaluation, comprises information about 52 cadastral offices in Spain during the inclusive period 2000-2005.

The results obtained in the study reveal significant differences between average levels and the identification of efficient units throughout the period under consideration. However, two groups of offices stand out from the rest both in positive (high and even unitary values in all years) and negative terms (values below 60% in most of years).

These results must be analysed quite cautiously as the values obtained with this methodology are highly sensitive to potential data errors, random shocks or the effect of factors that have not been taken into account in the

[18] The results obtained by Afonso and St. Aubyn (2006) and Cordero *et al* (2009) confirm this trend.

analysis because they are outside the control of the units evaluated. In this respect, it is worth noting that the possibility of having panel data at our disposal, which is not frequent in most of efficiency studies, makes it possible to conduct a separate analysis for each year, reinforcing the robustness of results.

The results obtained in a second stage analysis in which the potential influence of different external variables on efficiency is tested lead us to conclude that demographic and economic variables have little or no effect on efficiency. This fact reinforces the validity of estimated values which do not need to be corrected to take into account the effect of those exogenous variables. In contrast, the collaboration with public sector agents has a positive effect on efficiency levels. This result points out a simple way of achieving improvements in the management of this service.

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