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Assessing and explaining the relative efficiency of local government

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Abstract

We assess the relative efficiency of local municipalities using Data Envelopment Analysis and parametric analysis. As an output measure we compute a composite local government indicator of municipal performance, using data for Portuguese municipalities. This allows assessing the extent of possible municipal improvement relative to the "best-practice" frontier. Our results suggest that most municipalities could improve performance without necessarily increasing municipal spending. In a second stage efficiency scores are explained by means of a Tobit analysis with a set of relevant explanatory socio-economic factors playing the role of non-discretionary inputs, such as education and per capita purchasing power.

JEL classification: C14; C34; H72; R50

Keywords: Local government; Technical efficiency; Socio-economic factors; DEA; Tobit

1. Introduction

The relevance of local government's spending has been increasing as the implementation of decentralised policies is being designed to refocus public decision-making from central to municipal levels of government. Whether or not such local spending is done in an efficient manner

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is definitely an important issue. On the one hand, the degree to which the nature and organisation of the government leans toward a federal set up may depend on how efficient spending is perceived at the local level, notably in providing the best possible public local service at the lowest possible cost. On the other hand, and given the overall financial constraints faced by the governments in most European Union countries, public sector performance and efficiency should certainly be assessed as close as possible in order to provide some additional guidance for policy makers. Indeed, one can notice that growing attention has been given recently to the quality and efficiency of public spending in European countries (see EC, 2004), since in some countries General Government fiscal imbalances stem partly from the local government sector.

In this paper we evaluate and analyse public expenditure efficiency of Portuguese municipal governments. This is done by using Data Envelopment Analysis (DEA) to compute input and output Farrell efficiency scores for the 278 Portuguese municipalities located in the mainland for 2001. The analysis is performed by clustering municipalities into the five NUTS-2 regions defined for statistical purposes: *Norte*, *Centro*, *Lisboa e Vale do Tejo* (LVT), *Alentejo*, and *Algarve*.[1]

We provide evidence concerning the efficiency analysis of local government using a composite measure of municipal services' provision. Therefore, we construct a so-called Local Government Output Indicator (LGOI), used as a composite output measure in our non-parametric analysis, taking into account a set of municipal services provided by the local governments.

Understanding the possible relationships between the efficiency of local governments and the characteristics of municipal institutional and structural environment is of interest notably to local managers and policy makers. In fact, by giving insight into the causes of inefficiency, this helps to further identify the economic reasons for local inefficient behaviour and may support effective policy measures to correct and or control them. Therefore, the relevance of so-called environmental or non-discretionary inputs is also addressed in the paper through a Tobit analysis.

The paper is organised as follows. In Section 2, we provide some stylised facts about the institutional structure of the Portuguese local government sector and review some relevant literature on modelling local government production and measuring spending efficiency. In Section 3, we briefly describe the DEA analytical framework. In Section 4, we address data and measurement issues in order to construct our Local Government Output Indicator, and we present and discuss the empirical results of the non-parametric efficiency analysis. In Section 5, we use a set of explanatory non-discretionary inputs to explain the inefficiency scores. Section 6 concludes the paper.

2. Motivation and literature

2.1. Stylised facts for the Portuguese local government sector

The institutional setting of the Portuguese local government sector was formally established in the 1976 Constitution, and its budgetary framework relies on the application of public accounting principles. Accordingly, the Portuguese Public Sector is composed, on the one hand, by the administrative or general government sector, which encompasses those public authorities that develop state-specific economic activities through "non-profit" criteria, and on the other hand,

[1] The nomenclature of territorial units for statistics (NUTS) is the classification used by Eurostat for sub-national spatial units. For instance, NUTS-0 is the country and the higher the number the higher the territorial disaggregation.

by the public enterprise sector, which refers to the activities developed by those entities but exclusively through “economic” criteria.[2]

At the sub national level there are two tiers of government, regional and local, both resulting from decentralization processes. The first tier results from a political process and includes the autonomous regions in the islands of Madeira and Azores. The second tier results from an administrative process, and includes the local authorities.

There are currently 308 municipalities, 278 of which are located in Portugal mainland and the remaining 30 are overseas municipalities, belonging to the (politically) autonomous regions of Madeira and Azores. Local governments are territorially based organisations with administrative and fiscal autonomy, and with budgetary and patrimonial independence.

The activity of the local governments should be fine-tuned to satisfy local needs and should be concerned with improving the well being of the population that live in their territories. Accordingly, local governments should promote social and economic development, territory organisation, and supply local public goods such as water and sewage, transports, housing, healthcare, education, culture, sports, defence of the environment and protection of the civil population.

Local authorities have their own budgets, with some budgeting principles and rules that are also common to those binding the central government budget. As for the budgetary process, in the end of each year the executive body of the municipality (town council) proposes to the legislative body (municipal assembly) the local budget and the plan of activities for the following year.

Municipal authorities are also subject to several internal and external control mechanisms, the former being exercised by central government agencies and the latter by an independent Court of Accounts.[3] These control mechanisms limit the access to revenue and expenditure choices. For instance, in what concerns revenue decisions, local governments borrowing is under control from central government, which has been intensified during the last years, mainly since 2002 for budget consolidation purposes.

As for expenditures, compensation of employees related spending must not exceed 60% of municipal current expenditures. In fact, these expenditures limit local governments’ margin of manoeuvre because they are regulated by rigid labour contracts. Employment duration and wage rates are both defined by the central government. As a result we may reasonably assume that there is not much labour-input price variability within Portuguese municipalities. For instance, the main municipal expenditure items in 2001 (with the exception of financial operations) were investment and compensation of employees, accounting respectively for about 44.3 and 25.6% of total expenditures.

As for the revenue categories, although by law municipalities are financially autonomous, their main sources of revenue come largely from transfers that accounted for 51.7% of their total revenues in 2001, again not counting financial operations. On the other hand, municipal direct taxes accounted for 28.6% of total revenues.

In Table 1 we present some stylised facts for the local government sector for 2001, excluding the islands, grouped by five geographical regions defined according to the NUTS-2 regions: Norte, Centro, Lisboa e Vale do Tejo (LVT), Alentejo and Algarve. Our subsequent empirical analysis

[2] Under the European System of National and Regional Accounting’s principles (ESA 95), the general government or Public Administration sector is composed by the following sub-sectors: Central Administration, Regional and Local Administration, and Social Security.

[3] In what concerns external control, the results of audit actions may lead to judicial processes where public financial responsibility is scrutinised.

Table 1
Some stylised facts for the local government sector

	Classification level	Number of municipalities[a]	Area (km^2, 2001)[a]	Area share in total area (%)[a]	Resident population (2001)[b]	Population per km^2	Resident population, share in total population (%)[b]	Average spending per capita (2001)[a]
Portugal[c]	NUTS-0	278	88,785	100.00	9,869,343	111	100.00	795.40
Alentejo	NUTS-2	47	27,218	30.66	535,753	20	5.43	982.71
Algarve	NUTS-2	16	4,987	5.62	395,218	79	4.00	1128.78
Centro	NUTS-2	78	23,660	26.65	1,783,596	75	18.07	812.04
LVT	NUTS-2	51	11,643	13.11	3,467,483	298	35.13	683.40
Norte	NUTS-2	86	21,277	23.96	3,687,293	173	37.36	682.34
Maximum		86	27,218	30.66	3,687,293	20	37.36	1128.71
Minimum		16	4,987	5.62	395,218	298	4.00	682.34

[a] "Finanças locais: aplicação em 2001", DGAL, electronic edition at: http://www.dgaa.pt/publicacoes/financas_municipais/2001/FM_2001%20OK.pdf.
[b] INE, 2001, "Recenseamento Geral da População e Habitação, 2001" (Definitive Results).
[c] Mainland.

of local government relative efficiency will use information related to these 278 municipalities located in mainland Portugal.

According to Table 1, Algarve was the region that had the highest average spending per capita, but in what concerns resident population, area and number of municipalities it is clearly behind the other regions. By contrast, and despite of having the highest percentage of total resident population in mainland Portugal, 37.4%, and of having more municipalities than any of the other four regions, the Norte region has the lowest average spending per capita. As for the LVT region, which include the country's capital, and with an area amounting to only 13.1% of mainland Portugal (the second lowest), its population accounts for 35.1% of total population (the second highest), and it has the second lowest average spending per capita.

2.2. Literature review

The usual approach to evaluate production efficiency uses both input and output quantitative indicators and information about their unit prices in order to study productivity defined as the ratio of weighted outputs to weighted inputs. Here, market prices of outputs and inputs are the weights. However, one of the basic problems in evaluating public sector activities through this approach is that market prices for outputs are commonly unavailable given its not for profit nature.[4]

In addition to evaluating productivity as described above it is also possible to apply frontier analysis to evaluate technical efficiency (see Farrell, 1957). Here, there are two options: either to estimate parametrically an aggregate production function where multiple outputs have been weighted (e.g. by unit costs) into a single output; or to estimate non-parametrically a production function frontier and derive efficiency scores on the basis of relative distances of inefficient observations from the frontier. The main advantage of this latter approach is that production function frontiers can be derived in a multiple outputs and multiple inputs setting without requiring the definition of weights.

Following De Borger and Kerstens (2000) it is possible to identify two strands of empirical research in local efficiency literature. On the one hand, there are studies that evaluate efficiency in a global way, covering all or at least several services provided by local governments. See, for instance, Van den Eeckaut et al. (1993), De Borger et al. (1994), De Borger and Kerstens (1996a,b), Athanassopoulos and Triantis (1998), Worthington (2000), Prieto and Zofio (2001), Balaguer-Coll et al. (2002), Loikkanen and Susiluoto (2005) and Afonso and Fernandes (2006) among others. On the other hand, there are studies that evaluate a particular local service, as it is the case, for instance, of solid waste collection (Burgat and Jeanrenaud, 1994), fire protection (Bouckaert, 1992), local police units (Davis and Hayes, 1993) and general administration (Kalseth and Rattsø, 1995).

In Table 2 we survey some of the studies that evaluate both non-parametrically and globally local governments' efficiency. We can conclude that studies applying frontier analysis to the local government sector do not abound in the literature, mainly because of the difficulty in defining local outputs and/or in obtaining statistical information to quantify all or at least several of them.[5]

[4] For the Norwegian local government sector, Borge et al. (2004) overcame this problem by using national cost weights to aggregate the main outputs of each municipality into a single aggregate output. These outputs were then divided by aggregate resources (measured in revenues) to get a measure of efficiency for each municipality.

[5] For further literature reviews, see Worthington and Dollery (2000) and De Borger and Kerstens (2000).

Table 2
Studies that evaluate both non-parametrically and globally local governments' efficiency

Author(s)	Sample	Methodology	Indicators	
			Input	Output
Van den Eeckaut et al. (1993)	235 Belgian municipalities (cross-section)	FDH and DEA	Total current expenditures	Total population; Share of age group with more than 65 years on total population; Number of subsistence beneficiaries; Number of students in primary school; Municipal roads' surface; Number of local crimes
De Borger et al. (1994)	589 Belgian municipalities with (cross-section)	FDH	Number of blue and white-collar workers; Space of buildings	Surface of roads; Number of minimal subsistence grant recipients; Students enrolled in primary schools; Surface of public recreational facilities; Proxy for services delivered to non-residents defined as log (number of non-residents)/log (total employment)
De Borger and Kerstens (1996a)	589 Belgian municipalities (cross-section)	DEA, FDH, and stochastic method	Total current expenditures	Total population; Share of age group with more than 65 years on total population; Number of unemployment subsidy beneficiaries; Number of students in primary school; Leisure areas and parks surface
Athanassopoulos and Triantis (1998)	172 Greek municipalities (cross-section)	DEA and stochastic method	Total current expenditures	Number of resident families; Average residential area; Building area; Industrial; Tourism area
Sousa and Ramos (1999)	701 Brazilian municipalities from Minas Gerais and 402 from Baía (cross-section)	FDH and DEA	Total current expenditures	Resident population; Homes with clean water; Homes with solid waste collection; Illiterate population; Number of enrolled students in primary and secondary local schools
Worthington (2000)	166 Australian municipalities (cross-section)	DEA and stochastic method	No. of full-time workers; Financial expenditures (except depreciation); Other expenditures (materials)	Total population; Number of properties acquired to provide the following services: Potable water; Domestic waste collection; Surface of rural and urban roads (km)
Prieto and Zofio (2001)	209 Spanish municipalities from Castilla and Leon with less than 20,000 residents (cross-section)	DEA	Budgetary expenditure (estimation)	Potable water; Domestic waste collection; Road surface area; Lighting street points; Cultural and sportive infrastructures; Parks
Balaguer-Coll et al. (2002)	258 Valencian (Spain) municipalities (panel data)	DEA	Total expenditures	Number of lighting points; Total population; Tons of waste collected; Street infrastructure surface area; Registered surface area of public parks; Number of votes; "Quality" (dichotomous output variable)
Loikkanen and Susiluoto (2005)	353 Finnish municipalities (panel data)	DEA	Total expenditures	Children's day care centres; Children's family day care; Open basic health care; Dental care; Bed wards in basic health care; Institutional care of the elderly; Institutional care of the Handicapped; Comprehensive schools (hours of teaching); Senior secondary schools (hours of teaching); Municipal libraries (total loans)
Afonso and Fernandes (2006)	51 Lisbon region municipalities	DEA	Total per capita expenditures	Performance sub-indicators grouped in: General administration; Education; Social services; Cultural services; Domestic waste collection; Environment protection

Table 3
Studies that explain DEA efficiency scores with non-discretionary inputs

Author(s)	Country	Empirical evidence	
		Positive impact on efficiency	Negative impact on efficiency
Van den Eeckaut et al. (1993)	Belgium	High local tax rates	Higher per capita incomes and wealth of citizens
		Educational level of the adult population	Per capita block grant
			Political characteristics (number of coalition parties)
De Borger and Kerstens (1996a)	Belgium	Local tax rates	Per capita block grant
		Level of education	Income
Balaguer-Coll et al. (2002)	Spain	Largest populations	Higher per capita tax revenue
		Level of commercial activity	Higher per capita grants
Athanassopoulos and Triantis (1998)	Greece	High share of fees and charges in municipal income	Population density
		High investment share in total expenditures	Grants
			Parties affiliated to the central government
Loikkanen and Susiluoto (2005)	Finland	Big share of municipal workers in age group 35–49 years	Peripheral location
		Dense urban structure	High income level (high wages)
		High education level of inhabitants	Large population;
			High unemployment
			Diverse service structure
			Big share of services bought from other municipalities
			A high share of costs covered by state grants reduced efficiency in first years after the end of matching grant era in 1993

As non-discretionary and discretionary inputs jointly contribute to outputs, there are in the literature several proposals on how to deal with this issue, implying usually the use of two-stage and even three-stage models.[6] Some of the studies surveyed in Table 2 obtain efficiency scores from DEA calculations using only controllable local inputs and outputs in the first stage and explain the efficiency scores by socio-economic factors or non-discretionary inputs in a second stage, as reported in Table 3.

The purpose of those studies using regression models is to determine the impact of observable environmental variables on initial evaluation of local governments' performance, providing a framework which allows non-discretionary inputs to feature in the explanation of differences in

[6] See Ruggiero (2004) and Simar and Wilson (2004) for an overview.

efficiency scores empirically estimated In the first stage. For instance, the results obtained by De Borger and Kerstens (1996a), Athanassopoulos and Triantis (1998) and Balaguer-Coll et al. (2002) indicate that entities with higher tax revenues and/or those receiving higher grants are the most inefficient in the management of their resources.

Additionally Loikkanen and Susiluoto (2005) mention that factors such as peripheral location,[7] large population, high levels of income and unemployment, and a big share of services bought from other municipalities are negatively related to spending municipal efficiency. By contrast, high share of municipal workers in the age group of 35–49 years, narrow range of services, dense urban structure and high education level of population (proxy for education level of municipal workers in the basic service sectors) are factors that related positively to efficiency.

3. DEA framework

We use the non-parametric method DEA, which was originally developed and applied to firms that convert inputs into outputs. Coelli et al. (1998) and Sengupta (2000) introduce the reader to this literature and describe several applications.[8] The term "firm", sometimes replaced by the more encompassing Decision Making Unit (henceforth DMUs), the term coined by Charnes et al. (1978), may include non-profit or public organisations, such as hospitals, universities, local authorities, or countries if a cross country analysis is envisaged (see, for instance, Afonso and St. Aubyn, 2005).

Data Envelopment Analysis, originating from Farrell's (1957) seminal work and popularised by Charnes et al. (1978), assumes the existence of a convex production frontier. The production frontier in the DEA approach is constructed using linear programming methods. The terminology "envelopment" stems out from the fact that the production frontier envelops the set of observations.[9]

The general relationship that we expect to test regarding efficiency can be given by the following function for each municipality i:

$$Y_i = f(X_i), \quad i = 1, \ldots, n \tag{1}$$

where we have Y_i is the indicators reflecting output measures and X_i the spending or other relevant inputs in municipality i, either per inhabitant or in some other measure. If $Y_i < f(x_i)$, it is said that municipality i exhibits inefficiency. For the observed input level, the actual output is smaller than the best attainable one and inefficiency can then be measured by computing the distance to the theoretical efficiency frontier.

The purpose of an input-oriented example is to study by how much input quantities can be proportionally reduced without changing the output quantities produced. Alternatively, and by computing output-oriented measures, one could also try to assess how much output quantities can be proportionally increased without changing the input quantities used. The two measures provide the same results under constant returns to scale but give different values under variable

[7] This indicator was measured by the weighted average of road distances between the economic region of the municipality to all other domestic regions. In this measure pair-wise distances between regions are weighted with the Gross Regional Product of the destination region (cf. Loikkanen and Susiluoto, 2005).

[8] A possible alternative method would be Free Disposable Hull analysis (FDH), proposed by Deprins et al. (1984), which relaxes the convexity assumption implicit in the DEA model.

[9] Coelli et al. (1998) and Thanassoulis (2001) offer introductions to DEA, while Simar and Wilson (2003) and Murillo-Zamorano (2004) are good references for an overview of frontier techniques.

returns to scale. Nevertheless, both output and input-oriented models will identify the same set of efficient/inefficient producers. The efficiency scores to be computed, θ, can equal to 1 if the municipality is on the frontier (i.e. it is efficient) or below 1 if the municipality is not on the frontier (i.e. it is not efficient).[10]

4. Relative municipal efficiency analysis

4.1. Data

In our analysis we assess the relative efficiency of individual Portuguese municipalities for 2001, within each of the aforementioned five NUTS-2 regions: Norte, Centro, Lisboa e Vale do Tejo (LVT), Alentejo and Algarve. The municipalities located in the Madeira and Azores islands were not included because their specific geographical location could raise comparability problems.[11]

We believe that the focus of the analysis is more adequately done at the NUTS-2 level, due to the fact that municipalities within a given region share the same environmental context, e.g. natural resources, topography, population movements, geographical proximity and also due to the existence of coordinating structures and financial mechanisms at this level.[12] Indeed, and as pointed out by Dyson et al. (2001), one of the pitfalls of DEA relates to "(. . .) attempting to compare non-homogeneous units." As a possible solution to this problem, these authors suggest, notably, the clustering of units "(. . .) into homogeneous sets." Thus, we assume that municipalities within a given region are a more homogeneous set than one encompassing all continental municipalities.

To use the DEA methodology, in order to derive efficiency measures, we need data on municipal inputs and outputs. As for the former, no measures on local production factors (such as labour or capital) used by local governments were available. To overcome this problem, we selected per capita municipal expenditures registered on municipal accounts for the year 2001 as a measure of the municipal resources used in local services' provision.

Therefore, we are able to measure municipal spending efficiency (see Clements, 2002), not distinguishing technical from allocative efficiency. However, as the measurement of the latter requires price information, while the former only requires quantity data (Lovell, 2000), selecting per capita municipal spending gives us at least the guarantee that all inputs will be considered in our analysis (De Borger and Kerstens, 2000). Additionally, this variable is a more realistic municipal input measure if we acknowledge the reduced margin of manoeuvre that municipal authorities have to influence current expenditure choices, notably those concerning the compensation of employees.

As for municipal outputs, we use statistical information published by the National Institute of Statistics to construct a composite local government output indicator that tries to globally assess the several areas of municipal provision of services and goods. We explain in the next section the construction of such output indicator.

[10] We describe briefly in Appendix C the linear programming problem to be solved for each DMU.

[11] We do not consider the municipalities of Madeira an Azores essentially for two reasons. First, these municipalities are located in Autonomous regions, a form of political government that only exists in the aforementioned islands. Second, given the characteristics of insularity, such areas have specific financial and fiscal benefits absent in the mainland.

[12] For instance, the NUTS criterion is used for the definition and distribution of the European Cohesion Funds, whose scope is mainly regional, being such funds the main source of financing of municipal investments.

4.2. Local Government Output Indicator (LGOI)

We focus on global municipal performance stemming from the municipal provision of several local services. However, as we were confronted with the difficulty of directly measuring some of the municipal production results, we concentrate on more homogenous basic local activities taking into account those spending functions enumerated in the legal municipal government framework: rural and urban equipment, energy, transport and communications, education, patrimony, culture and science, sports and leisure, healthcare, social services, housing, protection of the civil population, environment and basic sanitation, consumer protection, promote social and economic development, territory organisation, and external cooperation. Furthermore, some of the municipal performance indicators are surrogate measures of municipal services supply.

The selection of indicators was based upon two general arguments implied within our analysis. First, municipalities with similar demand for homogeneous services should also have similar performance. Accordingly, we expect that a municipality with a younger population will allocate more public resources for the satisfaction of this particular group in terms, for example, of education and sportive services provision. Second, performance of municipal governments can be measured in terms of the improvement of observable factors directly controlled by municipal governments during the time period under consideration (see Lovell, 1993).

Our selected output indicators (Y_i) used to quantitatively proxy the results of individual municipal services provision are the following (sources are provided in Appendix D): social services (local inhabitants above 65 years old as a percentage of resident population, Y_1); basic education, Y_2 (school buildings per capita measured by the number of nursery and primary school buildings in percent of the total number of corresponding school-age inhabitants, Y_{21}, gross primary enrolment ratio, the number of enrolled students in nursery and primary education in percent of the total number of corresponding school age inhabitants, Y_{22}); cultural services, Y_3 (number of library users in percentage of the total resident population); sanitation, Y_4 (water supply, Y_{41}, solid waste collection, Y_{42}); territory organisation, Y_5 (licences for building construction); road infrastructures, Y_6 (length of roads maintained by the municipalities per number of the total resident population).

Table 4 reports the regional average values for the selected municipal services indicators, suggesting the existence of large differences in performance among regions, mainly for cultural, sanitation and territory organisation services provision.

On average, municipalities located in the LVT region score well in sanitation and territory organisation service provision. By contrast, they have one of the lowest performances in basic education. As for road infrastructure, municipalities of both LVT and Norte regions have the lowest scores. However, one has to mention that these regions siege the two main Portuguese cities: Lisbon (the capital) and Porto. Therefore, the measure of road infrastructure does not fully apply in both cities cases because their administrative division matches the respective municipalities' boundaries, which only include a single urban territory. Additionally, from Table 4 it is possible to see that those municipalities belonging to the Alentejo and Algarve regions seem to have a good performance in social and cultural services provision.

As suggested by several authors, we quantify the so-called Local Government Output Indicator (LGOI) as a single measure of municipal performance having in mind two objectives: on the one hand, to evaluate globally municipal performance; on the other hand, to carry with a frontier approach to local efficiency using that composite indicator as our output measure.[13]

[13] See, for example, De Borger and Kerstens (1996b) and Afonso et al. (2005).

Table 4
Regional average values for municipal result indicators (2001)

Region	Social services (Y_1)	Basic education (Y_2)		Cultural services (Y_3)	Sanitation (Y_4)		Territory organisation (Y_5)	Road infrastructures (Y_6)
		School buildings per capita (Y_{21})	Education enrolment (Y_{22})		Water supply (Y_{41})	Waste collection (Y_{42})		
Alentejo	0.257	0.023	0.626	1.149	1005.26	5639.66	83.26	0.020
Algarve	0.217	0.012	0.570	1.203	4280.19	18428.31	251.19	0.027
Centro	0.233	0.030	0.624	0.944	1864.24	8137.29	175.28	0.023
LVT	0.180	0.014	0.535	1.157	7811.96	36114.49	270.00	0.011
Norte	0.182	0.029	0.621	0.896	2708.06	18125.03	235.51	0.018
Minimum	0.180	0.012	0.535	0.896	1005.26	5639.66	83.26	0.011
Maximum	0.257	0.030	0.626	1.203	7811.96	36114.49	270.00	0.027

Table 5
Regional summary values for LGOI—2001

	Alentejo	Algarve	Centro	LVT	Norte
Average	1.00	1.00	1.00	1.00	1.00
Minimum (municipality)	0.61 (Portel)	0.65 (Tavira)	0.58 (Belmonte)	0.50 (Azambuja)	0.43 (Trofa)
Maximum (municipality)	1.73 (C.Vide)	1.65 (Monchique)	2.92 (Coimbra)	3.49 (Lisboa)	3.44 (Porto)
Standard deviation	0.26	0.30	0.44	0.49	0.47

The procedure adopted to construct the composite indicator for each region was as follows: first, all values of each sub-indicator mentioned in Table 4 were normalised by setting the average equal to one. Then, we compiled the performance indicator from the various sub-indicators giving equal weight to each of them. Notice that the indicators based on Y_2 and Y_4 will be obtained as a normalised average of respectively sub-indicators Y_{21} and Y_{22}, for basic education, and Y_{41} and Y_{42} for sanitation.

The summary values of our output measure, LGOI, observed within each of the five regions are reported in Table 5. These values refer to simple averages observed in the individual municipal results in each of the five regions. The detailed set of results for our LGOI construction is presented in Appendix A.

Table 5 suggests large differences in municipal services provision performance within and across regions. Particularly, the LVT, Norte and Centro regions show the highest standard deviation. These three regions are also those that on average spent less in 2001 in per capita terms (683.4, 812.04 and 682.34 euros, respectively, as seen before in Table 1). By contrast, the Algarve and Alentejo regions, although being less heterogeneous regions in terms of the LGOI, were the ones with the highest average spending per capita (1128.78 and 982.71 euros, respectively).

4.3. DEA results

In order to evaluate non-parametrically the efficiency in municipal provision on local services, we will now use the LGOI as the output measure, and the level of per capita municipal spending as the input measure.

Table 6
DEA efficiency results

Region	No. of DMUs	Efficient DMUs		Average efficiency scores	
		No. of DMUs (municipality)	% of DMUs in the region	Input oriented	Output oriented
Alentejo	47	4 (Santiago Cacém, Évora, Castelo de Vide, Portalegre)	8.5	0.654	0.610
Algarve	16	3 (Faro, Olhão, Monchique)	18.8	0.608	0.681
Centro	78	3 (Aveiro, Coimbra, Figueira da Foz)	3.9	0.237	0.353
LVT	51	3 (Lisboa, Caldas Rainha, Sintra)	5.9	0.606	0.479
Norte	86	4 (Braga, Vizela, Gondomar, Porto)	4.7	0.567	0.397
Mainland[a]	278	3 (Miranda do Corvo, Seia, Gondomar)	1.1	0.225	0.246

[a] Due to space constraints, the detailed set of results for the mainland is not presented but is available from the authors on request.

Table 6 summarizes our DEA results obtained with the one input, and one output specification, both in terms of input and output oriented efficiency scores for 2001. The individual and complete DEA results, for every municipality in each of the five regions, are presented in Appendix B. We also report the DEA results regarding the entire set of municipalities in mainland Portugal using, as for the five regions, a one input and one output specification.

We find that the highest share of municipalities that would be labelled as most efficient, and located on the theoretical production frontier within a given region, belong to Algarve (Faro, Monchique and Olhão) and Alentejo (Santiago do Cacém, Évora, Castelo de Vide and Portalegre) regions. However, one has to bear in mind that these two regions are also the ones with the lower number of municipalities. In what concerns the Norte region, which has the highest number of municipalities, only four municipalities (Braga, Vizela, Gondomar and Porto) were labelled as most efficient and located on the theoretical production frontier. Interestingly for the LVT region, the efficiency results confirm those reported by Afonso and Fernandes (2006) in what concerns both the identification of the efficient municipalities (Lisbon, Caldas da Rainha and Sintra) and the average input efficiency score (around 0.6).

By comparing the averages of input efficiency scores observed within each of the five regions, we conclude that Alentejo (0.654) and Algarve (0.608) have the highest values, suggesting that their municipalities could theoretically achieve on average roughly the same level of local output with about 34.6 and 39.2% fewer resources, respectively. By contrast, municipalities belonging to the Centro region are reported as being on average the least efficient (0.237), implying that these municipalities could theoretically achieve on average roughly the same level of local output with about 76.3% fewer resources, i.e., that local performance could be strongly improved without necessarily increasing municipal spending. Interestingly, it was also in this region that we observed both the lowest (128.37 euros for Figueira da Foz) and the highest (7683.33 euros for Figueira de Castelo Rodrigo) values for the selected input measure.

5. Explaining inefficiency

5.1. Non-discretionary factors

One has to assume that some municipalities may be unable to achieve the "best-practice" due to a relative harsh environment. Therefore, there is an interest in explaining the distribution of the efficiency scores previously calculated in the first-stage of our empirical analysis in light of local socio-economic and demographic specificities, as maintained, for example, by Bradford et al. (1969) and Schwab and Oates (1991), essentially mainly to help guiding public policy and assist the municipal decision-making process.

Indeed, the standard DEA model as the one described in (1) incorporates only discretionary inputs, those whose quantities can be changed at the DMU will, and does not take into account the presence of environmental variables or factors, also known as non-discretionary inputs. However, socio-economic differences may play a relevant role in determining heterogeneity across the municipalities and influence performance outcomes. These exogenous socio-economic factors can include, for instance, the level of education of the population in a given region, the municipality's purchasing power or even its geographical distance to the main decision centres.

In this section our purpose is to empirically examine how the DEA efficiency results may be associated to, and thereby explained by, hypothesized factors proposed in the literature on local government sector efficiency. These factors can be broadly identified under two main categories: inter-municipal competition and socioeconomic and demographic characteristics.

Regarding inter-municipal competition, for instance Tiebout (1956) and Heikkila (1996) argue that municipal inefficiency may be associated with the lack of competition pressures one municipality feels from other competing municipalities. This can arise because those competing forces can be related with the degree of choice mobile citizens/consumers do have to move into communities that offer a bundle of services that best match their own preferences.[14] In fact, Loikkanen and Susiluoto (2005) found that peripheral location was negatively related to municipal spending efficiency. Following this trend, to approach these competitive forces we calculated the geographical distance between the municipality and its capital of district. This variable is expected to exert a negative effect on efficiency.

Bureaucracy inefficiency models (see Niskanen, 1975; Migué and Bélanger, 1974) envisage monitoring as a pragmatic framework to avoid the hypothesized tendency of local governments to pursue self-interests and political agenda (see, for instance, Mueller, 2003; Hayes and Wood, 1995; Hayes et al., 1998). It has become common practice on local sector analysis the introduction of socio-economic and demographic characteristics that might explain variations in the ability of local residents to properly monitor local governments. These "community composition" elements may explain inter-municipal differences in the production of local goods consumed by local residents.

Although it is difficult to distinguish effects on demand from those determinants of inefficiencies, we may argue that efficiency may be affected by factors reflecting monitoring costs such as socio-economic factors. Indeed, the scope of "the disciplining effect of competition" (cf. Grossman et al., 1999) may be limited if monitoring the local government performance is difficult and costly due to, respectively, reduced ability of citizen-voters or the existence of opportunity costs to properly monitor local authorities (De Borger and Kerstens, 1996a).

Hamilton (1983) and Hayes et al. (1998) argue that local efficiency may depend on the ability of citizens to pressure local representatives and more specifically, that monitoring municipal performance, and even costs, depends on the education level of local residents.[15] In what concerns spending efficiency, the findings of Van den Eeckaut et al. (1993), De Borger and Kerstens (1996a) and Loikkanen and Susiluoto (2005) support the argument that efficiency is positively related to average level of education of local inhabitants. Therefore, we use two alternative measures of educational achievement: first, the percentage of population with secondary education; secondly, the percentage of population with tertiary education. We expect these variables to exert a positive effect in efficiency.[16]

[14] Hayes et al. (1998) and Grossman et al. (1999) findings support that intra-metropolitan suburban competition does positively contribute for the improvement of efficiency, and it may be expected that metropolitan suburbs within closer proximity of each other enhance higher mobility choices than non-metropolitan municipalities, resulting from this "voting by feet" mechanism (Tiebout, 1956) higher pressures on local governments to be more efficient in the provision of local services. Additionally, Grossman et al. (1999) argue that the more metropolitan suburban municipalities are perceived by mobile consumers as "effective substitutes" for metropolitan central city, the more technically efficient the central city tends to be.

[15] Milligan et al. (2004) find that education is related to several measures of political interest and involvement in US and UK. This effect was supposed to be exercised through the following channels: (i) the "quality" of participation of a given subset of citizens (as Hamilton, 1983) and (ii) enlarged participation among citizens (or, as is the same, as being negatively related with what Grossman et al., 1999; labelled as "rationale ignorance" and "rationale abstention", respectively). According to Milligan et al. (2004), "The first channel is important if education equips citizens with the cognitive skills they need to be effective participants in a representative democracy. In this case, education increases citizen's ability to select able leaders, understand the issues upon which they will vote, act as a check on the potential excess of the government, and recognize corruption in leaders".

[16] Afonso and St. Aubyn (2006) mention this is also the case in terms of cross country efficiency analysis.

To determine the impact of higher per capita incomes and wealth of citizens on spending efficiency we used municipal per capita purchasing power, an index estimated by the Portuguese National Institute of Statistics. The aim is then to assess whether richer local residents impose somehow an increased pressure in demanding more efficient local services. Indeed, according to several authors, the demand for local public services is expected to vary with income.[17] On the other hand, a point can also be made for the possibility that poorer residents may in the end be more interested in better and more efficient local services. Nevertheless, wealth together with education is expected to both increase locally collected revenues by the authorities and raise the degree of awareness vis-à-vis local government performance.

In what concerns demographic characteristics, Grossman et al. (1999) argue that monitoring costs are likely to vary positively with geographic 'scarcity of municipalities', which may indicate the presence of scale diseconomies. On the other hand, scale economies could exist when providing local public services for an enlarged number of residents, which would then increase its efficiency. We model this exogenous dimension by using population density variables and population growth.

5.2. Tobit analysis

Using the DEA output efficiency scores computed in the previous section, we now evaluate the importance of environmental or non-discretionary inputs. We present the results from Tobit estimations[18] by regressing the output efficiency scores, θ, on a set of possible explanatory variables as follows:

$$\theta_i = \beta_0 + \beta_1 Y_i + \beta_2 E_i + \beta_3 D_i + \beta_4 \, \mathrm{Pop}_i + \varepsilon_i, \qquad (2)$$

where Y is a measure of purchasing power at the municipality level, E a measure of the educational level, D a variable that captures the effect of the geographical distance between the municipality and its capital of district, and Pop is a population related indicator, for instance population density or population growth.

For a simpler reading of the results vis-à-vis the efficiency scores, we use the inverse of the geographical distance of each municipality to the capital of the respective district, which is then our variable D in (2). This means that a decrease in that distance increases its inverse and therefore would increase efficiency if the estimated coefficients for such variable were positive. We report in Table 7 the results from the censored normal Tobit regressions for several alternative specifications of Eq. (2) for each of the five regions and for the Mainland.

The results indicate that spending efficiency is positively and strongly related to the percentage of inhabitants with either secondary or tertiary education, across most regions and specifications. Furthermore, both variables had the same (positive) sign and were significant at 1% level at least once, which indicates that an increase in those variables would increase efficiency or, in other words, that the level of education has a relevant impact on the efficiency of municipal provision. The only exception is the Algarve region, but one must bear in mind that this region has a much small number of DMUs, which limits the accuracy of the results.

[17] See, for instance, Hamilton (1983), Hayes et al. (1998), De Borger et al. (1994), and De Borger and Kerstens (1996a).

[18] The use of censored regression techniques is appropriate for this two-step analysis since the efficiency scores, the dependent variable, are observed in only a certain range: in our case assuming a maximum value of 1. An overview of related applications is provided, for instance, by Ruggiero (2004).

Table 7a
Censored normal Tobit results: Alentejo and Algarve

	Alentejo				Algarve		
	1	2	3	4	1	2	3
Constant	0.264** (2.19)	0.262** (2.48)	0.257*** (2.78)	0.220** (2.32)	0.555*** (7.20)	0.639*** (3.09)	0.607*** (3.48)
Y	0.003* (1.83)						−0.001 (−0.33)
Esec		0.019** (2.15)				−0.006 (−0.44)	
Eter			0.037*** (2.66)	0.054*** (2.98)			
D	4.868*** (2.71)	4.702*** (2.64)	4.426** (2.54)	4.343** (2.54)	4.439* (1.86)	4.679* (1.90)	4.585 (1.87)
Popdens				−0.003 (−1.45)			
No. of obs.	43	43	43	43	15	15	15
$\hat{\sigma}_\varepsilon$	0.157	0.155	0.152	0.151	0.189	0.197	0.197

Notes. *Y*: purchasing power; Esec: population with secondary education; Eter: population with tertiary education; *D*: distance to capital of district, inverse; PopDens: population density. The *z* statistics are in parentheses. *, **, ***Significant at the 10, 5 and 1% level, respectively. $\hat{\sigma}_\varepsilon$: Estimated standard deviation of ε.

Table 7b
Censored normal Tobit results: LVT and Norte

	LVT			Norte			
	1	2	3	1	2	3	4
Constant	0.341*** (3.79)	0.374*** (4.87)	0.421*** (6.44)	0.080 (1.60)	0.230*** (4.91)	0.243*** (5.47)	0.199*** (3.84)
Y	0.002** (2.44)			0.005*** (6.45)			
Esec		0.010** (2.51)					0.016*** (3.15)
Eter			0.013** (2.97)		0.017** (2.27)	0.019*** (2.68)	
D	−1.897** (−2.10)	−1.957** (−2.16)	−1.979** (−2.16)	0.023 (0.08)		8.77E−5*** (2.60)	
PopDens					1.55E−4** (3.61)		7.21E−5** (2.17)
PopVar						0.005*** (2.81)	0.004** (2.33)
No. obs.	48	48	48	82	82	82	82
$\hat{\sigma}_\varepsilon$	0.106	0.177	0.178	0.160	0.168	0.151	0.149

Notes. *Y*: Purchasing power; Esec: population with secondary education; Eter: population with tertiary education; *D*: distance to capital of district, inverse; PopDens: population density; PopVar: population variation. The *z* statistics are in parentheses. *, **, ***Significant at the 10, 5 and 1% level, respectively. $\hat{\sigma}_\varepsilon$: Estimated standard deviation of ε.

Table 7c
Censored normal Tobit results: Centro and Mainland

	Centro				Portugal (Mainland)		
	1	2	3	4	1	2	3
Constant	0.137** (2.05)	0.202*** (3.36)	0.212*** (2.91)	0.201** (2.18)	0.043** (2.09)	0.081*** (3.52)	0.137*** (4.78)
Y	0.003*** (3.38)			0.003** (2.24)	0.002*** (2.61)	0.001* (1.65)	−2.03E−4 (−0.29)
Esec		0.015*** (3.23)	0.012** (2.09)				
Eter					0.013*** (2.95)	0.011*** (2.68)	0.014*** (3.36)
D		−0.642 (−0.82)					
PopDens				−1.042 (−1.30)		3.85E−5*** (3.43)	5.27E−5*** (4.47)
PopVar			0.002 (0.60)	0.002 (0.74)			0.002*** (3.00)
No. obs.	78	78	78	78	278	278	278
$\hat{\sigma}_{\varepsilon}$	0.164	0.165	0.166	0.164	0.119	0.116	0.115

Notes. *Y*: purchasing power; Esec: population with secondary education; Eter: population with tertiary education; *D*: distance to capital of district, inverse; PopDens: population density; PopVar: population variation. The *z* statistics are in parentheses. *, **, ***Significant at the 10, 5 and 1% level respectively. $\hat{\sigma}_{\varepsilon}$ – Estimated standard deviation of ε.

For the purchasing power exogenous factor, used to assess whether richer local residents impose an increased pressure in demanding more efficient local services, the estimation results show positive and significant coefficients for all regions apart from Algarve.

It is also worthwhile mentioning that the estimates for population density revealed positive and significant coefficients for the Norte region, indicating that a higher proportion of inhabitants living in dense settlement structures may facilitate the organisation and consumption of networked local services. For all the other regions, this variable is not relevant in explaining inefficiencies. Population growth has a positive effect on efficiency also only for the Norte region.

Finally, we found positive and statistically significant estimates for the coefficient of the geographical distance variable for the Alentejo, Algarve, and Norte regions. Hence, for those three regions, the closer the municipalities are to the capital of district the higher are their efficiency scores. On the other hand, this variable is not relevant for the Centro region. Interestingly, geographical distance impinges negatively on efficiency in the case of the LVT region, the more densely populated region, which includes the country's capital. In other words, for this region, closeness to the capital may be undesirable for efficiency.

6. Conclusion

In this paper, we evaluated public expenditure efficiency of Portuguese municipal governments using Data Envelopment Analysis to compute input and output efficiency scores for the 278 Portuguese municipalities located in the mainland. The analysis is performed by clustering municipalities into the five NUTS-2 regions defined for statistical purposes: Norte, Centro, Lisboa e Vale do Tejo (LVT), Alentejo and Algarve.

To implement our frontier analysis we computed a so-called Local Government Output Indicator (LGOI) as a single measure of municipal performance, for 2001, and used this composite indicator as our output measure for the DEA computations. Such composite indicator includes sub-indicators of municipal services provision in the following areas: social services, education, cultural services, sanitation, territory organisation and road infrastructures.

The results of the DEA calculations show that average regional input efficiency scores range from 0.237 in the Centro region to 0.654 in the Alentejo region. On the other hand, average regional output efficiency scores are between 0.353 in the Centro region and 0.681 in the Algarve region. On a municipal level, the evidence is naturally quite unequal, which implies that there is significant room for improvement in terms of possible theoretical efficiency gains. Regarding the five regions the number of municipalities that define the efficiency frontier is between three and four.

In order to see what factors may impinge on the efficiency level of municipal services provision, we performed a Tobit analysis both for each region. Regarding the possible explanatory variables of inefficiencies in the provision of local governments' services, the most relevant non-discretionary factors, which contribute positively to increase efficiency, seem to be: the level of education, secondary or tertiary; municipal per capita purchasing power; and geographical distance to the capital of district.

Ultimately, one has to mention that these results should be put into some perspective, essentially because of two reasons. Firstly, the fact that some municipalities are not located on the theoretical production possibility frontier, and therefore not being labelled efficient, does not mean that they could actually be on the frontier. Indeed, municipal policy decisions may simply favour a different set of output provision. Secondly, the environmental factors or socio-economic factors, as discussed before, are a possible strong constraint to movements towards the production possibility frontier.

Finally, our results suggest that local governments should try to learn from best practices in order to improve their own performance. That is paramount for a better use of scarce public resources in the context of the fiscal framework in place in the European Union. Moreover, policies that increase school and university enrolment (and student performance) can be expected, apart from the overall gains, to positively affect the future awareness of residents when demanding improved local public services. Additionally, scale economies also play a positive role since they may facilitate the organisation and consumption of networked local services. This could, for instance, imply that such services as sanitation or road infrastructures could be constructed and run in a cross-municipality set-up.

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Appendix A. Detailed values for the LGOI measure

See Tables A.1 and A.2.

Table A.1
Local Government Output Indicator (LGOI): Alentejo, Algarve and LVT

Alentejo		Algarve		LVT	
Municipality	LGOI	Municipality	LGOI	Municipality	LGOI
Aljustrel	0.84	Albufeira	1.08	Alcobaça	0.80
Almodôvar	1.34	Alcoutim	0.67	Bombarral	0.78
Alvito	1.04	Aljezur	1.11	Caldas da Rainha	0.89
Barrancos	1.10	Castro Marim	1.14	Nazaré	1.00
Beja	1.43	Faro	1.49	Óbidos	0.81
Castro Verde	1.04	Lagoa	1.03	Peniche	0.73
Cuba	1.40	Lagos	1.07	Alenquer	0.76
Ferreira do Alentejo	1.07	Loulé	1.35	Amadora	0.75
Grândola	1.09	Monchique	1.65	Arruda dos Vinhos	1.12
Mértola	0.84	Olhão	0.68	Cadaval	0.96
Moura	0.98	Portimão	0.94	Cascais	0.99
Odemira	1.32	São Brás de Alportel	0.89	Lisboa	3.49
Ourique	1.02	Silves	0.80	Loures	0.80
Santiago do Cacém	1.18	Tavira	0.65	Lourinhã	0.65
Serpa	0.88	Vila do Bispo	0.76	Mafra	1.12
Sines	0.94	Vila Real de Santo António	0.70	Odivelas	0.74
Vidigueira	0.92			Oeiras	1.07

Table A.1 (*Continued*)

Alentejo		Algarve		LVT	
Municipality	LGOI	Municipality	LGOI	Municipality	LGOI
Alandroal	0.87			Sintra	1.52
Alcacér do Sal	1.25			Sobral de Monte Agraço	1.35
Arraiolos	0.63			Torres Vedras	1.07
Borba	0.88			Vila Franca de Xira	0.90
Estremoz	0.97			Abrantes	0.69
Évora	1.70			Alcanena	1.06
Montemor-o-Novo	1.21			Almeirim	0.67
Mora	0.77			Alpiarça	0.93
Mourão	0.75			Azambuja	0.50
Portel	0.61			Benavente	0.79
Redondo	0.66			Cartaxo	0.69
Reguengos de Monsaraz	0.78			Chamusca	0.64
Vendas Novas	0.77			Constância	1.92
Viana do Alentejo	0.91			Coruche	2.18
Vila Viçosa	0.71			Entroncamento	0.96
Alter do Chão	1.14			Ferreira do Zêzere	0.96
Arronches	0.92			Golegã	0.97
Avis	0.68			Ourém	0.92
Campo Maior	0.84			Rio Maior	0.83
Castelo de Vide	1.73			Salvaterra de Magos	0.66
Crato	1.32			Santarém	0.93
Elvas	0.93			Sardoal	2.07
Fronteira	0.79			Tomar	0.79
Gavião	0.86			Torres Novas	0.73
Marvão	1.35			Vila Nova da Barquinha	0.95
Monforte	0.96			Alcochete	0.61
Nisa	0.82			Almada	1.37
Ponte de Sôr	1.05			Barreiro	0.74
Portalegre	0.95			Moita	1.01
Sousel	0.79			Montijo	0.61
				Palmela	1.14
				Seixal	1.02
				Sesimbra	0.76
				Setúbal	0.91
Average	1.00	Average	1.00	Average	1.00
Minimum (Portel)	0.61	Minimum (Tavira)	0.65	Minimum (Azambuja)	0.50
Maximum (Castelo de Vide)	1.73	Maximum (Monchique)	1.65	Maximum (Lisboa)	3.49
Stdev	0.26	Stdev	0.30	Stdev	0.49

Table A.2
Local Government Output Indicator (LGOI): Centro and Norte

Centro				Norte			
Municipality	LGOI	Municipality	LGOI	Municipality	LGOI	Municipality	LGOI
Águeda	0.87	Sabugal	0.82	Arouca	0.65	Vila do Conde	1.01
Albergaria-a-Velha	0.77	Seia	0.84	Castelo de Paiva	0.61	Vila Nova de Gaia	1.84
Anadia	0.69	Trancoso	0.82	Espinho	1.06	Arcos de Valdevez	0.70
Aveiro	2.92	Alvaiázere	0.73	Oliveira de Azeméis	1.01	Caminha	1.00
Estarreja	0.73	Ansião	0.91	Santa Maria da Feira	0.97	Melgaço	1.19
Ílhavo	0.85	Batalha	0.89	São João da Madeira	1.53	Monção	0.69

Table A.2 (*Continued*)

Centro				Norte			
Municipality	LGOI	Municipality	LGOI	Municipality	LGOI	Municipality	LGOI
Mealhada	0.94	Castanheira de Pêra	0.88	Vale de Cambra	0.72	Paredes de Coura	1.55
Murtosa	0.84	Figueiró dos Vinhos	0.89	Amares	0.60	Ponte da Barca	0.69
Oliveira do Bairro	1.35	Leiria	2.15	Barcelos	1.20	Ponte de Lima	1.17
Ovar	1.57	Marinha Grande	1.08	Braga	1.89	Valença	1.45
Sever do Vouga	0.83	Pedrógão Grande	1.14	Cabeceiras de Basto	0.59	Viana do Castelo	1.28
Vagos	0.88	Pombal	1.31	Celorico de Basto	0.55	Vila Nova de Cerveira	1.68
Belmonte	0.58	Porto de Mós	0.91	Esposende	1.01	Alijó	0.74
Castelo Branco	1.20	Mação	1.27	Fafe	0.88	Boticas	0.99
Covilhã	0.85	Carregal do Sal	0.79	Guimarães	1.61	Chaves	1.07
Fundão	1.11	Castro Daire	0.78	Póvoa de Lanhoso	0.58	Mesão Frio	1.19
Idanha-a-Nova	0.92	Mangualde	1.39	Terras de Bouro	0.64	Mondim de Basto	0.93
Oleiros	0.67	Mortágua	0.90	Vieira do Minho	0.65	Montalegre	0.98
Penamacor	0.72	Nelas	0.89	Vila Nova de Famalicão	1.30	Murça	0.78
Proença-a-Nova	2.23	Oliveira de Frades	0.78	Vila Verde	0.90	Peso da Régua	0.55
Sertã	0.71	Penalva do Castelo	1.08	Vizela	0.61	Ribeira de Pena	0.72
Vila de Rei	0.90	Santa Comba Dão	0.92	Alfândega da Fé	0.77	Sabrosa	0.90
Vila Velha de Ródão	0.87	São Pedro do Sul	0.89	Bragança	2.03	Santa Marta de Penaguião	0.82
Arganil	1.13	Sátão	0.64	Carrazeda de Ansiães	0.80	Valpaços	0.73
Cantanhede	1.47	Tondela	1.07	Freixo de Espada à Cinta	0.74	Vila Pouca de Aguiar	0.72
Coimbra	2.92	Vila Nova de Paiva	0.86	Macedo de Cavaleiros	0.83	Vila Real	2.60
Condeixa-a-Nova	0.60	Viseu	1.68	Miranda do Douro	0.79	Armamar	0.73
Figueira da Foz	1.42	Vouzela	0.92	Mirandela	0.71	Cinfães	0.62
Góis	0.99			Mogadouro	0.65	Lamego	0.67
Lousã	0.84			Torre de Moncorvo	1.45	Moimenta da Beira	0.66
Mira	0.76			Vila Flor	1.13	Penedono	1.32
Miranda do Corvo	0.59			Vimioso	0.74	Resende	1.14
Montemor-o-Velho	0.78			Vinhais	0.73	São João da Pesqueira	0.81
Oliveira do Hospital	0.70			Vila Nova de Foz Côa	0.67	Sernancelhe	0.75
Pampilhosa da Serra	0.87			Amarante	0.81	Tabuaço	0.98
Penacova	0.72			Baião	0.57	Tarouca	1.38
Penela	0.81			Felgueiras	0.84		
Soure	0.71			Gondomar	1.27		
Tábua	0.80			Lousada	0.65		
Vila Nova de Poiares	1.27			Maia	1.02		
Aguiar da Beira	0.90			Marco de Canaveses	0.95		
Almeida	0.61			Matosinhos	1.63		
Celorico da Beira	0.76			Paços de Ferreira	1.00		
Fig. Castelo Rodrigo	0.64			Paredes	0.86		
Fornos de Algodres	0.91			Penafiel	0.75		
Gouveia	0.74			Porto	3.44		
Guarda	1.12			Póvoa de Varzim	1.24		
Manteigas	1.23			Santo Tirso	1.22		
Meda	0.75			Trofa	0.43		
Pinhel	0.67			Valongo	0.82		
Average			1.00	Average			1.00
Minimum (Belmonte)			0.58	Minimum (Trofa)			0.43
Maximum (Coimbra)			2.92	Maximum (Porto)			3.44
Standard deviation			0.44	Standard deviation			0.47

Appendix B. Detailed DEA results for the five regions

See Tables B.1–B.5.

Table B.1
DEA results, Algarve: 1 input (spending per capita) and 1 output (LGOI)

Municipality	Input oriented		Output oriented	
	VRS TE	Rank	VRS TE	Rank
Albufeira	0.424	12	0.661	9
Alcoutim	0.264	16	0.406	16
Aljezur	0.419	13	0.677	7
Castro Marim	0.339	15	0.691	6
Faro	1.000	1	1.000	1
Lagoa	0.544	8	0.656	10
Lagos	0.459	11	0.664	8
Loulé	0.607	7	0.862	4
Monchique	1.000	1	1.000	1
Olhão	1.000	1	1.000	1
Portimão	0.656	6	0.614	11
São Brás de Alportel	0.699	5	0.587	12
Silves	0.924	4	0.750	5
Tavira	0.497	10	0.415	15
Vila do Bispo	0.393	14	0.467	13
Vila Real de Santo António	0.504	9	0.447	14
Average	0.608		0.681	

VRS TE: variable returns to scale, technical efficiency.

Table B.2
DEA results, Alentejo: 1 input (spending per capita) and 1 output (LGOI)

Municipality	Input oriented		Output oriented	
	VRS TE	Rank	VRS TE	Rank
Aljustrel	0.718	18	0.493	34
Almodôvar	0.537	35	0.777	9
Alvito	0.429	42	0.601	21
Barrancos	0.332	47	0.636	17
Beja	0.896	6	0.844	5
Castro Verde	0.631	25	0.608	20
Cuba	0.888	7	0.833	6
Ferreira do Alentejo	0.672	20	0.627	19
Grândola	0.563	30	0.635	18
Mértola	0.559	32	0.489	35
Moura	0.863	9	0.660	15
Odemira	0.806	11	0.775	10
Ourique	0.477	39	0.591	22
Santiago do Cacém	1.000	1	1.000	1
Serpa	0.722	17	0.516	30
Sines	0.539	34	0.547	24
Vidigueira	0.637	24	0.538	26
Alandroal	0.563	31	0.507	31
Alcácer do Sal	0.645	21	0.730	13
Arraiolos	0.577	28	0.367	46
Borba	0.774	14	0.517	29

Table B.2 (*Continued*)

Municipality	Input oriented		Output oriented	
	VRS TE	Rank	VRS TE	Rank
Estremoz	0.971	5	0.792	7
Évora	1.000	1	1.000	1
Montemor-o-Novo	0.729	16	0.710	14
Mora	0.484	38	0.446	41
Mourão	0.340	46	0.434	43
Portel	0.495	37	0.354	47
Redondo	0.624	26	0.386	45
Reguengos de Monsaraz	0.642	22	0.456	39
Vendas Novas	0.775	13	0.453	40
Viana do Alentejo	0.575	29	0.531	28
Vila Viçosa	0.819	10	0.443	42
Alter do Chão	0.369	44	0.659	16
Arronches	0.414	43	0.532	27
Avis	0.457	40	0.393	44
Campo Maior	0.781	12	0.494	33
Castelo de Vide	1.000	1	1.000	1
Crato	0.553	33	0.767	11
Elvas	0.641	23	0.544	25
Fronteira	0.433	41	0.457	38
Gavião	0.535	36	0.500	32
Marvão	0.677	19	0.789	8
Monforte	0.363	45	0.555	23
Nisa	0.611	27	0.479	36
Ponte de Sôr	0.886	8	0.735	12
Portalegre	1.000	1	1.000	1
Sousel	0.732	15	0.464	37
Average	0.654		0.610	

VRS TE: variable returns to scale, technical efficiency.

Table B.3
DEA results, LVT: 1 input (spending per capita) and 1 output (LGOI)

Municipality	Input oriented		Output oriented	
	VRS TE	Rank	VRS TE	Rank
Alcobaça	0.837	8	0.511	17
Bombarral	0.713	13	0.448	26
Caldas da Rainha	1.000	1	1.000	1
Nazaré	0.678	19	0.546	13
Óbidos	0.384	46	0.295	43
Peniche	0.660	22	0.398	32
Alenquer	0.578	26	0.377	33
Amadora	0.667	21	0.412	31
Arruda dos Vinhos	0.499	35	0.481	20
Cadaval	0.679	18	0.528	15
Cascais	0.521	33	0.448	27
Lisboa	1.000	1	1.000	1
Loures	0.698	14	0.453	25
Lourinhã	0.515	34	0.297	42
Mafra	0.493	37	0.477	22

Table B.3 (*Continued*)

Municipality	Input oriented		Output oriented	
	VRS TE	Rank	VRS TE	Rank
Odivelas	0.696	15	0.418	30
Oeiras	0.525	31	0.481	21
Sintra	1.000	1	1.000	1
Sobral de Monte Agraço	0.591	25	0.635	9
Torres Vedras	0.859	6	0.677	7
Moita	0.859	7	0.645	8
Vila Franca de Xira	0.738	11	0.529	14
Abrantes	0.472	38	0.295	44
Montijo	0.472	39	0.367	35
Alcanena	0.374	47	0.275	47
Almeirim	0.447	40	0.295	45
Alpiarça	0.327	49	0.197	50
Azambuja	0.425	42	0.373	34
Benavente	0.540	30	0.363	37
Cartaxo	0.628	24	0.189	51
Chamusca	0.298	50	0.550	12
Constância	0.269	51	0.981	4
Coruche	0.974	4	0.556	11
Entroncamento	0.733	12	0.465	23
Ferreira do Zêzere	0.568	29	0.351	39
Golegã	0.387	44	0.514	16
Ourém	0.688	16	0.283	46
Rio Maior	0.353	48	0.365	36
Salvaterra de Magos	0.674	20	0.488	19
Santarém	0.631	23	0.593	10
Sardoal	0.386	45	0.441	28
Tomar	0.684	17	0.358	38
Torres Novas	0.569	27	0.462	24
Vila Nova da Barquinha	0.569	28	0.270	48
Alcochete	0.495	36	0.755	5
Almada	0.742	9	0.261	49
Barreiro	0.739	10	0.435	29
Palmela	0.524	32	0.507	18
Seixal	0.920	5	0.715	6
Sesimbra	0.431	41	0.303	41
Setúbal	0.413	43	0.350	40
Average	0.606		0.479	

Table B.4
DEA results, Centro: 1 input (spending per capita) and 1 output (LGOI)

Municipality	Input oriented		Output oriented	
	VRS TE	Rank	VRS TE	Rank
Águeda	0.263	15	0.298	40
Albergaria-a-Velha	0.273	13	0.264	58
Anadia	0.290	9	0.246	67
Aveiro	1.000	1	1.000	1
Estarreja	0.250	19	0.250	64
Ílhavo	0.210	40	0.291	44

Table B.4 (*Continued*)

Municipality	Input oriented		Output oriented	
	VRS TE	Rank	VRS TE	Rank
Mealhada	0.185	44	0.322	26
Murtosa	0.185	45	0.288	46
Oliveira do Bairro	0.176	48	0.462	10
Ovar	0.457	6	0.648	6
Sever do Vouga	0.205	41	0.284	49
Vagos	0.324	8	0.338	24
Belmonte	0.225	32	0.199	78
Castelo Branco	0.227	30	0.411	15
Covilhã	0.215	37	0.291	45
Fundão	0.257	16	0.380	19
Idanha-a-Nova	0.109	70	0.315	27
Oleiros	0.142	59	0.229	71
Penamacor	0.100	74	0.247	66
Proença-a-Nova	0.364	7	0.764	5
Sertã	0.225	33	0.243	68
Guarda	0.225	34	0.308	32
Vila de Rei	0.124	65	0.298	41
Vila Velha de Ródão	0.086	77	0.387	17
Arganil	0.180	47	0.503	8
Cantanhede	0.242	21	0.384	18
Coimbra	1.000	1	1.000	1
Condeixa-a-Nova	0.186	43	0.205	76
Figueira da Foz	1.000	1	1.000	1
Góis	0.117	68	0.339	23
Lousã	0.175	49	0.288	47
Gouveia	0.174	50	0.260	59
Mira	0.166	52	0.202	77
Miranda do Corvo	0.257	17	0.267	55
Montemor-o-Velho	0.233	26	0.240	70
Oliveira do Hospital	0.243	20	0.298	42
Pampilhosa da Serra	0.108	72	0.255	62
Penacova	0.288	11	0.277	52
Penela	0.163	54	0.253	63
Soure	0.226	31	0.243	69
Tábua	0.205	42	0.274	53
Vila Nova de Poiares	0.107	73	0.435	12
Aguiar da Beira	0.109	71	0.308	33
Almeida	0.136	61	0.209	75
Celorico da Beira	0.087	76	0.260	60
Fig. Castelo Rodrigo	0.017	78	0.219	73
Fornos de Algodres	0.111	69	0.312	30
Manteigas	0.167	51	0.421	14
Meda	0.220	36	0.257	61
Pinhel	0.121	67	0.229	72
Sabugal	0.159	56	0.281	50
Seia	0.156	57	0.288	48
Trancoso	0.231	28	0.281	51
Alvaiázere	0.166	53	0.250	65
Ansião	0.222	35	0.312	31
Batalha	0.278	12	0.307	35
Castanheira de Pêra	0.099	75	0.301	39

Table B.4 (*Continued*)

Municipality	Input oriented		Output oriented	
	VRS TE	Rank	VRS TE	Rank
Figueiró dos Vinhos	0.122	66	0.305	36
Leiria	0.751	3	0.834	4
Marinha Grande	0.232	27	0.370	20
Pedrógão Grande	0.126	64	0.390	16
Pombal	0.252	18	0.449	11
Porto de Mós	0.289	10	0.323	25
Mação	0.141	60	0.435	13
Carregal do Sal	0.241	22	0.271	54
Castro Daire	0.231	29	0.267	56
Mangualde	0.264	14	0.476	9
Mortágua	0.151	58	0.308	34
Nelas	0.213	38	0.305	37
Oliveira de Frades	0.129	63	0.267	57
Penalva do Castelo	0.213	39	0.370	21
Santa Comba Dão	0.235	23	0.315	28
São Pedro do Sul	0.162	55	0.305	38
Sátão	0.235	24	0.219	74
Tondela	0.234	25	0.366	22
Vila Nova de Paiva	0.134	62	0.295	43
Viseu	0.460	5	0.634	7
Vouzela	0.182	46	0.315	29
Average	0.237		0.353	

VRS TE: variable returns to scale, technical efficiency.

Table B.5
DEA results, Norte: 1 input (spending per capita) and 1 output (LGOI)

Municipality	Input oriented		Output oriented	
	VRS TE	Rank	VRS TE	Rank
Arouca	0.699	27	0.320	45
Castelo de Paiva	0.471	50	0.204	81
Espinho	0.437	58	0.308	47
Oliveira de Azeméis	0.676	28	0.449	26
Santa Maria da Feira	0.743	23	0.478	21
São João da Madeira	0.645	32	0.576	15
Vale de Cambra	0.733	25	0.367	38
Amares	0.605	36	0.258	58
Barcelos	0.870	9	0.698	11
Braga	1.000	1	1.000	1
Cabeceiras de Basto	0.658	31	0.276	53
Celorico de Basto	0.465	52	0.182	86
Esposende	0.638	33	0.424	31
Fafe	0.788	18	0.469	22
Guimarães	0.854	10	0.783	6
Póvoa de Lanhoso	0.593	38	0.245	60
Terras de Bouro	0.397	63	0.186	85
Vieira do Minho	0.494	47	0.227	68
Vila Nova de Famalicão	0.871	8	0.724	9
Vila Verde	0.716	26	0.433	30

Table B.5 (*Continued*)

Municipality	Input oriented		Output oriented	
	VRS TE	Rank	VRS TE	Rank
Vizela	1.000	1	1.000	1
Alfândega da Fé	0.391	65	0.224	71
Bragança	0.618	34	0.619	13
Carrazeda de Ansiães	0.290	80	0.233	65
Freixo de Espada à Cinta	0.224	86	0.215	75
Macedo de Cavaleiros	0.393	64	0.241	61
Miranda do Douro	0.342	73	0.230	67
Mirandela	0.608	35	0.301	48
Mogadouro	0.325	77	0.189	84
Torre de Moncorvo	0.330	76	0.422	32
Vila Flor	0.400	62	0.328	43
Vimioso	0.272	83	0.215	76
Vinhais	0.420	61	0.213	77
Vila Nova de Foz Côa	0.359	70	0.195	82
Amarante	0.784	19	0.440	28
Baião	0.663	29	0.269	55
Felgueiras	0.826	13	0.504	18
Gondomar	1.000	1	1.000	1
Lousada	0.795	15	0.389	36
Maia	0.507	44	0.340	42
Marco de Canaveses	0.793	16	0.501	19
Matosinhos	0.762	21	0.704	10
Paços de Ferreira	0.790	17	0.521	16
Paredes	0.908	6	0.641	12
Penafiel	0.800	14	0.435	29
Porto	1.000	1	1.000	1
Póvoa de Varzim	0.536	41	0.420	33
Santo Tirso	0.897	7	0.754	7
Trofa	0.844	11	0.301	49
Valongo	0.840	12	0.515	17
Vila do Conde	0.464	53	0.309	46
Vila Nova de Gaia	0.749	22	0.740	8
Arcos de Valdevez	0.446	56	0.219	72
Caminha	0.491	48	0.324	44
Melgaço	0.233	85	0.346	40
Monção	0.434	59	0.210	79
Paredes de Coura	0.522	42	0.469	23
Ponte da Barca	0.477	49	0.231	66
Ponte de Lima	0.604	37	0.452	25
Valença	0.511	43	0.442	27
Viana do Castelo	0.735	24	0.589	14
Vila Nova de Cerveira	0.364	68	0.488	20
Alijó	0.455	55	0.234	64
Boticas	0.276	81	0.288	50
Chaves	0.663	30	0.462	24
Mesão Frio	0.343	72	0.346	41
Mondim de Basto	0.357	71	0.270	54
Montalegre	0.341	74	0.285	51
Murça	0.307	79	0.227	69
Peso da Régua	0.496	46	0.194	83
Ribeira de Pena	0.273	82	0.209	80

Table B.5 (*Continued*)

Municipality	Input oriented		Output oriented	
	VRS TE	Rank	VRS TE	Rank
Sabrosa	0.421	60	0.262	57
Santa Marta de Penaguião	0.383	66	0.238	62
Valpaços	0.445	57	0.226	70
Vila Pouca de Aguiar	0.499	45	0.250	59
Vila Real	0.913	5	0.913	5
Armamar	0.318	78	0.212	78
Cinfães	0.771	20	0.351	39
Lamego	0.569	39	0.268	56
Moimenta da Beira	0.464	54	0.216	74
Penedono	0.266	84	0.384	37
Resende	0.569	40	0.418	34
São João da Pesqueira	0.363	69	0.235	63
Sernancelhe	0.336	75	0.218	73
Tabuaço	0.383	67	0.285	52
Tarouca	0.469	51	0.401	35
Average	0.567		0.393	

Appendix C. DEA analytical description

The analytical description of the linear programming problem to be solved, in the variable-returns to scale hypothesis, is sketched below for an input-oriented specification. With k inputs and m outputs for n DMUs, for the i-th DMU, y_i is the column vector of the inputs and x_i is the column vector of the outputs. Moreover, we can define X as the $(k \times n)$ input matrix and Y as the $(m \times n)$ output matrix. The DEA model is then specified with the following mathematical programming problem, for a given i-th DMU[19]:

$$\begin{aligned}&\min_{\theta,\lambda}\theta\\&\text{subject to}: -y_i + Y\lambda \geq 0, \qquad \theta x_i - X\lambda \geq 0, \qquad n1'\lambda = 1, \qquad \lambda \geq 0\end{aligned} \tag{C.1}$$

In problem (C.1), θ is a scalar (that satisfies $\theta \leq 1$), more specifically it is the efficiency score that measures technical efficiency. It measures the distance between a municipality and the efficiency frontier, defined as a linear combination of the best practice observations. With $\theta < 1$, the municipality is inside the frontier (i.e. it is inefficient), while $\theta = 1$ implies that the municipality is on the frontier (i.e. it is efficient). The vector λ is a $(n \times 1)$ vector of constants that measures the weights used to compute the location of an inefficient DMU if it were to become efficient.

Appendix D. Data sources

See Tables D.1, D.2 and D.3a–D.3f.

[19] We simply present here the equivalent envelopment form, derived by Charnes et al. (1978), using the duality property of the multiplier form of the original programming model.

Table D.1
Input (*X*) and output variables (*Y*) (used in the construction of the LGOI), and respective sources

Variable	Input measure	Data Source
X	Total municipal expenditures per inhabitant, 2001	INE, 2001: Recenseamento Geral da População e Habitação, 2001 (Resultados Definitivos); "Finanças locais: aplicação em 2001", Electronic edition, DGAL (www.dgaa.pt)

Variable	Municipal Services	Municipal results indicators	Data Source
Y_1	Social services	Local inhabitants with ≥65 years old, in percentage of the total resident population, 2001	INE, 2001: Recenseamento Geral da População e Habitação, 2001 (Resultados Definitivos)
Y_2	Basic education	School buildings per capita measured by the number of nursery and primary school buildings in percent of the total number of corresponding school-age inhabitants (Y_{21}), 2001 Gross primary enrolment ratio, the number of enrolled students in nursery and primary education in percent of the total number of corresponding school-age inhabitants (Y_{22}), 2001	Anuários Estatísticos Regionais (CD-ROM) 2001–2003. INE; INE, 2001: Recenseamento Geral da População e Habitação, 2001 (Resultados Definitivos)
Y_3	Cultural services	Number of library users in percentage of the total resident population, 2001	Anuários Estatísticos Regionais (CD-ROM) 2001–2003. INE; INE, 2001: Recenseamento Geral da População e Habitação, 2001 (Resultados Definitivos)
Y_4	Sanitation	Water supply, 1000 m^3 (Y_{41}) Solid waste collection, tons (Y_{42})	Anuários Estatísticos Regionais (CD-ROM) 2001–2003. INE
Y_5	Territory organisation	The number of licences for building construction, 2001	Anuários Estatísticos Regionais (CD-ROM) 2001–2003. INE
Y_6	Roads infrastructures	The length of roads maintained by the municipalities per number of the total resident population, 1998	National Association of Portuguese Municipalities (ANMP), URL: http://www.anmp.pt

Table D.2
Non-discretionary variables (*Z*) and respective sources

Variable	Description	Data source
Z_1	*Y*: Purchasing power	Portuguese National Institute of Statistics (2002)
Z_2	Esec: Population with secondary education	INE, 2001: Recenseamento Geral da População e Habitação, 2001 (Resultados Definitivos)
Z_3	Eter: Population with tertiary education	INE, 2001: Recenseamento Geral da População e Habitação, 2001 (Resultados Definitivos)
Z_4	*D*: Distance to capital of district, inverse	Portuguese Geographical Institute (2005)
Z_5	PopDens: Population density	INE, 2001: Recenseamento Geral da População e Habitação, 2001 (Resultados Definitivos)
Z_6	PopVar: Population variation	INE, 2001: Recenseamento Geral da População e Habitação, 2001 (Resultados Definitivos); INE, 1991: Recenseamento Geral da População e Habitação, 1991 (Resultados Definitivos).

Table D.3a
Correlation matrix of non-discretionary variables: Alentejo

	Y	Esec	Eter	*D*	PopDens	PopVar
Y	1.000	0.883	0.823	0.075	0.812	0.672
Esec	0.883	1.000	0.956	0.107	0.760	0.528
Eter	0.823	0.956	1.000	0.141	0.681	0.471
D	0.075	0.107	0.141	1.000	0.061	−0.127
PopDens	0.812	0.760	0.681	0.061	1.000	0.537
PopVar	0.672	0.528	0.471	−0.127	0.537	1.000

Table D.3b
Correlation matrix of non-discretionary variables: Algarve

	Y	Esec	Eter	*D*	PopDens	PopVar
Y	1.000	0.886	0.810	0.147	0.622	0.762
Esec	0.886	1.000	0.946	0.226	0.581	0.759
Eter	0.810	0.946	1.000	0.205	0.509	0.687
D	0.147	0.226	0.205	1.000	0.401	0.112
PopDens	0.622	0.581	0.509	0.401	1.000	0.578
PopVar	0.762	0.759	0.687	0.112	0.578	1.000

Table D.3c
Correlation matrix of non-discretionary variables: Centro

	Y	Esec	Eter	*D*	PopDens	PopVar
Y	1.000	0.927	0.885	0.114	0.776	0.646
Esec	0.927	1.000	0.977	0.025	0.730	0.638
Eter	0.885	0.977	1.000	−0.015	0.715	0.557
D	0.114	0.025	−0.015	1.000	0.362	0.262
PopDens	0.776	0.730	0.715	0.362	1.000	0.633
PopVar	0.646	0.638	0.557	0.262	0.633	1.000

Table D.3d
Correlation matrix of non-discretionary variables: LVT

	Y	Esec	Eter	*D*	PopDens	PopVar
Y	1.000	0.970	0.948	0.117	0.636	0.270
Esec	0.970	1.000	0.976	0.106	0.638	0.242
Eter	0.948	0.976	1.000	0.139	0.629	0.156
D	0.117	0.106	0.139	1.000	0.289	−0.170
PopDens	0.636	0.638	0.629	0.289	1.000	−0.061
PopVar	0.270	0.242	0.156	−0.170	−0.061	1.000

Table D.3e
Correlation matrix of non-discretionary variables: Norte

	Y	Esec	Eter	*D*	PopDens	PopVar
Y	1.000	0.955	0.921	0.096	0.887	0.451
Esec	0.955	1.000	0.978	0.105	0.819	0.380
Eter	0.921	0.978	1.000	0.083	0.824	0.271
D	0.096	0.105	0.083	1.000	0.078	0.119
PopDens	0.887	0.819	0.824	0.078	1.000	0.261
PopVar	0.451	0.380	0.271	0.119	0.261	1.000

Table D.3f
Correlation matrix of non-discretionary variables: Mainland

	Y	Esec	Eter	*D*	PopDens	PopVar
Y	1.000	0.944	0.885	0.119	0.635	0.558
Esec	0.944	1.000	0.958	0.111	0.613	0.502
Eter	0.885	0.958	1.000	0.124	0.653	0.393
D	0.119	0.111	0.124	1.000	0.139	0.094
PopDens	0.635	0.613	0.653	0.139	1.000	0.147
PopVar	0.558	0.502	0.393	0.094	0.147	1.000

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