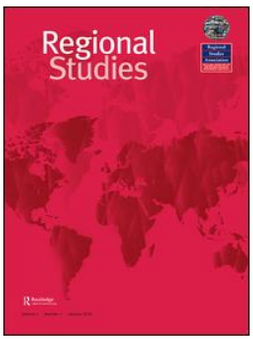

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# Measuring Local Government Spending Efficiency: Evidence for the Lisbon Region

ANTÓNIO AFONSO*† and SÓNIA FERNANDES‡§
*Department of Economics, ISEG/UTL – Technical University of Lisbon, CISEP – Research Centre on the Portuguese Economy, R. Miguel Lupi 20, P-1249-078 Lisbon, Portugal. Email: aafonso@iseg.utl.pt
†European Central Bank, Kaiserstraße 29, D-60311 Frankfurt am Main, Germany. Email: antonio.afonso@ecb.int
‡Court of Accounts, Av. República, 65, P-1069-045 Lisbon, Portugal. Email: sonia.fernandes@tcontas.pt
§ISCSP/UTL – Technical University of Lisbon, Pólo Universitário do Alto da Ajuda, Rua G, P-1345-055 Lisbon, Portugal. Email: sonfer1@sapo.pt

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AFONSO A. and FERNANDES S. (2006) Measuring local government spending efficiency: evidence for the Lisbon region, *Regional Studies* **40**, 39–53. The expenditure efficiency of Portuguese local governments in 2001 was assessed using Data Envelopment Analysis for production frontier estimation. A composite municipal output indicator was constructed and input and output efficiency scores were computed for 51 Portuguese municipalities in the region of Lisbon and Vale do Tejo. This allows a determination of the extent of municipal spending that seems to be 'wasted' relative to the theoretical 'best-practice' frontier. The results suggest that Vale do Tejo municipalities could achieve, on average, the same level of output allegedly using around one-third fewer resources, improving performance without necessarily increasing municipal spending.

Municipal expenditure Technical efficiency Data Envelopment Analysis (DEA) Lisbon

AFONSO A. et FERNANDES S. (2006) L'efficacité de la dépense de l'administration locale: des preuves DEA pour la région de Lisbonne, *Regional Studies* **40**, 39–53. A partir de la *Data Envelopment Analysis* quant à l'estimation de la frontière de la production, on évalue l'efficacité de l' administration locale au Portugal en 2001. On construit une indice composite des sorties de la municipalité et, par la suite, on calcule des scores de l'efficacité des entrées et des sorties pour 51 municipalités portugaises dans région de Lisbonne et de Vale do Tejo. Cela permet la détermination de l'importance de la dépense municipale qui semble être 'gaspillée' par rapport à la frontière de 'la meilleure pratique' théorique. Les résultats laissent supposer que les municipalités de Vale do Tejo pourraient atteindre, en moyenne, le même niveau de sorties en employant, prétendument, un tiers des ressources, ce qui permet une amélioration de la performance sans augmenter, nécessairement, la dépense municipale.

Dépenses municipales Efficacité technique *Data Envelopment Analysis (DEA)* Lisbonne

AFONSO A. und FERNANDES S. (2006) Ausgaben Efficienz von Ortsverwaltungen: DEA-Beweise für die Lissaboner Region, *Regional Studies* **40**, 39–53. Die Ausgabenefficienz von portugiesischen Ortsverwaltungen im Jahre 2001 wird mit Hilfe einer DEA-Analyse für Produktionsgrenzberechnungen beurteilt. Die Autoren konstruieren einen gegliedetenen Gemeindeaufwandsindikator, und berechnen Aufwands- und Ertragseffizienzspunkte für 51 portugiesische Gemeinden in den Regionen von Lissabon und Vale do Tejo. Dies gestattet die Bestimmung des Ausmaßes städtischer Ausgaben, die, gemessen an der theoretischen bestmöglichen Praxisgrenze, anscheinend verschwendet werden. Die Ergebnisse legen nahe, daß Vale do Tejo im Durchschnitt die bei angeblich etwa 1/3 geringeren Aufwand die gleiche Ertragshöhe erreichen und die Leistung also steigern könnten, ohne unbedingt die Gemeindeausgaben zu erhöhen.

Gemeindeausgaben technische Leistung *Data Envelopment Analysis (DEA)* Lissabon

AFONSO A. y FERNANDES S. (2006) Gestión eficaz del gasto público por parte de gobiernos locales: Pruebas de AED para la región de Lisboa, *Regional Studies* **40**, 39–53. En este ensayo analizamos en qué medida los gobiernos portugueses locales gestionaron eficazmente el gasto público en 2001. Para ello utilizamos el método de Análisis Envolvente de Datos (AED) con el objetivo de obtener una estimación de producción aplicable según un valor límite. Asimismo construimos un indicador de rendimiento municipal compuesto y calculamos la puntuación en función de la eficacia de entrada y de salida en 51 municipios portugueses de la región de Lisboa y Vale do Tejo. Esto nos permite determinar cuál es el gasto municipal 'desperdiciado' con relación al valor límite teórico de 'mejores métodos de trabajo'. Nuestros resultados indican que los municipios de Vale do Tejo supuestamente podrían obtener de promedio el mismo nivel de rendimiento utilizando un tercio menos de los recursos de modo que mejorasen el rendimiento sin tener que aumentar necesariamente el gasto municipal.

Gasto público municipal Eficacia técnica Análisis Envolvente de Datos (AED) Lisboa

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## INTRODUCTION

The debate over spending efficiency of local governments has been renewed with the implementation of decentralized policies designed to refocus public decision-making from central to municipal levels of government. The theoretical rationale behind this decentralization suggests that higher participation of local governments when choosing the use of public resources allows for a better match between public services provision and the needs and preferences of a heterogeneous citizenry.

The present paper evaluates and analyses the public expenditure efficiency of Portuguese municipal governments by interpreting public sector activities as production processes that transform inputs such as labour and capital into outputs/outcomes (BRADFORD *et al.*, 1969; FISHER, 1996). Data Envelopment Analysis (DEA) is used to compute input and output Farrell efficiency measures (efficiency scores) for 51 Portuguese municipalities located in the region of Lisbon and Vale do Tejo (RLVT) for 2001. This allows the estimation of the extent of municipal spending that is 'wasteful' relative to the 'best-practice' frontier.

The paper contributes to the literature by supplying new evidence concerning the efficiency analysis of local government.[1] Indeed, studies of local spending efficiency are still not abundant in the economic literature and, as far as the authors know, are not available for Portugal. Another contribution is the construction of a so-called total municipal output indicator (TMOI) that can in the future be extended to other samples of local governments. The DEA analysis is then performed both with the composite TMOI as the output measure and alternatively using the several sub-indicators directly as outputs.

Even if the paper focuses on a specific Portuguese set of local governments, its interest is not purely parochial. Indeed, local governments account, in different degrees, for a significant part of the general government across the European Union. On the other hand, increasing attention is being given to the quality and efficiency of public spending in European countries (e.g. EUROPEAN COMMISSION, 2004), and the issue should certainly also be addressed at the local government level. Such analysis might be relevant for several regions in the European Union that benefit from European funds, and where output quality of local public services could therefore be an additional assessment item.

The paper is organized as follows. The second section provides some stylized facts about the institutional structure of the Portuguese local government sector and it briefly mentions some theoretical aspects. The third section addresses the issue of modelling local government production and measuring spending efficiency and it also briefly describes the DEA analytical framework. The fourth section addresses data and measurement issues in order to construct the TMO index, and it presents and discusses the empirical results of the non-parametric efficiency analysis. The fifth section concludes the paper.

## SOME STYLIZED FACTS AND THEORETICAL ASPECTS

*Stylized facts for the Portuguese local government sector*

To put the empirical analysis in perspective, some stylized facts about the institutional structure, revenue and expenditure components of the Portuguese local sector for 2001 are presented. The actual institutional setting of the Portuguese local government sector was formally established in the 1976. Fig. 1 illustrates the organization of the Portuguese Public Sector.

According to the Portuguese Constitution, local governments are territorially based organizations with

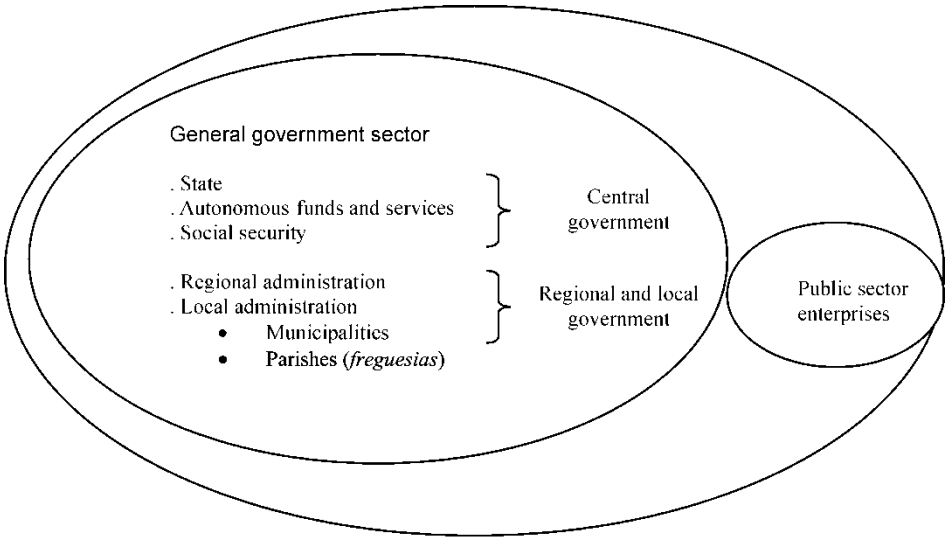


*Fig.* 1. *Organization of the Portuguese public sector*

administrative and fiscal autonomy. They have their own employees, patrimony and fiscal independence, whose activity 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. Municipalities should promote social and economic development, territorial organization, 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. It can nevertheless be argued that there is still scope for improvement in the Portuguese fiscal decentralization process. This is particularly true in order to 'establish an adequate relationship between the decisions to increase [local] expenditures and the responsibility for raising additional revenue (in particular through tax increases)' (BRONCHI, 2003, p. 20).

Under the current local finances legal framework, Portuguese municipalities have their own budgets, to which budgeting principles and rules apply, some of which are also common to those binding the central government budget. Municipal authorities are subject to several control mechanisms by central government agencies. These control mechanisms limit both their access to revenues and their expenditure choices. In what concerns the former, local government borrowing is also under control by central government, and this has intensified in recent years, mainly since 2002 for budget consolidation purposes, under the fiscal framework of the Stability and Growth Pact. As for the latter, for example, compensation of employees may not exceed 60% of their current expenditures.

The study will limit the observations to 51 Portuguese municipalities located in the continental region of Lisbon and RLVT. There are two reasons for this decision. First, those municipalities represented in 2001 about 37% of total expenditures and revenues of all municipalities located on the Portuguese mainland, and 34% of the Portuguese population in 2002, while being responsible for 44.5% of the total added value of the country in the same year (CCDRLVT, 2005). Second, a more comprehensive data set is available for these municipalities for fiscal year 2001.

### *Some theoretical underpinning*

Given the role assigned to local governments, there are several reasons for quantifying efficiency measures in order to assess the performance of local governments. First, they make possible comparison across similar units and allow relative efficiency to be evaluated (FARRELL, 1957). Second, if measurement reveals inefficiencies among the units under evaluation, further analysis can be undertaken to explain them (LOVELL, 1993, 2000; KALIRAJAN and SHAND, 1999). Third, the conclusions of such analysis may have practical policy implications for the improvement of efficiency and may assist the public decision-making process (LOVELL, 1993). Fourth, as citizens at large have the 'uneasy feeling that public resources are not always used in an efficient and effective way' (MOESEN, 1994, p. 263), it helps the application of general principles such as accountability.[2]

These principles bind public-sector institutions by providing local residents and citizens in general with the information they need effectively to monitor and control their political representatives. This ensures they perform efficiently and pursue the local interests and objectives motivating decentralization processes.

TIEBOUT (1956) initiated the theory of local finance by applying the idea of competitive markets to the local government sector. Tiebout argued that if there were increased competition among local jurisdictions, local services would tend toward more Pareto-efficient provision. Embedded in the Tiebout hypothesis is the implicit assumption that local governments employ local public resources in a cost-minimizing way for local public interests. However, SCHWAB and OATES (1988, 1991), DELLER (1992) and DAVIS and HAYES (1993), for example, argue that local service provision also depends on factors other than fiscal considerations such as the specific characteristics of local residents.

Additionally, CARD and KRUEGER's (1992) and KRUEGER's (1997) empirical research demonstrates, for example, that the levels of local provision of educational services strongly depend on factors such as the 'composition' of local communities. SCHWAB and OATES (1991) defined an analytical model where several aspects related to the composition of the local residents were explicitly controlled for, in order to identify the possible determinants of optimal distribution of individuals between jurisdictions. They concluded that the decentralization of public responsibilities does not necessarily lead to an efficient outcome.

## MODELLING GOVERNMENT PRODUCTION AND ANALYTICAL FRAMEWORK

This section first discusses how to model local government production and how to measure its efficiency. It then briefly presents the non-parametric analytical framework that is applied in this paper.

### *Local government production and efficiency*

The evaluation of local spending efficiency derives from the microeconomic theory of production, and it will be based on the interpretation of local sector activities as production processes, which transform inputs (such as labour, capital, etc.) into outputs/outcomes. Consequently, one must translate the way local governments transform inputs into outputs and select appropriate indicators.

In what concerns process indicators, and following BRADFORD *et al.* (1969) and LOVELL (2000), suppose that for a given set of $k = 1, \ldots, K$ municipalities ('producers'), each employs a vector of $N$ inputs/resources, $x = (x_1, \ldots, x_N)$, to provide a set of $D$ directly produced outputs, $y = (y_1, \ldots, y_D)$ through the development of activities with a variety of characteristics.[3] In this simple framework (Fig. 2), process indicators would measure the efficiency of municipal transformation process of primary inputs, such as labour and capital, into activities capturing 'operational performance' (DE BORGER and KERSTENS, 2000; AGRELL and WEST, 2001). Conversely, performance indicators measure how the activities of the municipalities are transformed into direct outputs or results for consumption.

If only input/output quantitative data are available, then a technical approach is feasible. Farrell's 'technical efficiency' is then defined as the ability of a unit to produce the maximum possible output from a given set of inputs, i.e. the ability to produce on its production possibility frontier, for a given production technology. If, in addition, resource prices are also available, an economic approach is also feasible.

The performance indicators defined above do not capture the effectiveness of municipal service provision. In fact, if one considers the conceptual distinction proposed by BRADFORD *et al.* (1969) between D-Output and C-Output, one may argue that citizens are more concerned about the outcomes/final results of the municipal activities than in the directly produced outputs. Therefore, outputs may not necessarily reflect the services desired by local residents. The ultimate outcome of these services is measured by effect indicators, which 'reflect the degree to which direct outputs of municipal activities translate into welfare improvements' (DE BORGER and KERSTENS, 2000, p. 306).

Therefore, and as shown above, in line with Farrell's definition of efficiency and recent literature, it is assumed that municipal output means the results of local public policies, and spending municipal efficiency as the outcome relative to the spending inputs (e.g. TANZI and SCHUKNECHT, 2000; CLEMENTS, 2002; AFONSO and ST AUBYN, 2005; AFONSO *et al.*, 2005). Accordingly, one possible method for assessing the efficiency of local public expenditures is to compare how well given spending is transformed into local services. For that purpose, municipal expenditure and performance data must be assembled as the basis for attempts to infer the efficiency with which these spending inputs are translated into local services.

*DEA framework*

DEA, originating from FARRELL's (1957) seminal work and popularized by CHARNES *et al.* (1978), assumes the existence of a convex production frontier, a hypothesis that is not required for instance in the Free Disposable Hull approach. 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.[4]

DEA allows the calculation of technical efficiency measures that can be either input or output oriented. The purpose of an input-oriented study is to evaluate by how much input quantity can be proportionally reduced without changing the output quantities. 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 returns to scale. Nevertheless, and since the computation uses linear programming, not subject to statistical problems such as simultaneous equation bias and specification errors, both output- and input-oriented models will identify the same set of efficient/inefficient producers or Decision-Making Units (DMUs).[5]

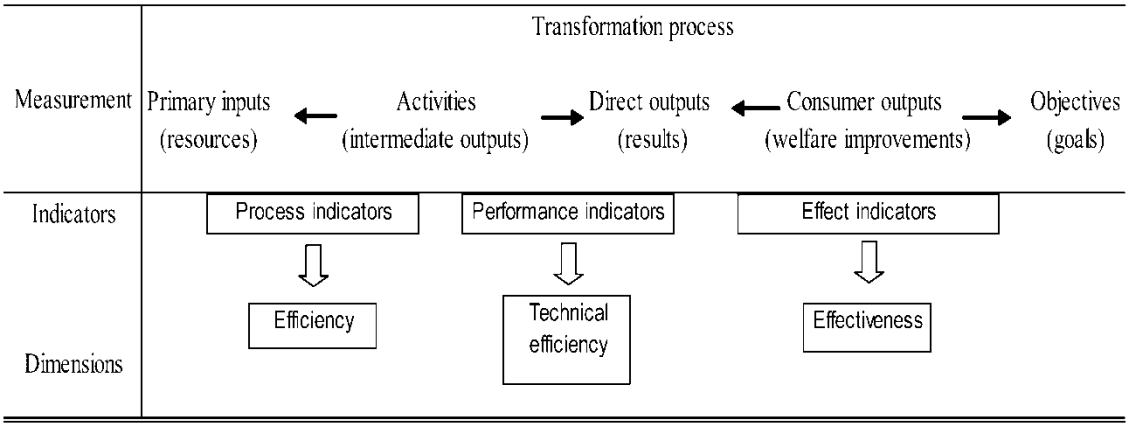


*Fig.* 2. *Modelling the local sector production process*

The analytical description of the linear programming problem to be solved, in the variable returns-to-scale hypothesis, is sketched out below. Suppose there are $k$ inputs and $m$ outputs for $n$ DMUs. For the $i$th DMU, $y_i$ is the column vector of the outputs and $x_i$ is the column vector of the inputs. One can also 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:[6]

$$\begin{aligned} &\text{Min}_{\theta,\lambda}\,\theta \\ &\text{subject to} \quad -y_i + Y\lambda \geq 0 \\ &\qquad\qquad \theta x_i - X\lambda \geq 0 \qquad (1) \\ &\qquad\qquad n1'\lambda = 1 \\ &\qquad\qquad \lambda \geq 0 \end{aligned}$$

where $\theta$ is a scalar (that satisfies $\theta \leq 1$). More specifically, it is the efficiency score that measures technical efficiency of unit $(x_i, y_i)$. It measures the distance between a decision unit and the efficiency frontier, defined as a linear combination of best practice observations. With $\theta < 1$, the decision unit is inside the frontier (i.e. it is inefficient), while $\theta = 1$ implies that the decision unit is on the frontier (i.e. it is efficient).

The vector $\lambda$ is a $(n \times 1)$ vector of constants, which measures the weights used to compute the location of an inefficient DMU if it were to become efficient. The inefficient DMU would be projected on the production frontier as a linear combination, using those weights, of the peers of the inefficient DMU. The peers are other DMUs that are more efficient and therefore are used as references for the inefficient DMU.

$n1$ is an $n$-dimensional vector of ones. The restriction $n1'\lambda=1$ imposes convexity of the frontier, accounting for variable returns to scale. Dropping this restriction would be tantamount to admitting that returns to scale were constant. Additionally, notice that problem (1) has to be solved for each of the $n$ DMUs, local governments in our case, in order to obtain the $n$ efficiency scores.

In a simple example, three different hypothetical municipalities display the following values for the output indicator $y$ and expense level $x$, as reported in Fig. 3, which illustrates DEA frontiers. The variable returns to scale frontier unites the origin (not depicted) to municipality A, and then municipality A to municipality C.

Expenditure is lower in municipality A, and the output level is also the lowest. Municipality C does not exhibit the highest expenditure, and attains the best level of output. Municipality B may be considered inefficient, in the sense that it performs worse than municipality C, because there is: $Y(B) < Y(C)$ and $X(B) > X(C)$. The latter achieves a better status with less expenditure.

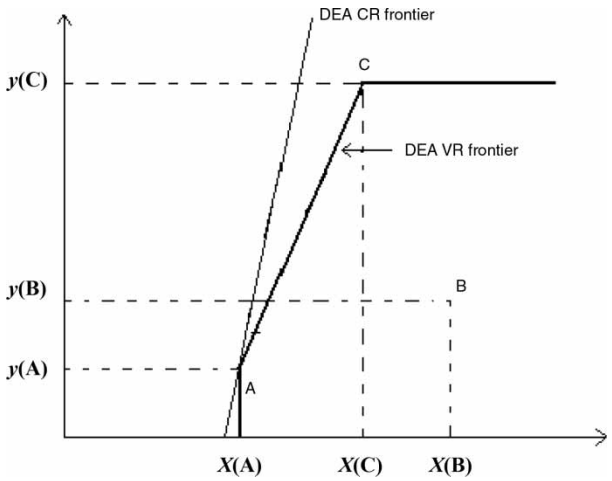


*Fig. 3. Data Envelopment Analysis (DEA) frontiers*

## NON-PARAMETRIC EFFICIENCY ANALYSIS OF SPENDING IN RLVT

This section now explains the construction of the output measure, basically a composite indicator of municipal performance. It then uses this output indicator to perform the non-parametric analysis using the DEA framework.

### *Total municipal output indicator (TMOI)*

A 'one input/one output' approach is used to measure municipal spending efficiency. Accordingly, to proxy for the municipal resources consumption (input) induced by the provision of municipal services, take for each municipality its total per-capita expenditures registered on municipal accounts for 2001.[7]

As a result, the spending efficiency analysis does not distinguish technical from allocative efficiency. However, as the measurement of the latter requires price information, while the former only requires quantity data, selecting per-capita municipal spending gives at least the guarantee that all inputs will be considered in the analysis. Additionally, this variable is a more realistic municipal input measure (FISHER, 1996; HAYES, 1998; DE BORGER and KERSTENS, 2000) if one acknowledges the reduced margin of manoeuvre of Portuguese municipal authorities to influence current expenditure choices, mainly those concerning municipal compensation of employees.

Concerning municipal outputs, focus is on global municipal performance stemming from the municipal provision of specific services (e.g. waste collection, water supply). However, as the present authors were confronted with the difficulty of directly measuring some of the municipal production results, some performance indicators are surrogate measures of municipal demand. For instance, the selected 'Total resident population' and 'Centrality index' indicators are used to capture the needs of local authorities to provide

common basic administrative services. These factors are mostly beyond the control of individual municipal authorities (ATHANASSOPOULOS, 1995). Table 1 describes the selected performance indicators used to proxy the results of individual municipal services provision.

As suggested by several authors (e.g. DE BORGER and KERSTENS, 1996b; AFONSO *et al.*, 2005), to quantify a single municipal performance indicator, all values of each sub-indicator mentioned in Table 1 were normalized by setting the average equal to one. Then, each sub-indicator is recalculated relative to the overall average, giving them an equal weight.[8] Finally, these sub-indicators were grouped under five broader categories, giving each sub-indicator an equal weight in order to compute a single municipal performance indicator. The municipal output indexes and the TMOI for 2001 are reported in Table 2 (data sources are reported in the Appendix).

The municipal performance sub-indicators reported in Table 2 suggest the existence of large differences in performance across municipalities belonging to the sample, mainly for general administrative services provided to local residents proxied by the 'Total population' sub-indicator and for social services proxied by 'Population with $\geq$65 years old' sub-indicator. Note that Lisbon is 'best' in these two services and that Sintra is also in both cases the 'second-best' municipality.

As expected, the highest values for the 'Centrality index' sub-indicator[9] are recorded in those municipalities that belong to the Lisbon Metropolitan Area. On one hand, the sub-indicator 'Present population divided by the total resident population' mainly favoured the performance of non-metropolitan municipalities such as Constância and Ferreira do Zêzere. On the other hand, the other sub-indicator ('Resident population that came from other municipalities divided by the total resident population') was the key determinant in identifying the 'best' performers for the 'Centrality index', such as the metropolitan municipalities of Sesimbra, Sintra, Seixal and Oeiras.

One can interpret these findings as follows. First, if those municipalities that strongly suffer from seasonal population movements for location-specific reasons as is the case of Constância and Ferreira do Zêzere, Rio Maior and Lisbon finance their services mainly through taxation, local residents could subsidise the consumption of local services by non-residents. If, instead of taxation, local services were mainly financed through user charges, the 'spill over effect' or the indirect subsidization element would be reduced (DE BORGER *et al.*, 1994; CULLIS and JONES, 1998). Second, one may hypothesize that mobile citizens/consumers tend to move into those communities that have a bundle of services that best match their own preferences (TIEBOUT, 1956).

Moreover, one may also argue the metropolitan municipalities of Sesimbra, Sintra, Seixal and Oeiras were successful in terms of being perceived by mobile consumers as 'effective substitutes' for other communities, including the capital (GROSSMAN *et al.*, 1999). Additionally, although metropolitan areas face more costly demands from both residents and non-residents, they benefit form such factors as greater economies of scale deriving from an enlarged population served by – and thus able to contribute to – for such investments, unlike non-metropolitan municipalities.

Education performance is best in Sardoal, followed by Ferreira do Zêzere and Constância. Within the ten 'best' municipalities for education performance, none belongs to the Lisbon Metropolitan Area. Although registering the highest values in the 'School buildings per pupil' sub-indicator for education services, the municipalities of Ferreira do Zêzere, Constância and Sardoal also have the lowest number for the 'Residents $\leq$ 9 years old' sub-indicator for the same services. In fact, the ten youngest municipalities within RLVT belong to the Lisbon Metropolitan Area. With the exception of Lisbon, it is also in the Lisbon Metropolitan Area municipalities where the tenth lowest values were observed for both 'School enrolment' and 'School buildings per capita' sub-indicators for educational services. These findings suggest further investigation needs to be undertaken to answer the following question. Does the low performance in 'Education' observed in these municipalities derive from underprovision relative to the respective demand or from a decreasing demand for education services?

'Sanitation and environment' performs best in Lisbon, followed by Cascais and Oeiras. Again, note that the ten 'best' municipalities in the provision of these services all belong to Lisbon Metropolitan Area.

Finally, regarding the TMOI, Lisbon Metropolitan Area's municipalities lead with the ten highest values, with Lisbon scoring with the highest of all (5.146), followed by Sintra (2.363), while Alpiarça has the smallest one (0.570).

### *Results of DEA analysis*

This section computes the efficiency scores for the 51 Portuguese municipalities located in RLVT. This allows one to estimate the extent of municipal spending that is 'wasteful' relative to the theoretical 'best practice' frontier, measured as the distance of individual observations relative to that frontier.

One input measured by total per-capita municipal expenditures (see the Appendix), is used and this section starts by using one output given by the previously computed TMOI (Table 2). The results for the input and output efficiency scores, along with each municipality's ranking, are shown in Table 3. Input efficiency scores start at 0.166 for Constância; output efficiency scores start at 0.141 for Golegã. The average input efficiency score is 0.588, suggesting the municipalities could achieve on average roughly

*Table* 1. *Sample output/outcome measures for selected municipal services*

| | | D-output | | C-output | |
|---|---|---|---|---|---|
| Functions | Local services | Indicators | Observations | Indicators | Observations |
| General administration | General administrative services provided to local residents | Total resident population | Total municipal resident population is used to capture the needs of municipal authorities to provide common administrative services (WALLIS and OATES, 1988; EECKAUT *et al.*, 1993) | | |
| | General administrative services provided to non-residents | Present population divided by the total resident population*<br>Resident population that came from other municipalities divided by the total resident population* | Following DE BORGER *et al.* (1994), this proxy of municipal services delivered to non-residents was included<br>*Natural logarithm | | |
| Education | Basic education | School buildings per capita | Calculated as the number of nursery and primary school buildings as a percentage of the respective total number of school-age persons | Education attainment | Proxied by the gross enrolment ratio in nursery and primary education as the number of enrolled students as a percentage of the total number of corresponding school-age persons |
| Social activity | Social services for the elderly | | | Local residents $\geq$65 years old | Gives the number of senior citizens, reflecting the supply of municipal social services to the elderly such as home-based general assistance, retirement houses, etc. (WALLIS and OATES, 1988; EECKAUT *et al.*, 1993) |
| Basic sanitation and environment protection | Water supply | | | Percentage of the population with clean water<br>Percentage of the population with draining water systems<br>Percentage of the population with water treatment stations | Water pumping, distribution and treatment are mainly municipal responsibilities |
| | Solid waste collection | Percentage of the population served with solid waste collection<br>Percentage of the buildings with solid waste collection | Solid waste collection is mainly a municipal responsibility | | |
| | Recycling activities | | | Recycled materials given or sold | As a damaging environment translates into negative externalities, the intention is to assess environment protection municipal initiatives through this indicator |

*Source:* Adapted from FISHER (1996).

*Table 2. Total municipal output indicator (TMOI), 2001*

| Municipalities[a] | General administration | | Education | Social services | Sanitation and environment | Total municipal output[b] |
|---|---|---|---|---|---|---|
| | Resident population | Centrality index | | | | |
| Abrantes | 0.622 | 0.968 | 1.203 | 0.903 | 0.863 | 0.912 |
| Alcanena | 0.215 | 0.943 | 1.403 | 0.267 | 0.877 | 0.741 |
| Alcobaça | 0.816 | 0.976 | 1.072 | 0.853 | 0.844 | 0.912 |
| Alcochete | 0.192 | 1.042 | 0.667 | 0.180 | 0.842 | 0.584 |
| Alenquer | 0.577 | 1.030 | 0.971 | 0.610 | 0.894 | 0.816 |
| Almada | 2.370 | 1.036 | 0.666 | 2.430 | 1.234 | 1.547 |
| Almeirim | 0.324 | 0.965 | 0.833 | 0.384 | 0.879 | 0.677 |
| Alpiarça | 0.118 | 0.968 | 0.846 | 0.167 | 0.751 | 0.570 |
| Amadora | 2.591 | 1.034 | 0.555 | 2.220 | 1.168 | 1.514 |
| Arruda dos Vinhos | 0.152 | 1.016 | 1.025 | 0.165 | 0.739 | 0.619 |
| Azambuja | 0.307 | 0.996 | 0.802 | 0.348 | 0.693 | 0.629 |
| Barreiro | 1.164 | 1.007 | 0.678 | 1.126 | 0.865 | 0.968 |
| Benavente | 0.343 | 1.025 | 0.704 | 0.309 | 0.891 | 0.654 |
| Bombarral | 0.196 | 0.971 | 1.466 | 0.259 | 0.777 | 0.734 |
| Cadaval | 0.205 | 0.980 | 1.421 | 0.295 | 0.695 | 0.719 |
| Caldas da Rainha | 0.720 | 1.010 | 1.057 | 0.794 | 0.857 | 0.888 |
| Cartaxo | 0.345 | 0.994 | 0.786 | 0.385 | 0.735 | 0.649 |
| Cascais | 2.515 | 1.036 | 0.696 | 2.323 | 1.955 | 1.705 |
| Chamusca | 0.169 | 0.946 | 1.410 | 0.238 | 0.781 | 0.709 |
| Constância | 0.056 | 0.991 | 2.042 | 0.067 | 0.935 | 0.818 |
| Coruche | 0.314 | 0.935 | 1.416 | 0.480 | 0.665 | 0.762 |
| Entroncamento | 0.268 | 1.033 | 0.653 | 0.236 | 0.914 | 0.621 |
| Ferreira do Zêzere | 0.139 | 0.954 | 2.141 | 0.234 | 0.720 | 0.838 |
| Golegã | 0.084 | 0.955 | 0.803 | 0.115 | 0.943 | 0.580 |
| Lisboa | 8.320 | 1.034 | 0.936 | 12.024 | 3.418 | 5.146 |
| Loures | 2.933 | 1.031 | 0.589 | 2.200 | 1.657 | 1.682 |
| Lourinhã | 0.343 | 0.992 | 1.198 | 0.369 | 0.890 | 0.758 |
| Mafra | 0.801 | 1.042 | 0.922 | 0.764 | 0.798 | 0.865 |
| Moita | 0.994 | 1.016 | 0.603 | 0.784 | 0.853 | 0.850 |
| Montijo | 0.577 | 1.005 | 0.762 | 0.613 | 0.749 | 0.741 |
| Nazaré | 0.222 | 0.938 | 0.877 | 0.227 | 0.917 | 0.636 |
| Óbidos | 0.160 | 0.991 | 1.508 | 0.199 | 0.905 | 0.753 |
| Odivelas | 1.972 | 1.031 | 0.595 | 1.446 | 1.661 | 1.341 |
| Oeiras | 2.389 | 1.047 | 0.501 | 2.179 | 1.629 | 1.549 |
| Ourém | 0.681 | 0.976 | 1.359 | 0.776 | 0.699 | 0.898 |
| Palmela | 0.786 | 1.043 | 0.643 | 0.726 | 0.940 | 0.828 |
| Peniche | 0.402 | 0.958 | 0.927 | 0.411 | 0.809 | 0.701 |
| Rio Maior | 0.311 | 0.972 | 1.453 | 0.349 | 0.753 | 0.768 |
| Salvaterra de Magos | 0.297 | 0.982 | 0.756 | 0.343 | 0.676 | 0.611 |
| Santarém | 0.937 | 0.991 | 1.106 | 1.177 | 0.964 | 1.035 |
| Sardoal | 0.060 | 0.933 | 2.166 | 0.102 | 0.815 | 0.815 |
| Seixal | 2.214 | 1.050 | 0.483 | 1.364 | 1.283 | 1.279 |
| Sesimbra | 0.554 | 1.068 | 0.606 | 0.497 | 0.848 | 0.715 |
| Setúbal | 1.679 | 1.016 | 0.575 | 1.518 | 1.703 | 1.298 |
| Sintra | 5.359 | 1.067 | 0.501 | 3.365 | 1.524 | 2.363 |
| Sobral de Monte Agraço | 0.132 | 1.020 | 1.082 | 0.145 | 0.803 | 0.636 |
| Tomar | 0.544 | 0.970 | 1.324 | 0.839 | 0.740 | 0.883 |
| Torres Novas | 0.544 | 0.975 | 1.368 | 0.695 | 0.771 | 0.870 |
| Torres Vedras | 1.065 | 1.000 | 1.064 | 1.133 | 0.822 | 1.017 |
| Vila Franca de Xira | 1.811 | 1.043 | 0.527 | 1.225 | 0.961 | 1.114 |
| Vila Nova da Barquinha | 0.112 | 1.004 | 1.251 | 0.140 | 0.894 | 0.680 |
| Mean | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| Standard deviation | 1.452 | 0.036 | 0.418 | 1.738 | 0.459 | 0.693 |
| Minimum | 0.056 | 0.933 | 0.483 | 0.067 | 0.665 | 0.570 |
| Maximum | 8.320 | 1.068 | 2.166 | 12.024 | 3.418 | 5.146 |

*Notes:* [a]The underlined municipalities ($n = 19$) belong to the Lisbon Metropolitan Area, which was formally created in 1991.
[b]Each sub-indicator contributes with an equal weight (one-fifth) for the total municipal output indicator.

*Table 3. DEA efficiency scores for the Lisbon region, 2001, 1 input (expenditure) and 1 output (TMOI)*

| | Input-oriented | | Output-oriented | |
|---|---|---|---|---|
| Municipalities | VRS TE | Rank | VRS TE | Rank |
| Abrantes | 0.473 | 37 | 0.259 | 24 |
| Alcanena | 0.361 | 46 | 0.173 | 44 |
| Alcobaça | 0.839 | 5 | 0.376 | 13 |
| Alcochete | 0.495 | 35 | 0.171 | 45 |
| Alenquer | 0.578 | 24 | 0.266 | 23 |
| Almada | 0.713 | 13 | 0.557 | 6 |
| Almeirim | 0.447 | 40 | 0.185 | 40 |
| Alpiarça | 0.324 | 48 | 0.122 | 51 |
| Amadora | 0.707 | 15 | 0.543 | 7 |
| Arruda dos Vinhos | 0.475 | 36 | 0.177 | 42 |
| Azambuja | 0.425 | 43 | 0.166 | 46 |
| Barreiro | 0.744 | 10 | 0.370 | 14 |
| Benavente | 0.540 | 29 | 0.204 | 37 |
| Bombarral | 0.713 | 14 | 0.274 | 21 |
| Cadaval | 0.669 | 18 | 0.258 | 25 |
| Caldas da Rainha | 1.000 | 1 | 1.000 | 1 |
| Cartaxo | 0.628 | 22 | 0.224 | 33 |
| Cascais | 0.549 | 28 | 0.511 | 8 |
| Chamusca | 0.298 | 49 | 0.142 | 49 |
| Constância | 0.166 | 51 | 0.159 | 47 |
| Coruche | 0.505 | 33 | 0.227 | 31 |
| Entroncamento | 0.722 | 12 | 0.234 | 29 |
| Ferreira do Zêzere | 0.559 | 27 | 0.268 | 22 |
| Golegã | 0.381 | 45 | 0.141 | 50 |
| Lisboa | 1.000 | 1 | 1.000 | 1 |
| Loures | 0.750 | 9 | 0.621 | 4 |
| Lourinhã | 0.515 | 32 | 0.229 | 30 |
| Mafra | 0.469 | 39 | 0.245 | 27 |
| Moita | 0.837 | 6 | 0.350 | 16 |
| Montijo | 0.472 | 38 | 0.211 | 36 |
| Nazaré | 0.662 | 19 | 0.227 | 32 |
| Óbidos | 0.384 | 44 | 0.184 | 41 |
| Odivelas | 0.725 | 11 | 0.494 | 9 |
| Oeiras | 0.537 | 30 | 0.462 | 10 |
| Ourém | 0.684 | 16 | 0.327 | 18 |
| Palmela | 0.497 | 34 | 0.244 | 28 |
| Peniche | 0.660 | 20 | 0.250 | 26 |
| Rio Maior | 0.353 | 47 | 0.176 | 43 |
| Salvaterra de Magos | 0.674 | 17 | 0.221 | 34 |
| Santarém | 0.634 | 21 | 0.356 | 15 |
| Sardoal | 0.215 | 50 | 0.158 | 48 |
| Seixal | 0.927 | 4 | 0.596 | 5 |
| Sesimbra | 0.431 | 41 | 0.190 | 39 |
| Setúbal | 0.427 | 42 | 0.334 | 17 |
| Sintra | 1.000 | 1 | 1.000 | 1 |
| Sobral de Monte Agraço | 0.537 | 31 | 0.198 | 38 |
| Tomar | 0.587 | 23 | 0.292 | 19 |
| Torres Novas | 0.569 | 25 | 0.281 | 20 |
| Torres Vedras | 0.836 | 7 | 0.416 | 12 |
| Vila Franca de Xira | 0.752 | 8 | 0.425 | 11 |
| Vila Nova da Barquinha | 0.562 | 26 | 0.218 | 35 |
| Mean | 0.588 | | 0.328 | |
| Metropolitan municipalities* | 0.656 | | 0.447 | |
| Non-metropolitan municipalities | 0.548 | | 0.257 | |
| Per-capita spending intervals**: | | | | |
| <€532.45 | 0.769 | | 0.449 | |
| [€532.45 €837.58] | 0.518 | | 0.257 | |
| >€837.58 | 0.387 | | 0.251 | |

*Notes:* *Underlined municipalities.
**Limits are as follows: $]0; \mu - \sigma/2[$, $[\mu - \sigma/2; \mu + \sigma/2]$ and $]\mu + \sigma/2; \infty[$, where $\mu = €685.01$ and $\sigma = €305.13$.
VRS, TE, variable returns to scale technical efficiency.

*Table* 4. *DEA efficiency scores for the Lisbon region, 2001, 1 input (expenditure) and 4 outputs (sub-indicators included in the TMOI)*

| | Input-oriented | | Output-oriented | |
|---|---|---|---|---|
| Municipalities | VRS TE | Rank | VRS TE | Rank |
| Abrantes | 0.542 | 37 | 0.658 | 36 |
| Alcanena | 0.472 | 41 | 0.724 | 24 |
| Alcobaça | 0.859 | 12 | 0.896 | 13 |
| Alcochete | 0.495 | 39 | 0.506 | 46 |
| Alenquer | 0.582 | 32 | 0.687 | 32 |
| Almada | 0.730 | 19 | 0.789 | 17 |
| Almeirim | 0.449 | 45 | 0.531 | 45 |
| Alpiarça | 0.324 | 50 | 0.476 | 49 |
| Amadora | 0.719 | 21 | 0.716 | 26 |
| Arruda dos Vinhos | 0.475 | 40 | 0.565 | 42 |
| Azambuja | 0.425 | 47 | 0.451 | 50 |
| Barreiro | 0.752 | 17 | 0.672 | 35 |
| Benavente | 0.544 | 36 | 0.568 | 41 |
| Bombarral | 0.925 | 9 | 0.937 | 9 |
| Cadaval | 0.846 | 14 | 0.845 | 15 |
| Caldas da Rainha | 1.000 | 1 | 1.000 | 1 |
| Cartaxo | 0.628 | 30 | 0.592 | 39 |
| Cascais | 0.898 | 10 | 0.930 | 10 |
| Chamusca | 0.374 | 49 | 0.705 | 28 |
| Constância | 0.320 | 51 | 0.974 | 6 |
| Coruche | 0.637 | 29 | 0.695 | 30 |
| Entroncamento | 0.731 | 18 | 0.675 | 34 |
| Ferreira do Zêzere | 1.000 | 1 | 1.000 | 1 |
| Golegã | 0.388 | 48 | 0.497 | 47 |
| Lisboa | 1.000 | 1 | 1.000 | 1 |
| Loures | 0.947 | 8 | 0.967 | 8 |
| Lourinhã | 0.592 | 31 | 0.708 | 27 |
| Mafra | 0.471 | 43 | 0.549 | 43 |
| Moita | 0.844 | 15 | 0.689 | 31 |
| Montijo | 0.472 | 42 | 0.487 | 48 |
| Nazaré | 0.670 | 26 | 0.725 | 23 |
| Óbidos | 0.547 | 34 | 0.773 | 18 |
| Odivelas | 0.950 | 7 | 0.969 | 7 |
| Oeiras | 0.642 | 28 | 0.745 | 22 |
| Ourém | 0.856 | 13 | 0.864 | 14 |
| Palmela | 0.505 | 38 | 0.535 | 44 |
| Peniche | 0.660 | 27 | 0.696 | 29 |
| Rio Maior | 0.455 | 44 | 0.721 | 25 |
| Salvaterra de Magos | 0.674 | 24 | 0.582 | 40 |
| Santarém | 0.712 | 22 | 0.802 | 16 |
| Sardoal | 1.000 | 1 | 1.000 | 1 |
| Seixal | 0.973 | 6 | 0.900 | 12 |
| Sesimbra | 0.431 | 46 | 0.444 | 51 |
| Setúbal | 0.572 | 33 | 0.687 | 33 |
| Sintra | 1.000 | 1 | 1.000 | 1 |
| Sobral de Monte Agraço | 0.547 | 35 | 0.657 | 37 |
| Tomar | 0.726 | 20 | 0.756 | 21 |
| Torres Novas | 0.705 | 23 | 0.768 | 20 |
| Torres Vedras | 0.896 | 11 | 0.903 | 11 |
| Vila Franca de Xira | 0.761 | 16 | 0.654 | 38 |
| Vila Nova da Barquinha | 0.672 | 25 | 0.769 | 19 |
| Mean | 0.674 | | 0.734 | |
| Metropolitan municipalities* | 0.715 | | 0.721 | |
| Non-metropolitan municipalities | 0.650 | | 0.742 | |
| Per-capita spending intervals**: | | | | |
| <€532.45 | 0.831 | | 0.815 | |
| [€532.45 €837.58] | 0.597 | | 0.656 | |
| >€837.58 | 0.542 | | 0.763 | |

*Notes:* *Underlined municipalities.

**Limits are as follows: $]0; \mu - \sigma/2[$, $[\mu - \sigma/2; \mu + \sigma/2]$ and $]\mu + \sigma/2; \infty[$, where $\mu = €685.01$ and $\sigma = €305.13$.

VRS, TE, variable returns to scale technical efficiency.

the same level of local output with about 41.2% fewer resources, i.e. that local performance could be improved without necessarily increasing municipal spending. Three municipalities are placed on the theoretical production frontier: Caldas da Rainha, Lisboa and Sintra.

Two interesting patterns are indicated in Table 3. First, municipalities with higher per-capita expenditures levels, above the $\mu + \sigma/2$ limit, tend to have lower efficiency scores than municipalities with lower per-capita expenditures levels, below the $\mu + \sigma/2$ threshold, where $\mu$ and $\sigma$ are, respectively, the average and the standard deviation of per-capita spending in the sample. Second, metropolitan municipalities enjoy greater efficiency in the use of municipal resources than their non-metropolitan counterparts.

Moreover, Table 3 shows some interesting variations in individual ranking positions when first considering input and then output efficiency results. For instance, there is a decrease of the relative ranking positions of non-metropolitan municipalities such as Entroncamento, Salvaterra de Magos, Nazaré and Cartaxo, of more than ten places, when measuring output efficiency compared with input efficiency results. On the other hand, municipalities such as Setúbal, Cascais, Oeiras, Abrantes and Mafra improve their relative ranking, by more than ten places, when one considers output efficiency rather than input efficiency.

One distinguishing feature between the two above-mentioned groups of municipalities can be pointed out. Municipalities that perform better in terms of input efficiency, despite registering on average levels of per-capita expenditures 16.4% below the overall average sample (685.01), report on average a total performance indicator equivalent to 0.757, which is below the average sample (1.0). Municipalities that perform better in terms of output efficiency, despite having on average levels of per-capita expenditure 12.6% above the overall sample average, report a total output indicator equal to 1.023, which is higher than the former subset and also superior to the overall average sample (1.0).

An alternative result in the efficiency analysis is that if instead of municipal per-capita expenditures total municipal expenditures had been used as the input measure, the average output efficiency score would have raised. Furthermore, a higher number of municipalities would be labelled efficient, and the number of those declared efficient by default would also be higher. This somehow implies that this per-capita 'size dimension' implicit in our selected input measure captures better the uncontrollable demand-based dynamics of local services provision.

A model with four outputs and the same input variable, per-capita expenditure, was also used. Concerning the selection of outputs and inputs, as a general rule of thumb there should be at least three DMUs for each input and output variable used in the model. This allows one to have sufficient degrees of freedom when implementing the DEA methodology.[10]

The disaggregated output measures are the four following sub-indicators: general administration, education, social services, and sanitation and environment (Table 2). Additionally, the output sub-indicator general administration is computed as the simple average of the indicators resident population and centrality index. The DEA input and output oriented results are reported in Table 4.

From this new set of results, one can see that now five DMUs turn out to be located on the theoretical production possibility frontier: the previous three municipalities, Caldas da Rainha, Lisboa and Sintra, plus Ferreira do Zêzere and Sardoal. Moreover, note that using the disaggregated output indicators directly in the DEA analysis, the overall input and output efficiency scores increase as well. Nevertheless, note that by increasing the number of inputs and outputs, there is automatically, by construction, an increase of the so-called efficient DMUs. However, this is a trade-off one has to incur in order not to throw away a lot of relevant information, and this does not seem too critical in our case.

Some policy relevance can be ascribed to this type of results. Indeed, if consumers were fully mobile in the Lisbon area, which has a dimension of around 11 656 $km^2$, they would tend to move to the municipalities that are perceived as supplying the best public goods at the lowest cost. However, two things caution against such judgement. First, significant revenues are transferred from the central government to the local authorities, blurring the link between locally provided public goods and local taxes imposed on the consumers. Second, it is not clear that consumers can actually assess fully the differences in the quality of locally supplied public goods across municipalities.

## CONCLUSION

This paper has assessed the spending efficiency of the 51 municipalities in the Lisbon area (RLVT). It first constructed a composite indicator of municipal performance, the total municipal output indicator. Using that indicator as an output measure and municipal per-capita expenditure as the input measure, the DEA methodology was then applied to the data set.

The efficiency results measured in terms of input and output efficiency scores suggest that, on average, RLVT municipalities are relatively inefficient. Using the composite output measure, among the 51 municipalities assessed, it was found that they could have achieved, on average, roughly the same level of local output with about 41% fewer resources, i.e. that local performance could be improved without necessarily increasing municipal spending. On the other hand, using an alternative model with four output sub-indicators, this measure of 'wasted' resources is still high, even if it then decreases to 33%.

Considering both individual efficiency scores and ranking positions of RLVT municipalities, it is concluded that the results reveal a wide dispersion in performance. Three RLVT municipalities are considered to be efficient, of which one (Lisbon) is declared 'efficient by default' under the DEA methodology. With more outputs in the analysis, five DMUs are found placed on the theoretical production possibility frontier.

Furthermore, it was also found that 'wasted' municipal spending in RLVT is, on average, higher within municipalities that show above-average per-capita spending. These results seem to support the general argument that more spending does not necessarily translate into better local living standards. Additionally, a higher degree of inefficiency seems to exist in the subset of the 19 'non-metropolitan' municipalities belonging to the sample.

Concerning future work avenues, further analysis could be done using different several inputs and outputs in order to check further for the robustness of the results, even if then available homogeneous data are at the moment a limitation. Finally, the current work could eventually be extended to the entire universe of the Portuguese municipalities or to other relevant sub-samples of that universe.

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## APPENDIX: DATA AND SOURCES[11]

- Total resident population (2001)[a]
- Population ≤9 years old (2001)[a]
- population ≥65 years old (2001)[a]
- Present population (2001)[a]
- Enrolled students in primary school (2000/01)[b]
- Enrolled students in nursery school (2000/01)[b]
- Nursery and primary school buildings (2000/01)[b]

- Percentage of buildings with solid waste collection (2001)[a]
- Population that came from other municipalities (relative to 31 December 1995)[a]
- Percentage of the population with clean water (2000)[c]
- Percentage of the population with water treatment stations (2000)[c]
- Percentage of the population with draining water systems (2000)[c]
- Percentage of the population served with solid waste collection (2000)[c]
- Recycled materials given or sold (tons) (2000)[c]
- Municipal expenditures (2001)[d]

*Table* A1. *Municipal expenditures, 2001*

| Municipalities | Expenditure (€)[a] | Total resident population[b] | Expenditure per capita (€) |
|---|---|---|---|
| Abrantes | 30 498 948 | 42 235 | 722.12 |
| Alcanena | 13 799 369 | 14 600 | 945.16 |
| Alcobaça | 22 545 705 | 55 376 | 407.14 |
| Alcochete | 8 963 313 | 13 010 | 688.96 |
| Alenquer | 23 125 323 | 39 180 | 590.23 |
| Almada | 81 680 924 | 160 825 | 507.89 |
| Almeirim | 16 755 310 | 21 957 | 763.10 |
| Alpiarça | 8 448 599 | 8 024 | 1052.92 |
| Amadora | 89 821 655 | 175 872 | 510.72 |
| Arruda dos Vinhos | 7 424 497 | 10 350 | 717.34 |
| Azambuja | 16 697 524 | 20 837 | 801.34 |
| Barreiro | 36 456 505 | 79 012 | 461.40 |
| Benavente | 14 683 318 | 23 257 | 631.35 |
| Bombarral | 6 368 806 | 13 324 | 478.00 |
| Cadaval | 7 108 913 | 13 943 | 509.86 |
| Caldas da Rainha | 16 649 809 | 48 846 | 340.86 |
| Cartaxo | 12 688 680 | 23 389 | 542.51 |
| Cascais | 114 086 322 | 170 683 | 668.41 |
| Chamusca | 13 166 439 | 11 492 | 1145.70 |
| Constância | 7 815 884 | 3 815 | 2048.72 |
| Coruche | 14 393 088 | 21 332 | 674.72 |

(*Continued*)

*Table* A1 *Continued*

| Municipalities | Expenditure (€)[a] | Total resident population[b] | Expenditure per capita (€) |
|---|---|---|---|
| Entroncamento | 8 578 760 | 18 174 | 472.03 |
| Ferreira do Zêzere | 5 743 508 | 9 422 | 609.58 |
| Golegã | 5 112 449 | 5 710 | 895.35 |
| Lisboa | 672 612 065 | 564 657 | 1191.19 |
| Loures | 97 203 859 | 199 059 | 488.32 |
| Lourinhã | 15 391 591 | 23 265 | 661.58 |
| Mafra | 39 475 953 | 54 358 | 726.22 |
| Moita | 27 459 842 | 67 449 | 407.12 |
| Montijo | 28 269 251 | 39 168 | 721.74 |
| Nazaré | 7 759 081 | 15 060 | 515.21 |
| Óbidos | 9 644 956 | 10 875 | 886.89 |
| Odivelas | 65 590 178 | 133 847 | 490.04 |
| Oeiras | 109 353 503 | 162 128 | 674.49 |
| Ourém | 23 039 784 | 46 216 | 498.52 |
| Palmela | 36 600 962 | 53 353 | 686.02 |
| Peniche | 14 115 532 | 27 315 | 516.77 |
| Rio Maior | 20 373 964 | 21 110 | 965.13 |
| Salvaterra de Magos | 10 189 059 | 20 161 | 505.38 |
| Santarém | 34 630 560 | 63 563 | 544.82 |
| Sardoal | 6 504 115 | 4 104 | 1584.82 |
| Seixal | 57 289 921 | 150 271 | 381.24 |
| Sesimbra | 29 715 670 | 37 567 | 791.00 |
| Setúbal | 94 423 714 | 113 934 | 828.76 |
| Sintra | 141 208 527 | 363 749 | 388.20 |
| Sobral de Monte Agraço | 5 668 070 | 8 927 | 634.94 |
| Tomar | 21 419 035 | 36 908 | 580.34 |
| Torres Novas | 22 125 433 | 36 908 | 599.48 |
| Torres Vedras | 29 802 571 | 72 250 | 412.49 |
| Vila Franca de Xira | 56 876 353 | 122 908 | 462.76 |
| Vila Nova da Barquinha | 4 618 250 | 7610 | 606.87 |
| Average | 44 391 675 | 67 870 | 685.01 |
| Standard deviation | 95 543 244 | 98 560 | 305.13 |
| Minimum | 4 618 250 | 3815 | 340.86 |
| Maximum | 672 612 065 | 564 657 | 2048.72 |

*Sources:* [a]CCRLVT (2001); [b]INE (2001).

## NOTES

1. For some other studies that assess municipal spending efficiency, see EECKAUT *et al.* (1993); DE BORGER *et al.* (1994); and DE BORGER and KERSTENS (1996a, b).
2. For example, BIRD and VAILLANCOURT (1999) and BLAIR (2000) point out the complexity of such a concept.
3. BRADFORD *et al.* (1969) labelled the direct output (D-output) and the outcomes demanded by citizens as 'C-output'. For example, for police services, municipalities provide surveillance and traffic control. However, citizens ultimately care about safety and smoothness in the flow of travel. Under their model, the transformation of D-output into C-output is affected by environmental factors such as 'community composition'.
4. COELLI *et al.* (2002) and THANASSOULIS (2001) offer good introductions to the DEA methodology.
5. In fact, the choice between input and output orientations is not crucial since only the two measures associated with the inefficient units may be different between the two methodologies.
6. This is the equivalent envelopment form, derived by CHARNES *et al.* (1978), using the duality property of the multiplier form of the original programming model.
7. For instance, DELLER and RUDNICKI (1992) proxy the price of the selected service 'administrative services' by the 'school expenditures on administration per pupil' variable in their work on Maine's public education services.
8. This weighing up of the variables is quite straightforward and economically intuitive (even though it is still somewhat ad hoc). It avoids the problem of a lack of economic justification of a more complex statistical approach such as principal component analysis that might come to mind in this context.
9. The Centrality Index is computed using two ratios: first, by the ratio between mobile present population in a municipality and its resident population; and second, by the ratio between local residents that came from other municipalities and the resident population for the municipality in question.
10. With less than three DMUs per input and output, there is the risk that too many DMUs will turn out to be efficient (BOWLIN, 1998).
11. Data are from: [a]INE (2001); [b]INE (2000/01a); [c]INE (2000/01b); and [d]CCRLVT (2001).

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