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The relevance of commuting zones for regional spending efficiency

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The relevance of commuting zones for regional spending efficiency*

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Abstract

We use Data Envelopment Analysis (DEA) efficiency scores to show that clustering municipalities into encompassing regional clusters improves spending efficiency of single stand-alone municipalities. We propose a new geographic aggregation based on municipalities-to-municipalities commuting flows, defined using hierarchical cluster analysis. Our example for Portugal shows that from an output oriented perspective, between 85 and 95 percent of municipalities would increase their efficiency scores, while from an input oriented perspective, between 81 and 97 percent of municipalities would also be better off in terms of efficiency. Our strategy and results are naturally quite relevant in a context of public spending control.

JEL: C14, H72, R50.
Keywords: public spending efficiency, local government, data envelopment analyis (DEA), commuting.

[*] The opinions expressed herein are those of the authors and do not necessarily reflect those of the ECB or the Eurosystem.

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1. Introduction

Reducing local government spending and increasing the efficiency of regional governments has been a significant issue in public finance and regional economics for quite a long time. This is particularly relevant when governments try to reign in public spending, as it is the case, for instance, in many European Union (EU) countries.

This paper contributes to the literature by showing that having a cluster of several municipalities improves the spending efficiency of once single stand-alone municipalities. We draw on the labor market concept of commuting zones and on the Data Envelopment Analysis (DEA) framework. Our geographic unit of analysis is community zones, groups of municipalities where the majority of the inhabitants live, work or study. This geographic concept was based on municipalities-to-municipalities commuting flows of working population. To compute the DEA efficiency scores, we use a composite indicator of municipal outputs, as in Afonso and Fernandes (2008), and we use local government spending as the input. We test our approach for the case of Portugal, both for the mainland and for the European Union Nomenclature of Territorial Units for Statistics (NUTS) regions.

Portugal provides an excellent context in which to analyze the impact of clustering municipalities on spending efficiency. First, Portugal is one the OCDE's countries with more spending per 100,000 inhabitants. Second, the Portuguese municipalities are all covered by the same rules and legislation but the local politicians have some discretionary power on how to implement their policies and to use their resources. Finally, the Portuguese government agreed on April 2011 with the EU and with the International Monetary Fund (IMF), in the context of the Memorandum of Economic and Financial Policies (MEFP), to reduce the number of parishes and municipalities and in this way reduce public spending and increase its efficiency.

Our results show that indeed, there are potential efficiency gains, from clustering municipalities. This is true notably from an output oriented perspective, given that between 85 and 95 percent of municipalities would be able to increase their efficiency scores. In addition, we obtain a similar result from an input oriented perspective, with between 81 and 97 percent of municipalities being better off in terms of efficiency scores if one follows our commuting zone aggregation via hierarchical cluster analysis. Our conclusions hold both for an overall mainland assessment and for the NUTII regions. Our results are also robust considering different clustering criteria. In fact, our results are likely to extend beyond the context of this study, and might be particularly relevant to reduce local and regional spending, and for countries wishing to restructure its administrative regions.

The organization of the paper is as follows. Section 2 reviews the related literature. Section 3 presents the methodology. Section 4 reports and discusses the empirical results. Section 5 is the conclusion.

2. Related Literature

In the literature that assesses production efficiency, it is rather common to use frontier analysis to evaluate technical efficiency (a concept stemming from Farrell, 1957). In fact, and to assess the efficiency of government spending, many studies usually estimate non-parametrically a production function frontier and derive efficiency scores based on the relative distances of inefficient observations from the frontier.

Several specific government functions such as education and health have been addressed notably by Afonso and St. Aubyn (2005, 2006, 2011). Moreover, St. Aubyn et al. (2009) studied the case of Universities in the European Union, and Eugène (2008) assessed the relative efficiency of Belgian general government as provider of public order and safety, in addition to health care and education services. On the other hand, Afonso et al. (2005, 2010) studied the overall public sector efficiency, taking into account the level of general government spending. Overall, those studies show the existence of room for improvement regarding public spending efficiency.

Conversely, public spending efficiency studies covering services provided by local governments include, for instance, Van den Eeckaut, Tulkens and Jamar (1993), De Borger et al. (1994), De Borger and Kerstens (1996, 2000), Athanassopoulos and Triantis (1998), Worthington (2000), Prieto and Zofio (2001), Balaguer-Coll, Prior-Jiménez and Vela-Bargues (2002), Afonso and Fernandes (2006, 2008), and Afonso and Scaglioni (2007). Once again, the results of this strand of the literature points to the fact that governments can attain efficiency gains at the municipal level as well.

Still, the novel approach that we develop in this paper, showing the increase in efficiency via the clustering of municipalities based on commuting flows, has not been done the literature so far.

3. Methodology

3.1. Commuting Zones

Portugal's administrative regions are organized into three tiers: districts and two autonomous regions of Azores and Madeira, municipalities and parishes. There are 18 districts, 308 municipalities and 4261 parishes.[1] In this study, we define a new geographic unit of analysis, community zone: groups of municipalities where the majority of the inhabitants live, work or study.

To construct our new measure (geographic unit), we use the methodology defined by Tolbert and Killian (1987) and Tolbert and Sizer (1996). We start by constructing a matrix with the commuting flows between municipalities. To account for variations in municipality work population, we convert these absolute flows into proportional measures. The strength of commuting ties between two municipalities *i* and *j*, T_{ij}, is measured according to:

$$T_{ij} = \frac{c_{ij}}{\min(r_i, r_j)} \quad (1)$$

where r_k is the number of all workers residing in municipality k, ($k=i,j$) and c_{ij} is the number of workers who reside in municipality *i* and work or study in municipality *j* or vice versa.

The statistic T_{ij} depicts the relationship between the flow of workers who commute between two municipalities, independent of the direction and the number of individuals who live in the smallest municipality. In this way, the statistic defines better the commuting tie between municipalities with large size differentials. The proportional matrix of T_{ij} is a similarity matrix. The stronger the commuting relationship between two municipalities, the higher is the value of T_{ij}.

We employ a hierarchical cluster analysis to delineate the labor market areas. This analysis starts by grouping the municipality pairs with largest value of T_{ij} and subsequently forms clusters of interrelated municipalities. As suggested by previous literature, we choose the average linkage between clusters as a statistical algorithm. In the average-linkage method the distance between two clusters is obtained by taking the average distance between all subjects in the two

[1] For statistical purposes, the EU redefined the Portuguese territory into Nomenclature of Territorial Units for Statistics (NUTS) regions. The NUTS system subdivides the country into three levels: NUTS I (Portugal mainland and 2 autonomous regions of Azores and Madeira), NUTS II (7 regions) and NUTS III (30 sub-regions). These latter classifications were developed for the purpose of delivering structural funds for less favored regions and sub-regions.

clusters. Alternatively, we also consider other sets of algorithms (single linkage, centroid linkage and ward linkage). All of them point to similar market labor areas.

As defined in Dorn (2009), municipalities with stronger ties are the ones with an average value of T_{ij} above 0.02.

3.2. DEA Efficiency Analysis

The DEA methodology, which originates with Farrell's (1957) seminal work and was further used by Charnes, Cooper and Rhodes (1978), assumes the existence of a convex production frontier. The production frontier in the DEA approach uses linear programming methods.[2] The general relationship that we consider is the following function for each municipality *i*:

$$Y_i = f(X_i),\ i=1,\dots,n \qquad (2)$$

where Y_i is the composite output measure for municipality i and X_i is the per capita municipal expenditures registered on municipal accounts for the year 2001 as a measure of the municipal resources used in local services' provision input in municipality *i*.

If $Y_i < f(X_i)$, it is said that municipality *i* exhibits inefficiency. For the observed input levels, the actual output is smaller than the best attainable one and inefficiency is measured by computing the distance to the theoretical efficiency frontier.

In an output-oriented framework, we provide here the description of the linear programming problem in the variable-returns to scale hypothesis. Suppose there are *k* inputs and *m* outputs for *n* Decision Management Units (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. We can also define X as the $(k\times n)$ input matrix and Y as the $(m\times n)$ output matrix. The following mathematical programming problem, for a given i-th DMU, specifies the DEA model:[3]

$$\begin{aligned} & Max_{\ \delta,\lambda}\,\delta \\ \text{s. to}\quad & -\delta y_i + Y\lambda \geq 0 \\ & x_i - X\lambda \geq 0 \\ & n1'\lambda = 1 \\ & \lambda \geq 0 \end{aligned} \qquad . \qquad (3)$$

[2] Coelli et al. (1998) and Thanassoulis (2001) offer introductions to DEA.
[3] 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.

In (3), δ is a scalar (that satisfies $1/\delta \leq 1$), and specifically is the efficiency score that measures technical efficiency, the distance between a municipality and the efficiency frontier, defined as a linear combination of the best practice observations. With $1/\delta < 1$, the municipality is inside the frontier (i.e. it is inefficient), while $\delta = 1$ 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, and $n1$ is an n-dimensional vector of ones. The inefficient DMU can theoretically be on the production frontier as a linear combination of those weights, related to the peers of the inefficient DMU. The peers are other DMUs that are more efficient, and used as references for the inefficient DMU. The restriction $n1'\lambda = 1$ imposes convexity of the frontier, accounting for variable returns to scale. Dropping this restriction would amount to admit that returns to scale were constant. Problem (3) is solved for each of the n DMUs in order to obtain the n efficiency scores.

4. Empirical analysis

4.1. Portuguese Commuting zones

Data on community flows and workers population per municipality are from the 2001 Census data.[4] With these commuting patterns, the clustering procedure yielded 107 commuting zones for the entire country and 91 commuting zones for mainland Portugal. For purpose of our analysis, we exclude the two autonomous regions of Azores and Madeira and we only consider the mainland region.

Figure 1 presents a map of the 91 labor market areas. The labor market areas are outlined in bold while the municipalities are outlined in thin grey. From the picture, we can infer that all areas are geographically contiguous. Note that these set of labor market areas result from a data-driven method without requiring any subsequent ad-hoc manipulation to exclude unusual distant commuting patterns. By using solely the commuting data, we partition the country very sensibly without manually imposing region restrictions. In the Appendix, we present the entire list of municipalities included in each community zone in 2001 for mainland Portugal.

[4] These data are available from the Portuguese Statistic Office's website under the variable names "Commuting of the employed or student resident population by place of residence or destination and place of destination or residence" and "Resident population by place of residence (at the date of Census), sex and by main source of livelihood".

[Figure 1]

Column 1 of Table 1 presents the summary statistics for the commuting zones in Portugal mainland for T_{ij} above 0.02. On average, 48.000 workers reside in a commuting zone in mainland Portugal and the largest labor market is Lisbon with over 1,100,000 work inhabitants. Each commuting zone includes roughly three municipalities, with the number of municipalities ranging from 1 to 16. Isolated commuting zones (single municipalities) accounted for approximately 14% of the total municipalities in Portugal mainland. Table 1 also reports statistics for alternative clustering thresholds, notably based on geographic distances.

[Table 1]

4.2. Baseline DEA efficiency scores

The DEA efficiency scores computed by Afonso and Fernandes (2008), for Portugal mainland and for the NUTS II regions, use municipal spending as an input measure and as an output measure a composite of the Local Government Output Indicator (LGOI). This composite is a single measure of municipal performance evaluated in terms of social services, Y1 (local inhabitants above 65 years old as a percentage of resident population); basic education Y2 (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, Y21, 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, Y22); cultural services, Y3 (number of library users in percentage of the total resident population); sanitation, Y4 (water supply, Y41, solid waste collection, Y42); territory organization, Y5 (licenses for building construction); road infrastructures, Y6 (length of roads maintained by the municipalities per number of the total resident population). Table 2 provides a summary of the DEA results obtained for 2001.

[Table 2]

The purpose of an input-oriented assessment 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 can assess how much output quantities can be proportionally increased without changing the input quantities used. In the case of the baseline for the NUTS II regions, we can see from Table 2 that input efficiency scores range between 0.567 and 0.654, implying that inputs could be theoretically lower by around 35%-45%, keeping the same level of output. On the other hand, output efficiency scores range between 0.353 and 0.681, which means that one might envisage and output increase of around 32%-65% with the same level of inputs.

4.3. Cluster DEA efficiency scores

Afterwards, the main question of our study is to assess, using the commuting zones explained above, whether the resulting regional clusters would provide a gain in efficiency. For that purpose, and as an intermediate step, we computed the municipal spending and the composite local government output indicator (the so-called LGOI) for each commuting zone using the approach defined in Afonso and Fernandes (2008).Then we have calculated the DEA efficiency scores, both for the mainland new aggregation of regions, and also for the new aggregations inside each NUTS II region.

Therefore, using the commuting zone methodology for T_{ij} above 0.02, we are able to identify 91 clusters for Portugal (mainland) down from the number of existing 278 municipalities. On the other hand, and for the case of the NUTS II aggregation, we had to consider only three regions, North, Centre (aggregating *Centre* and *Região de Lisboa e Vale do Tejo*) and South (aggregating *Alentejo* and *Algarve*). In this way, we have arrived to the following number of clusters: 32, 50, and 28 respectively for the North, Centre, and South (see lines 9, 10, and 11 in Table 3). The number of municipalities in each of those aggregations is 86, 129, and 63, respectively.

Using this alternative aggregation, we have then computed the DEA input and output oriented efficiency scores, for the country and for the NUTS II area, for the corresponding clusters.[5] Table 3 summarizes those results. For the country case we can compare lines 1 (baseline) and 2 (commuting zones clustering) and observe several points. The average efficiency scores are higher both for input (0.692 vs. 0.225) and for output (0.543 vs. 0.246) oriented approaches, when the clusters are used for the DEA calculations. Indeed, around 93% and 96.8% of the municipalities would theoretically increase respectively output and input efficiency (as depicted in the last two columns of Table 3).

[5] We also had to make these calculations for the baseline, since we are now aggregating into three NUTS II regions instead of five, as was reported in Afonso and Fernandes (2008).

[Table 3]

In terms of the new aggregation for the NUTS II classification, obtained also via the commuting zones approach considering $T_{ij}>0.02$, we can compare the results in lines, 6, 7 and 8 (baseline) with lines 9, 10, 11 (commuting zones clustering) respectively for the North, Centre, and South. Again, there is an overall increase in the average efficiency scores, both input and output oriented, with the exception of the South area. In addition, the number of DMUs (municipalities) that are on the efficiency frontier are still rather similar.

Therefore, promoting such aggregation in terms of municipalities would be helpful in terms of increasing the overall government spending efficiency of the local authorities. Given the geographic closeness of the ensuing partition via the commuting clusters, one can expect in fact the existence of scale economies in the provision of several local public services.

4. 4. Robustness Analysis

We have conducted several robustness exercises. As an alternative, we used a different threshold for the commuting ties between municipalities widening a bit more the geographic incidence of those commuting flows (we used an average value of T_{ij} above 0.01 instead of 0.02). The descriptive statistics for this new regional definition are presented in Column 2 of Table 1. As expected, the commuting zones are larger in terms of workers and number of municipalities. With this regional aggregation, on average 66,000 workers reside in a commuting zone and each commuting zone includes roughly four municipalities (they were around three before). Table 3, in line 3, reports the DEA alternative sets of results for the country case, and in lines 12, 13, and 14, for the NUTS II analysis. The results for the country case are quite similar to the ones with the previous threshold, and the same holds true for the NUTS II.

Another exercise that we carried out was to aggregate municipalities according to their geographic distance instead of looking at the commuting flows between municipalities. From the Portuguese Geographic Institute, we retrieved information on the geographic distance (in straight line) between the municipality capitals. On average, municipality capitals in Portugal mainland are 188 km apart. Then, we employ a hierarchical cluster analysis using the nearby algorithm to delineate the new geographic regions. In our nearby approach, we defined ex-ante the distance between the municipalities. Therefore, we limited that distance to both 20 km and to 30 km, in order to partition the country and NUTS II regions into clusters. Summary statistics for these two geographic aggregations are presented in Column 3 and 4 of Table 1. Again, the DEA results presented in Table 3 (for the country in lines 4 and 5 and for the NUTS analysis in lines 15 to 20) show higher efficiency scores implying the existence of efficiency gains from such aggregation.

5. Conclusion

This study shows that clustering municipalities improves local government spending. Using hierarchical clustering methods to define new encompassing geographic units and DEA framework to define the efficiency scores, we find that from an output oriented perspective, 85 to 95 percent of municipalities are able to increase their efficiency scores. Whereas from an input oriented perspective 81 to 97 percent of municipalities are better off in terms of efficiency scores. Our results hold both for Portugal mainland and for its NUTII regions.

This conclusion comes with some caveats. We did not consider possible economies of scales that might occur when we cluster municipalities together. For example, costs with electricity, personnel and other inputs might decrease. Therefore, the conservative nature of our approach could bias our previous efficiency estimates downward. In addition, we use data from the year 2001, since then, the Portuguese macroeconomic context has deteriorated. Therefore, this study does not consider possible efficiency gains that might have occurred afterwards.

This study is motivated by the growing need to reduce government spending and increase its efficiency given the global economic and financial context. In fact, our novel approach is particularly relevant for countries like Portugal that have signed international financial support programs, and to meet the terms of the agreement, the respective governments have to cut public expenditure among other policies. Moreover, our approach to efficiency gains via commuting zones clustering has obvious policy implications for decision makers.

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Figure 1 - Geography of Labor Market Areas in 2001: Mainland Portugal
(91 labor market areas)

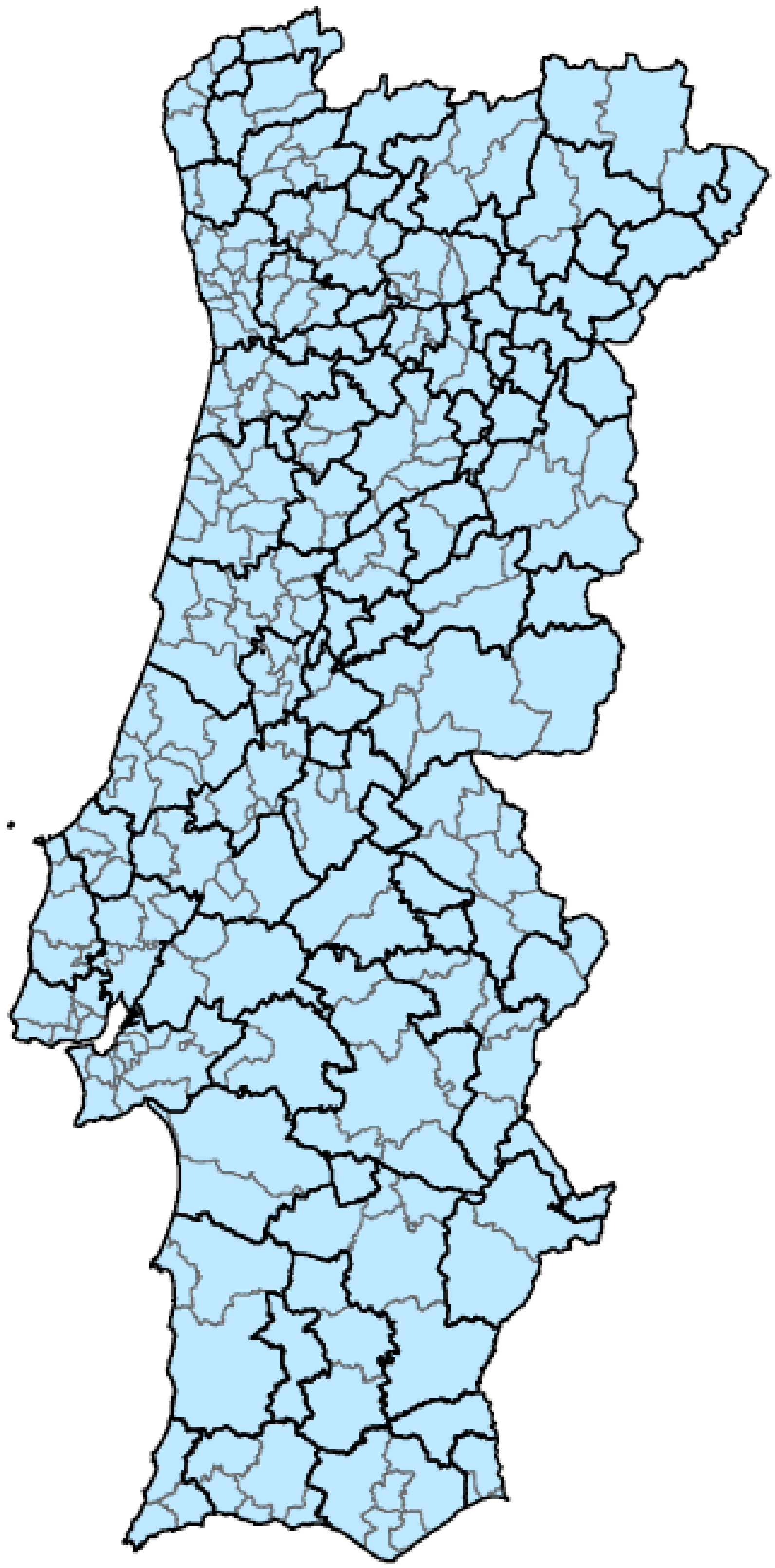

Table 1: Descriptive Statistic on Commuting Zones

	Commuting Zones T<0.01	Commuting Zones T<0.02	Nearby Municipalities 20Km	Nearby Municipalities 30Km
	(1)	**(2)**	**(3)**	**(4)**
Number of areas	91	66	115	69
Panel A: Resident Workers				
Mean	48,157	66,398	38,107	63,511
Standard Deviation	143,906	186,472	91,074	145,930
Median	11,846	9,359	10,225	19,412
Minimum	607	607	607	607
Maximum	1,170,514	1,274,633	729,268	1,077,398
Panel B: Municipalities Composition				
Mean	3.05	4.21	2.42	4.03
Standard Deviation	2.74	4.26	1.70	2.85
Median	2	2	2	3
Minimum	1	1	1	1
Maximum	16	21	10	13
Sole Municipalities	14%	10%	15%	4%

Table 2: Baseline DEA efficiency results

Region	N. of DMUs	Efficient DMUs		Average efficiency scores	
		N. 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	278	3 (Miranda do Corvo, Seia, Gondomar)	1.1	0.225	0.246

Source: Afonso and Fernandes (2008).

Table 3: DEA efficiency scores comparisons (VRS)

					Input				Output				Cz-baseline (a)	
			DMUs	Efficient DMUs	Average	Max	Min	Stdev	Average	Max	Min	Stdev	Output	Input
1	**Country, baseline DEA**		**278**	**3**	**0.225**	**1.000**	**0.017**	**0.134**	**0.246**	**1.000**	**0.075**	**0.146**	-	-
2	Country cz 91 (T<0,2) (b)		91	5	0.692	1.000	0.060	0.180	0.543	1.000	0.276	0.200	93.2	96.76
3	Country cz 66 (T<0,1)		66	3	0.720	1.000	0.061	0.177	0.584	1.000	0.335	0.174	95.0	96.76
4	Country nearby 20km		115	4	0.431	1.000	0.096	0.130	0.421	1.000	0.274	0.123	88.8	90.3
5	Country nearby 30km		67	3	0.588	1.000	0.140	0.154	0.447	1.000	0.271	0.131	89.9	95.3
6		**N**	**86**	**4**	**0.567**	**1.000**	**0.224**	**0.213**	**0.397**	**1.000**	**0.182**	**0.211**	-	-
7	**Baseline Nuts II**	**C**	**129**	**6**	**0.380**	**1.000**	**0.189**	**0.254**	**0.403**	**1.000**	**0.056**	**0.171**	-	-
8		**S**	**63**	**7**	**0.642**	**1.000**	**0.264**	**0.205**	**0.628**	**1.000**	**0.354**	**0.184**	-	-
9		N	32	5	0.686	1.000	0.330	0.136	0.640	1.000	0.419	0.149	87.2	73.3
10	Nuts II cz (T<0.2) (b)	C	50	3	0.670	1.000	0.334	0.173	0.530	1.000	0.268	0.179	72.9	89.9
11		S	28	4	0.659	1.000	0.449	0.130	0.574	1.000	0.357	0.137	47.6	55.6
12		N	27	5	0.690	1.000	0.333	0.136	0.656	1.000	0.429	0.152	88.4	73.3
13	Nuts II cz (T<0.1)	C	42	5	0.686	1.000	0.344	0.175	0.699	1.000	0.408	0.159	89.1	83.7
14		S	23	4	0.665	1.000	0.455	0.116	0.580	1.000	0.464	0.131	47.6	60.3
15		N	31	5	0.816	1.000	0.392	0.160	0.786	1.000	0.512	0.164	93.0	90.7
16	Nuts II, nearby 20km	C	49	2	0.469	1.000	0.100	0.143	0.482	1.000	0.294	0.129	69.0	60.5
17		S	44	3	0.756	1.000	0.383	0.169	0.698	1.000	0.394	0.169	71.4	84.1
18		N	18	3	0.810	1.000	0.549	0.156	0.834	1.000	0.471	0.147	95.3	81.4
19	Nuts II, nearby 30km	C	26	2	0.711	1.000	0.158	0.159	0.571	1.000	0.312	0.183	77.5	86.0
20		S	25	3	0.799	1.000	0.402	0.131	0.736	1.000	0.530	0.135	81.0	82.5

Notes: N - North; C - Centre; S – South. C = C + LVT; S = Algarve + Alentejo. cz - commuting clusters.
Efficient DMUs for Nuts II, we report in this column the number of efficient DMUs in the Nuts II.
(a) % of cases (municipalities) where there is a gain in efficiency as a result of the clustering strategy, by comparing the initial standalone efficiency score of the municipalities and the efficiency score of the cluster where the municipality would be allocated. (b) As defined in Dorn (2009), municipalities with stronger ties are the ones with an average value of T_{ij} above 0.02.

Appendix

Table A.1 - List of municipalities included in each community zone for 2001 in Mainland Portugal

ID	Municipality Name	Commuting Zones $T_{ij}<0.01$	Commuting Zones $T_{ij}<0.02$	Nearby Municipalities 20Km	Nearby Municipalities 30Km
101	Águeda	33	24	1	20
102	Albergaria-a-Velha	33	24	2	21
103	Anadia	33	24	1	20
104	Arouca	15	11	3	46
105	Aveiro	33	24	4	21
106	Castelo de Paiva	9	7	3	46
107	Espinho	8	6	5	47
108	Estarreja	15	11	2	21
109	Santa Maria da Feira	15	11	2	46
110	Ílhavo	33	24	4	21
111	Mealhada	33	24	1	20
112	Murtosa	15	11	2	21
113	Oliveira de Azeméis	15	11	2	46
114	Oliveira do Bairro	33	24	1	20
115	Ovar	15	11	2	21
116	São João da Madeira	15	11	2	46
117	Sever do Vouga	34	24	2	21
118	Vagos	33	24	4	21
119	Vale de Cambra	15	11	2	46
201	Aljustrel	79	57	6	1
202	Almodôvar	79	57	7	2
203	Alvito	80	58	8	3
204	Barrancos	81	59	9	4
205	Beja	82	60	10	5
206	Castro Verde	79	57	11	2
207	Cuba	82	60	12	3
208	Ferreira do Alentejo	82	60	13	1
209	Mértola	82	60	14	6
210	Moura	83	60	15	7
211	Odemira	66	47	16	8
212	Ourique	84	61	11	2
213	Serpa	83	60	17	5
214	Vidigueira	82	60	12	3
301	Amares	5	4	18	48
302	Barcelos	6	1	19	49
303	Braga	5	4	18	48
304	Cabeceiras de Basto	10	5	20	50
305	Celorico de Basto	7	5	20	50
306	Esposende	6	1	19	49
307	Fafe	7	5	21	51
308	Guimarães	7	5	21	51
309	Póvoa de Lanhoso	5	4	18	48
310	Terras de Bouro	5	4	18	48
311	Vieira do Minho	5	4	18	48
312	Vila Nova de Famalicão	8	6	22	49
313	Vila Verde	5	4	18	48

ID	Municipality Name	Commuting Zones T_{ij}<0.01	Commuting Zones T_{ij}<0.02	Nearby Municipalities 20Km	Nearby Municipalities 30Km
314	Vizela	7	5	21	51
401	Alfândega da Fé	26	20	23	52
402	Bragança	27	15	24	53
403	Carrazeda de Ansiães	16	12	25	54
404	Freixo de Espada à Cinta	17	13	26	55
405	Macedo de Cavaleiros	19	15	27	56
406	Miranda do Douro	28	21	28	57
407	Mirandela	19	15	29	56
408	Mogadouro	29	22	30	55
409	Torre de Moncorvo	18	14	31	52
410	Vila Flor	19	15	23	52
411	Vimioso	27	15	32	57
412	Vinhais	27	15	24	53
501	Belmonte	60	39	33	22
502	Castelo Branco	48	35	34	23
503	Covilhã	60	39	33	22
504	Fundão	60	39	35	22
505	Idanha-a-Nova	48	35	36	24
506	Oleiros	48	35	37	25
507	Penamacor	59	43	38	26
508	Proença-a-Nova	49	35	39	27
509	Sertã	42	31	40	27
510	Vila de Rei	50	36	41	27
511	Vila Velha de Ródão	48	35	42	23
601	Arganil	37	27	43	28
602	Cantanhede	33	24	44	20
603	Coimbra	35	25	45	28
604	Condeixa-a-Nova	35	25	46	29
605	Figueira da Foz	35	25	47	29
606	Góis	38	28	43	28
607	Lousã	35	25	48	28
608	Mira	33	24	44	20
609	Miranda do Corvo	35	25	48	28
610	Montemor-o-Velho	35	25	47	29
611	Oliveira do Hospital	37	27	49	30
612	Pampilhosa da Serra	39	29	37	25
613	Penacova	35	25	45	28
614	Penela	40	25	48	28
615	Soure	35	25	46	29
616	Tábua	37	27	50	30
617	Vila Nova de Poiares	35	25	45	28
701	Alandroal	75	55	51	9
702	Arraiolos	76	48	52	10
703	Borba	75	55	51	9
704	Estremoz	75	55	51	9
705	Évora	76	48	52	10
706	Montemor-o-Novo	77	48	53	11
707	Mora	68	48	54	12
708	Mourão	78	56	55	13
709	Portel	76	48	12	3
710	Redondo	76	48	51	9
711	Reguengos de Monsaraz	75	55	55	13
712	Vendas Novas	77	48	56	11

ID	Municipality Name	Commuting Zones T_{ij}<0.01	Commuting Zones T_{ij}<0.02	Nearby Municipalities 20Km	Nearby Municipalities 30Km
713	Viana do Alentejo	76	48	8	3
714	Vila Viçosa	75	55	51	9
801	Albufeira	87	63	57	64
802	Alcoutim	88	64	58	65
803	Aljezur	89	65	59	66
804	Castro Marim	90	66	60	67
805	Faro	91	66	61	68
806	Lagoa	87	63	62	64
807	Lagos	89	65	62	64
808	Loulé	91	66	61	68
809	Monchique	87	63	63	66
810	Olhão	91	66	61	68
811	Portimão	87	63	62	64
812	São Brás de Alportel	91	66	61	68
813	Silves	87	63	62	64
814	Tavira	91	66	64	67
815	Vila do Bispo	89	65	65	69
816	Vila Real de Santo António	90	66	60	67
901	Aguiar da Beira	43	32	66	31
902	Almeida	54	39	67	32
903	Celorico da Beira	54	39	68	31
904	Figueira de Castelo Rodrigo	55	40	67	32
905	Fornos de Algodres	52	38	68	31
906	Gouveia	53	27	69	22
907	Guarda	54	39	70	31
908	Manteigas	56	41	69	22
909	Meda	57	42	71	33
910	Pinhel	54	39	67	32
911	Sabugal	54	39	72	26
912	Seia	53	27	69	22
913	Trancoso	58	39	68	31
914	Vila Nova de Foz Côa	20	16	31	52
1001	Alcobaça	36	26	73	38
1002	Alvaiázere	40	25	74	34
1003	Ansião	40	25	74	34
1004	Batalha	36	26	75	35
1005	Bombarral	61	44	76	39
1006	Caldas da Rainha	61	44	76	39
1007	Castanheira de Pêra	41	30	48	28
1008	Figueiró dos Vinhos	40	25	40	34
1009	Leiria	36	26	75	35
1010	Marinha Grande	36	26	75	35
1011	Nazaré	36	26	73	38
1012	Óbidos	61	44	76	39
1013	Pedrógão Grande	42	31	40	34
1014	Peniche	62	44	77	39
1015	Pombal	35	25	74	29
1016	Porto de Mós	36	26	75	35
1101	Alenquer	63	45	78	40
1102	Arruda dos Vinhos	63	45	78	40
1103	Azambuja	63	45	79	41
1104	Cadaval	61	44	76	39
1105	Cascais	65	45	80	42

ID	Municipality Name	Commuting Zones T_{ij}<0.01	Commuting Zones T_{ij}<0.02	Nearby Municipalities 20Km	Nearby Municipalities 30Km
1106	Lisboa	65	45	81	42
1107	Loures	65	45	81	42
1108	Lourinhã	62	44	77	39
1109	Mafra	62	44	82	40
1110	Oeiras	65	45	80	42
1111	Sintra	65	45	80	42
1112	Sobral de Monte Agraço	62	44	78	40
1113	Torres Vedras	62	44	82	40
1114	Vila Franca de Xira	63	45	78	40
1115	Amadora	65	45	81	42
1116	Odivelas	65	45	81	42
1201	Alter do Chão	69	49	83	14
1202	Arronches	70	50	84	15
1203	Avis	71	51	85	16
1204	Campo Maior	72	52	86	15
1205	Castelo de Vide	70	50	87	14
1206	Crato	70	50	83	14
1207	Elvas	72	52	86	15
1208	Fronteira	73	53	88	16
1209	Gavião	74	54	89	17
1210	Marvão	70	50	87	14
1211	Monforte	70	50	84	15
1212	Nisa	70	50	42	14
1213	Ponte de Sor	71	51	90	17
1214	Portalegre	70	50	87	14
1215	Sousel	75	55	88	16
1301	Amarante	7	5	91	58
1302	Baião	11	8	91	58
1303	Felgueiras	7	5	21	51
1304	Gondomar	8	6	5	47
1305	Lousada	12	6	92	51
1306	Maia	8	6	5	47
1307	Marco de Canaveses	12	6	91	58
1308	Matosinhos	8	6	5	47
1309	Paços de Ferreira	12	6	92	51
1310	Paredes	12	6	92	51
1311	Penafiel	12	6	92	51
1312	Porto	8	6	5	47
1313	Póvoa de Varzim	8	6	19	49
1314	Santo Tirso	8	6	22	49
1315	Valongo	8	6	5	47
1316	Vila do Conde	8	6	19	49
1317	Vila Nova de Gaia	8	6	5	47
1318	Trofa	8	6	22	49
1401	Abrantes	51	37	89	43
1402	Alcanena	64	46	93	43
1403	Almeirim	85	46	94	41
1404	Alpiarça	85	46	94	41
1405	Benavente	86	62	79	41
1406	Cartaxo	63	45	79	41
1407	Chamusca	85	46	93	43
1408	Constância	51	37	93	43
1409	Coruche	86	62	95	44

ID	Municipality Name	Commuting Zones T_{ij}<0.01	Commuting Zones T_{ij}<0.02	Nearby Municipalities 20Km	Nearby Municipalities 30Km
1410	Entroncamento	64	46	93	43
1411	Ferreira do Zêzere	64	46	41	43
1412	Golegã	64	46	93	43
1413	Mação	51	37	89	27
1414	Rio Maior	85	46	76	39
1415	Salvaterra de Magos	86	62	79	41
1416	Santarém	85	46	94	41
1417	Sardoal	51	37	89	43
1418	Tomar	64	46	96	43
1419	Torres Novas	64	46	93	43
1420	Vila Nova da Barquinha	64	46	93	43
1421	Ourém	36	26	96	43
1501	Alcácer do Sal	67	47	97	18
1502	Alcochete	65	45	81	42
1503	Almada	65	45	81	42
1504	Barreiro	65	45	81	42
1505	Grândola	67	47	98	18
1506	Moita	65	45	81	42
1507	Montijo	65	45	81	42
1508	Palmela	65	45	99	45
1509	Santiago do Cacém	66	47	100	19
1510	Seixal	65	45	81	42
1511	Sesimbra	65	45	101	45
1512	Setúbal	65	45	99	45
1513	Sines	66	47	100	19
1601	Arcos de Valdevez	1	1	102	48
1602	Caminha	2	1	103	59
1603	Melgaço	3	2	104	60
1604	Monção	3	2	105	59
1605	Paredes de Coura	4	3	105	59
1606	Ponte da Barca	1	1	102	48
1607	Ponte de Lima	1	1	102	48
1608	Valença	2	1	105	59
1609	Viana do Castelo	2	1	106	61
1610	Vila Nova de Cerveira	2	1	103	59
1701	Alijó	21	8	107	54
1702	Boticas	30	23	108	62
1703	Chaves	30	23	108	62
1704	Mesão Frio	11	8	91	58
1705	Mondim de Basto	7	5	20	50
1706	Montalegre	31	4	109	62
1707	Murça	32	8	107	54
1708	Peso da Régua	21	8	110	58
1709	Ribeira de Pena	13	9	111	50
1710	Sabrosa	21	8	107	54
1711	Santa Marta de Penaguião	21	8	110	58
1712	Valpaços	30	23	29	56
1713	Vila Pouca de Aguiar	30	23	111	50
1714	Vila Real	21	8	110	58
1801	Armamar	22	10	110	58
1802	Carregal do Sal	44	33	50	30
1803	Castro Daire	45	33	112	36
1804	Cinfães	9	7	91	58

ID	Municipality Name	Commuting Zones T_{ij}<0.01	Commuting Zones T_{ij}<0.02	Nearby Municipalities 20Km	Nearby Municipalities 30Km
1805	Lamego	22	10	110	58
1806	Mangualde	44	33	113	37
1807	Moimenta da Beira	23	17	66	63
1808	Mortágua	46	34	50	30
1809	Nelas	44	33	113	37
1810	Oliveira de Frades	47	33	114	36
1811	Penalva do Castelo	44	33	115	37
1812	Penedono	24	18	71	63
1813	Resende	14	10	91	58
1814	Santa Comba Dão	46	34	50	30
1815	São João da Pesqueira	25	19	25	54
1816	São Pedro do Sul	47	33	114	36
1817	Sátão	44	33	115	37
1818	Sernancelhe	23	17	66	63
1819	Tabuaço	23	17	110	58
1820	Tarouca	22	10	110	58
1821	Tondela	46	34	50	30
1822	Vila Nova de Paiva	44	33	115	37
1823	Viseu	44	33	113	37
1824	Vouzela	47	33	114	36