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How distant are the Portuguese regions? A multidimensional scaling application

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HOW DISTANT ARE THE PORTUGUESE REGIONS?
A MULTIDIMENSIONAL SCALING APPLICATION

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Abstract

Despite being a small country, Portugal is characterised by significant regional disparities which are evident from the analysis of numerous indicators such as the level of income or the unemployment rate. These regional disparities acquire characteristics that, in a sense, do not respect the traditional pattern as the one expected when assuming that standards of living decrease with the distance of each region to the region where economic prosperity is higher. Plainly, this means that, besides the geographical map, it is possible to construct an alternative map of the regions of Portugal which, by its characteristics, is certainly much more interesting from the regional economics point of view. This can be done through the use of multidimensional scaling as it allows representing graphically the regions in a way to reproduce as close as possible the economic distances of the regions as measured by traditional indicators. The analysis of the multidimensional scaling output makes it then possible, on the one hand, to verify how geographical distances are related with economic ones and, on the other hand, to verify if the Portuguese regional economic policies have, indeed, contributed to a diminishment of those regional disparities.

KEY-WORDS: Distance, Multidimensional Scaling, Portugal, Regional Disparities
JEL CLASSIFICATION: C14, R12, R15

1. Introduction and Motivation

Despite being a small country, Portugal is characterised by significant regional disparities which are evident from the analysis of numerous indicators such as the level of income or the unemployment rate. These regional disparities acquire characteristics that, in a sense, do not respect the traditional pattern as the one expected when assuming that standards of living decrease with the distance of each region to the region where economic prosperity is higher. Plainly, this means that, besides the geographical map, it is possible to construct an alternative map of the regions of Portugal which, by its characteristics, is certainly much more interesting from the regional economics point of view. This can be done through the use of multidimensional scaling as it allows representing graphically the regions in a way to reproduce as close as possible the economic distances between the regions as measured by traditional indicators. The analysis of the multidimensional scaling output makes it then possible, on the one hand, to verify how geographical distances are related with economic ones and, on the other hand, to verify if the Portuguese regional economic policies have, indeed, contributed to a diminishment of those regional disparities.

As is well-known, region and space are different concepts. Space can be defined by disperse economic data (in different localisation), because what is really important, what gives coherence to space, is the nature of interdependent relations. But the concept of region implicates proximity. In other words, for the concept of region, physical distance is important as the elements that compose a region have to be nearby.

In accordance with the objectives of the analysis, there are different ways of space organization to form regions. The first one is based on the criterion of homogeneity, resulting in the minimisation of the variability on the relevant characteristics within the elements that compose the region. Homogeneity is thus a formal concept, which does not consider the economic relations within the region and with other regions. The second one is based on the polarization criterion, which involves grouping together nearby geographical units that reveal a great interdependency. A polarized region is then the one which economic relations within it are higher than with other regions. So a polarized space is a group of units or economic poles that maintain more economic relations with other poles of a superior order, than with the poles of the same order. Finally, a third criterion is planning, which is based on the other two.

In a sense, planning is like a compromise criterion to establish the better regional board to political aims and also tries to use the advantages of the other ones.

The polarization must be established taking into account the centrality, which means defining a net of centres (central locals) that guarantees an effectiveness distribution of goods and services and the correspondent accessibility.¹ The functional regions (criterion of polarization) allow establishing the hierarchy on a system of regions, in other words allow establishing a system of different sizes regions, each one containing a higher number of much small regions, of an inferior order.

That being said, the way space can be divided in regions should be present when verifying to which extent the, say, economic distance between Portuguese regions is related with spatial distance. This is, indeed, the basic goal of our study. The rest of the paper is structured as follows. In section 2, brief descriptions of the data and of the methodology that will be used to achieve the purposes of the paper are presented. Section 3 offers the analysis of the results obtained when using the multidimensional scaling techniques to give an answer to the question: “how distant are the Portuguese regions” in terms of (per capita) purchasing power. Section 4 concludes.

2. Brief Descriptions of the Data and of the Multidimensional Scaling Methodology

As said before, we will use data for purchasing power, at the municipality level, for the Portuguese mainland.² It may be illuminating to start by presenting the definition due to the Portuguese Statistical Office (Instituto Nacional de Estatística) which is the source of the data: “*The per capita indicator is an index number that compares the purchasing power regularly manifested by the municipalities or regions, in per capita terms, with the average purchasing power of the country to which a level 100 is attributed.*”³, in Instituto Nacional de Estatística (2002b).⁴

¹ As it is well-known, behind the concept of polarization is the *Central Places* theory due to Christaller.

² Given that we are considering data from 1997 onwards, this gives 275 observations, despite this not being the actual number of municipalities in the mainland of Portugal.

³ As we are considering only the mainland municipalities, all the data was re-scaled in order to consider the average purchasing power at the mainland level being 100.

⁴ Note that the index number is indeed the result obtained when many aspects of economic activity are considered. For instance, concerning the year 2002, the number of variables from which results the index is 19. See Instituto Nacional de Estatística (2002a,b).

That being said, let us consider the following figures, which give a graphic image of the data:

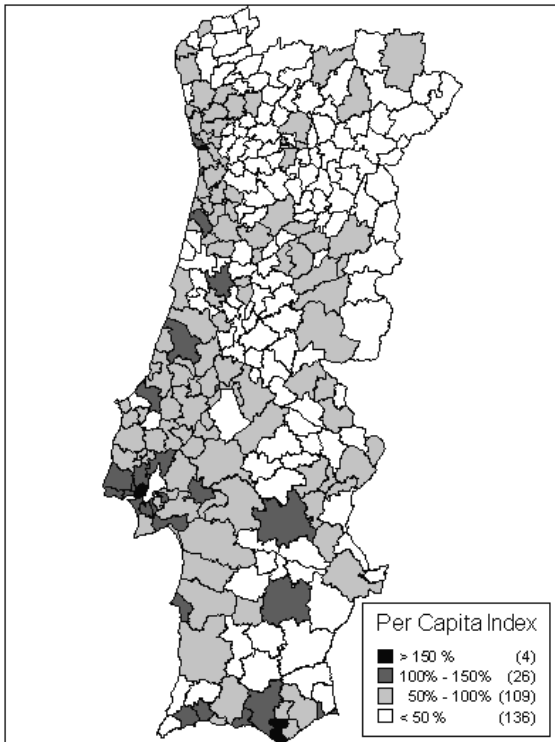


Figure 1 – Purchasing Power in 1995

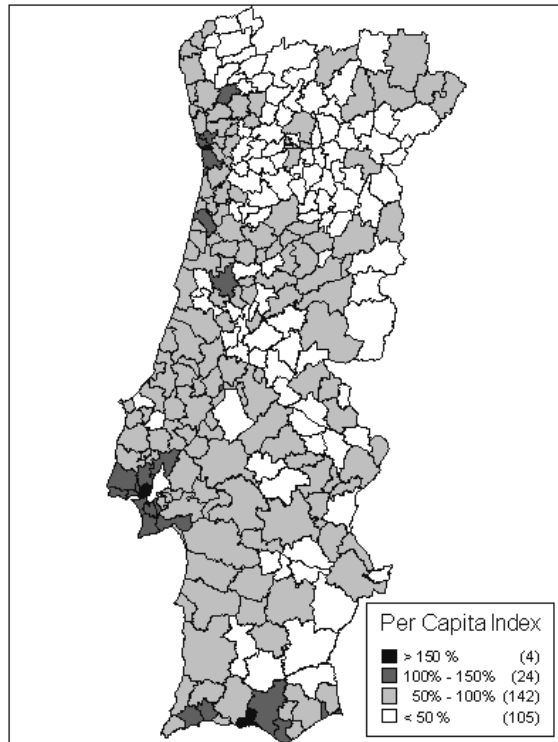


Figure 2 – Purchasing Power in 1997

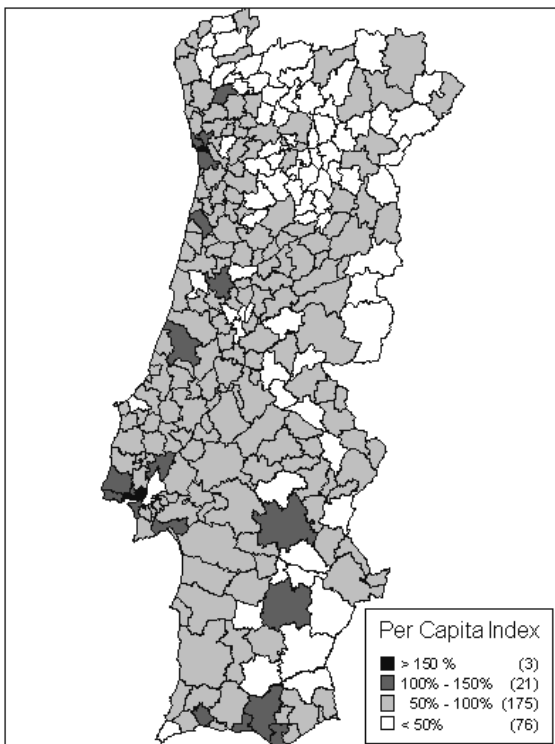


Figure 3 – Purchasing Power in 2000

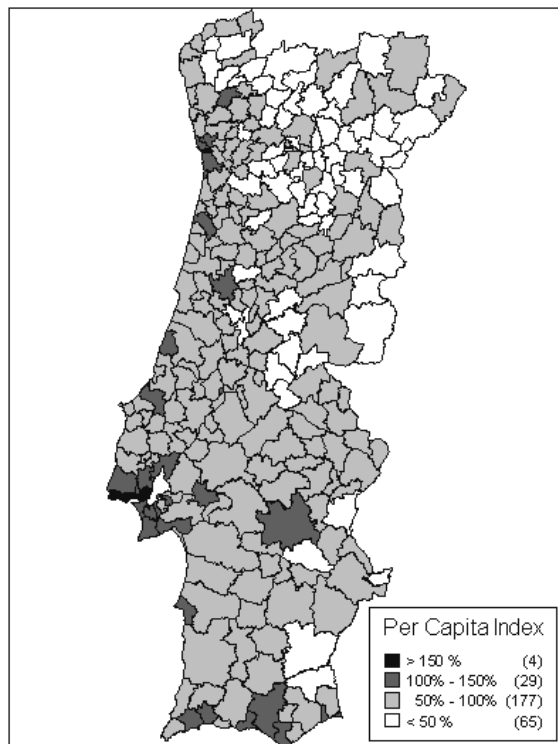


Figure 4 – Purchasing Power in 2002

From the figures above presented, it is apparent that, during the period 1997-2002, the purchasing power in Portugal has become more equally distributed.⁵ Nevertheless this fact, it also true that, because basically the municipalities with the lowest levels of purchasing power – under 50% – improved their position whereas those with values between 50% and 100% remained basically the same, behind that equalization is hidden a clear and persistence disparity in the level of purchasing power. In order to shed some light on this evolution and how it may be related with the geographical localisation of purchasing power we then propose to use multidimensional scaling techniques.

Given a (geographical) map, it is obviously easy to calculate the (geographical) distance between the points located on the map. In simple terms, what multidimensional scaling does is the inverse operation, that is, it finds a map which (most) plausibly has generated those distances.⁶

Generally speaking, the first stage of multidimensional scaling consists on obtaining the dis/similarity data matrix, say being constituted by the elements d_{ij} , which is done by assuming some concept of distance (*e.g.* Euclidean) between the ‘objects’. Using this information on the dis/similarity, in a second stage a solution is obtained consisting of a configuration, that is on the localisation of the ‘objects’ on a space of a small number of dimensions (usually two or, at most, three) where the distances between the points on that space, \hat{d}_{ij} , approximate, as most as possible, the dissimilarities between the data points.⁷

By doing so, when the structure underlying the data generation process is complex, multidimensional scaling thus provides a useful graphical representation of the data as, for instance, it may allow to visualise, on the one hand, how distant/dissimilar are the ‘objects’ and, on the other hand, which are the ‘objects’ that, despite being relatively far away in

⁵ A certain caution should be used as, in fact, the values of the index of a certain year cannot be compared with those concerning another year. See Instituto Nacional de Estatística (2002b). Still, as all values are made relative to the average level, which is normalised at 100%, one can indeed conclude on that direction.

⁶ Some applications of multidimensional scaling have been made in the field of social sciences, namely social psychology, voting behaviour or marketing. A recent and quite interesting application to the study of academic dishonesty is given in Pincus and Schmelkin (2003). See also Cox and Cox (1994).

⁷ As a measure of the imperfection of the approximation it is traditional to consider the so-called ‘stress’ statistic

given by $\sqrt{\frac{\sum (d_{ij} - \hat{d}_{ij})^2}{\sum \hat{d}_{ij}^2}}$ where the estimated distances \hat{d}_{ij} are obtained by an optimization algorithm.

accordance to some concept of distance (*e.g.* geographical), are indeed closer/similar to others.

Given the nature of the data on purchasing power, the distance as measured in Euclidean terms, seems to be inappropriate. To illustrate the problem let us consider, for instance, four municipalities, A, B, C and D, such that the purchasing power indexes are 60, 80, 100 and 120. In mere Euclidean terms, the municipalities A and B are as distant as municipalities B and D are. Plainly, the absolute distance, *i.e.* 20, means much more for municipalities A and B than for municipalities C and D. Hence we propose another measure of distance which indeed eliminates this problem. The distance between municipalities i and j , as measured by the indexes p_i and p_j , is given by the following expression:

$$d_{ij} = \frac{1}{2} \left(\frac{|p_i - p_j|}{p_i} + \frac{|p_j - p_i|}{p_j} \right), \quad (2.1)$$

in a single index case or, in case of n indexes:

$$d_{ij} = \frac{1}{2n} \sum_{t=1}^n \left(\frac{|p_{i,t} - p_{j,t}|}{p_{i,t}} + \frac{|p_{j,t} - p_{i,t}|}{p_{j,t}} \right). \quad (2.2)$$

3. How distant are the Portuguese regions? Analysis of the results

The multidimensional scaling results were obtained as follows: in the first place, a distance matrix was calculated for each of the four years, using expression (2.1); in the second place, this distance matrix was considered as an input for a multidimensional scaling MATLAB routine.⁸ The following figures plot the results.

⁸ The MATLAB routine was written by Mark Steyvers, 1999.

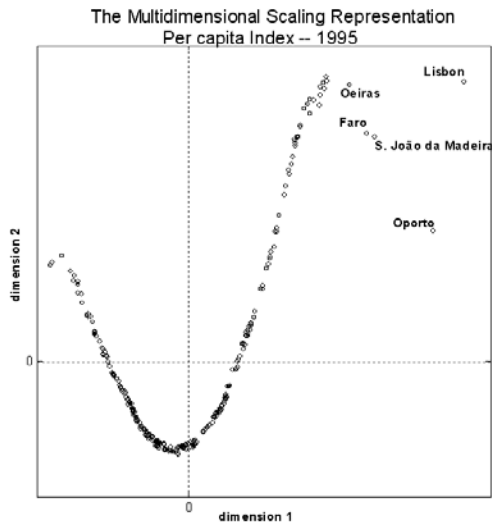


Figure 5 – The MDS configuration for 1995

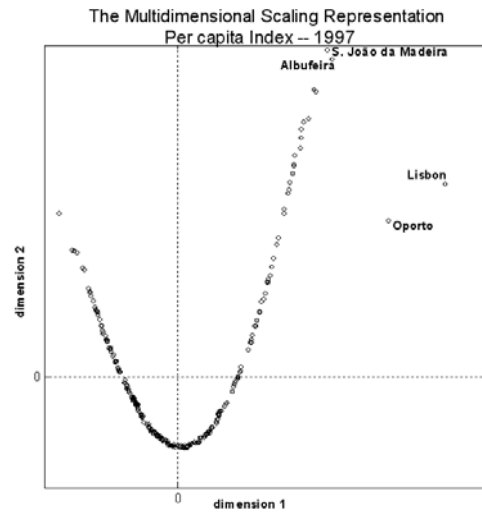


Figure 6 – The MDS configuration for 1997

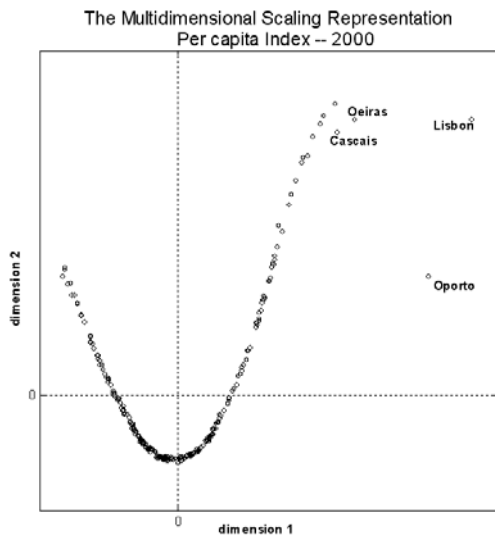


Figure 7 – The MDS configuration for 2000

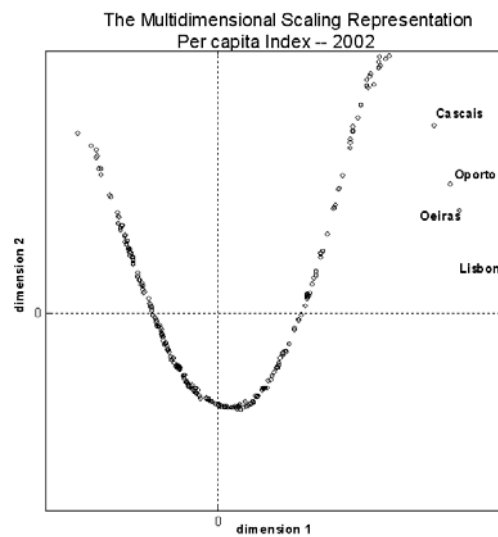


Figure 8 – The MDS configuration for 2002

The very first comment on the figures gives respect to the apparent similarity of the multidimensional representations. In fact, a *u*-type of curve characterises all the years, being clearly evident that some (very few, indeed) municipalities are located in a position that escapes the pattern. This is certainly the case with Lisbon and Oporto but, in some years, some municipalities of Algarve and some others physically close to Lisbon and Oporto appear in positions obviously separated from the rest of the others.

In the second place, one has to note the close connection between dimension 1 and the level of purchasing power. The correlation between these two variables is as high as about 94%

and, in 2002, is even higher, 97%; see Appendix 1. This result is clearly important to understand what the figures are showing us. It means that municipalities that are located in the first and fourth quadrants are, on average, similar from the point of view of purchasing power whereas the same happens with municipalities located in the second and third quadrants. Moreover, this also would mean that within the two groups what would distinguish the localisation should be the latitude, in case of being true that the North-South dichotomy is preponderant or the longitude, in case of being true that the Interior-Littoral dichotomy is, indeed, preponderant. As is clear from the correlation matrix in appendix 1, that is not indeed the reason explaining the values behind dimension 2.

This being said, in order to shed some light on the issue, let us consider the following figures, which plot the localisation of municipalities (by the 4 quadrants) in space.

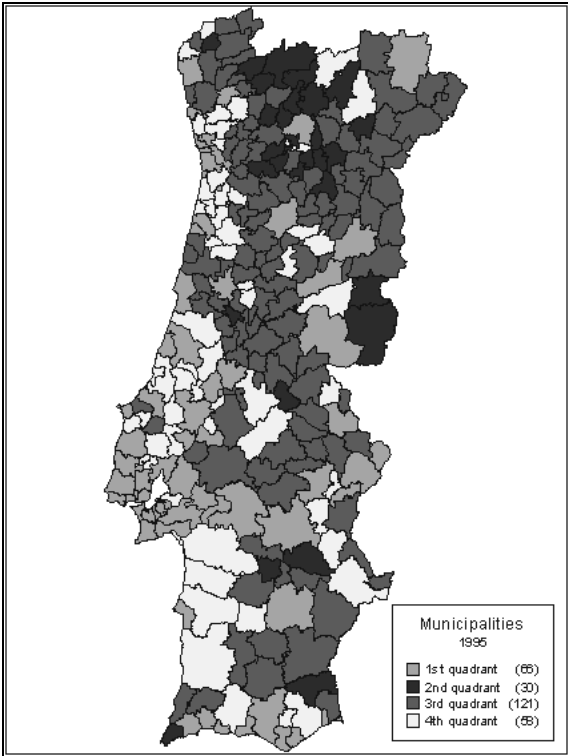


Figure 9 – The localisation for 1995

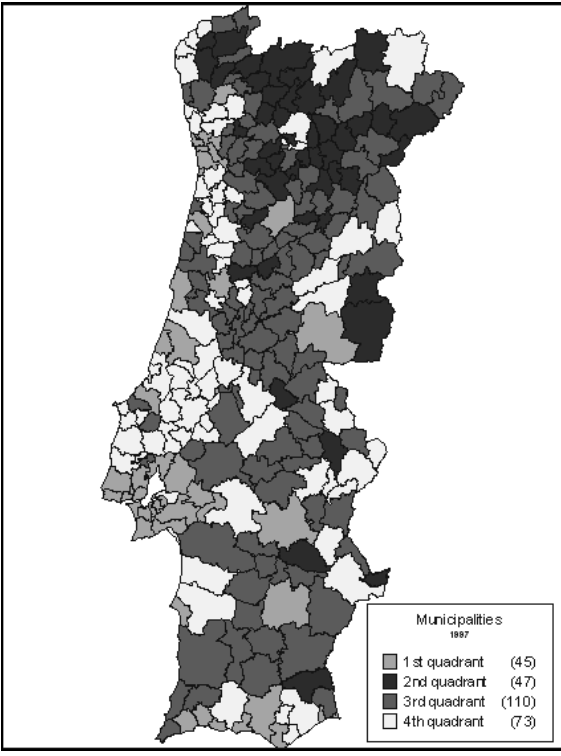


Figure 10 – The localisation for 1997

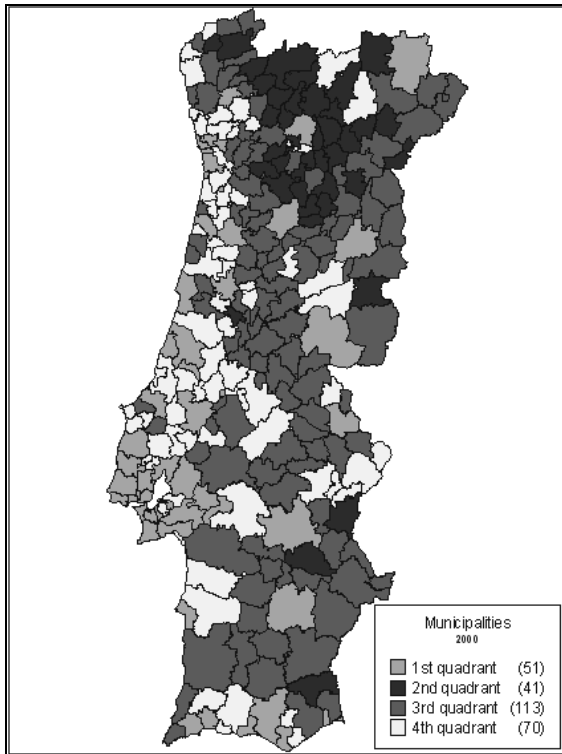


Figure 11 – The localisation for 2000

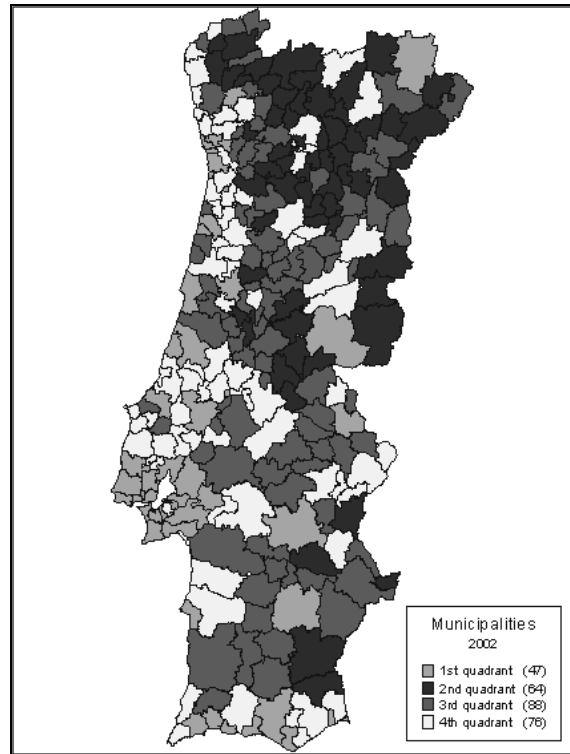


Figure 12 – The localisation for 2002

The general lesson is that there are central places (quite evident in the case of Lisbon and Oporto) that, in general, coincide with the capitals of districts that, in fact, are characterised by a higher level of purchasing power and that tend to be surrounded by municipalities less privileged. This is in clear agreement with the fact that the population of the interior is concentrated in medium-size cities where the standard of living is fairly high. See Ministério da Economia (2003). This, nevertheless, does not completely shadows the fact that, in general, the municipalities located in the littoral are characterised by higher levels of purchasing power. Despite being true that the dichotomy “regions under pressure” *versus* “sleepy regions” is much more evident than the dichotomy “littoral” *versus* “interior”, as pointed out by, for instance, Ferrão (2003), it is also true that the major part of the “sleepy” part of the country is located in the interior of the country, in particular in the north and center of Portugal.⁹

Plainly, we have been so far analysing the information for each year as an isolated ‘picture’ of the country. The inter-temporal comparison of the results led us to conclusions that we would

⁹ The distinction between the ‘sleepy’ and ‘under pressure’ regions must not ignore the crucial role of urban ‘craters’. Again see Ferrão (2003).

like to put in contrast with the ones obtained when considering the evolution that took place between 1995 and 2002, in what concerns purchasing power. It turns out that multidimensional scaling may indeed combine all the information provided by the four years under analysis, thus giving a unique ‘picture’ of all the period under analysis. This can be done by the use of an ‘aggregate’ distance level such as provided by expression (2.2).

Following the same procedure as above described, the use of (2.2) produced the following multidimensional scaling map.

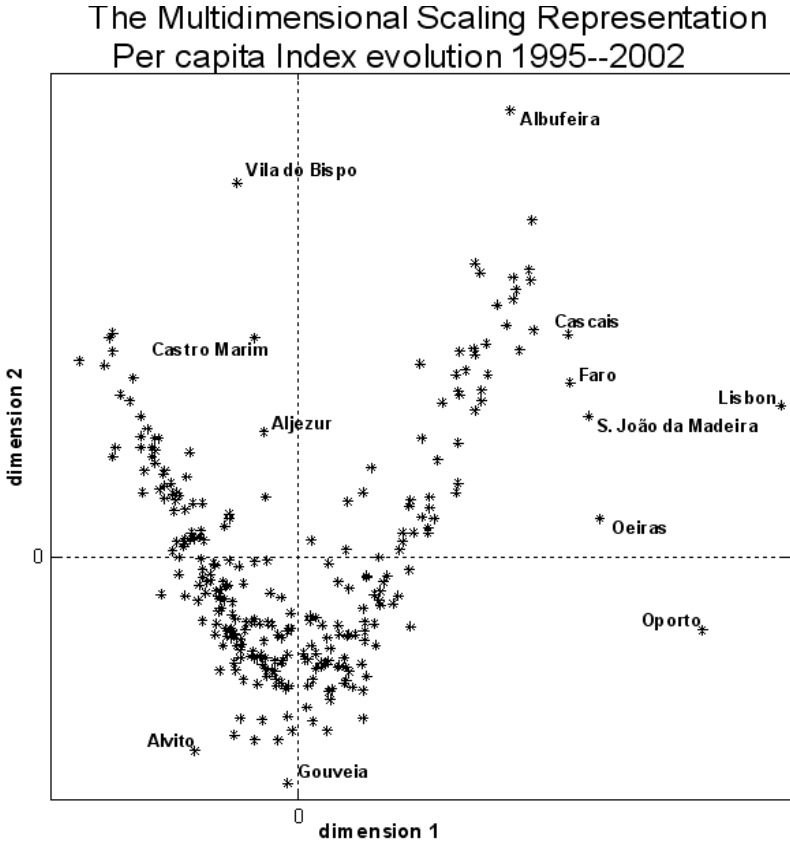


Figure 13 – The MDS configuration for 1995-2002

Clearly, the ‘agglomeration’ of the four *u*-type multidimensional scaling configurations into a single one did not result in a significantly different pattern on the configuration, which may indicate that, despite the inevitable ‘de-localisation’ of certain municipalities in what concerns purchasing power, the map presents the same kind of pattern. Obviously, the ‘variability’ around the *u*-shape is considerably higher than for each year separately. See figures 5, 6, 7 and 8. This variability immediately confirms that some municipalities geographically close to

Lisbon and Oporto are indeed closer in terms of purchasing power, namely Cascais and Oeiras in relation to Lisbon and S. João da Madeira in relation to Oporto. From figure 13 it also comes as evident the privileged position of some municipalities located in the Algarve such as Faro and Albufeira but, interesting enough, it also puts in evidence that other municipalities of the Algarve are far from being closer to those two, such as Aljezur, Castro Marim and Vila do Bispo. Finally, two (among possibly) other municipalities located in the interior of the country, Alvito and Gouveia, quite far in geographical terms, are indeed close in terms of their quite low levels of purchasing power.

4. Conclusion and Directions for Further Investigation

This application of multidimensional scaling showed that, despite the average geographical distance between Portuguese municipalities being low, the same does not happen with the economic distance as measured by the (per capita) purchasing power index. Despite the apparent approximation of municipalities, Portugal is still characterised by considerably high regional disparities.¹⁰ Purchasing power is concentrated mainly around major cities such as Lisbon, Oporto and Faro, all located in the littoral but some medium-sized cities located in the interior still (?) function as attraction points because of their standards of living.

The policy implications of the situation as described above should be evident. A recent report asked for the Portuguese government indicates that those municipalities belonging to the 'less-favoured' Portugal, that is, those with a (per capita) purchasing power index smaller than 75% of the average level must be positively discriminated by the use of fiscal, financial and social incentives. See Ministério da Economia (2003). A crucial objective of the regional policy should indeed be to invert the vicious tendency to purchasing power concentration.

A final word goes to what may be considered promising avenues for further research. Being true that the data used in this study already reflects many aspects of economic activity, we consider that the use of additional information, namely on the distribution of wealth among families, may enrich the results. Another possible improvement is to consider other possible

¹⁰ At the fiscal level, that is when analysing the geographical provenience of taxes receipts, it is indeed clear that the littoral 'generates' more wealth than the interior. This fact, nevertheless, reflects the localisation of firms' headquarters, which is mainly concentrated in cities located in the littoral such as Lisbon and Oporto. See Domingos (1999).

measures of distance. For the reasons above explained, the ‘Euclidean’ distance was not considered and, instead, a modified concept of distance as given by expression (2.2) was used. This was, clearly, one possibility among others. The use of other measures of distance is to be considered in further studies.

5. References

Costa, José Silva (ed.) (2002), **Compêndio de Economia Regional**, Coleção APDR, Coimbra.

Cox, T.F., and M.A.A. Cox (1994), **Multidimensional Scaling**, Chapman & Hall, London.

Domingos, Estela (1999), “Dinâmica de Desenvolvimento Espacial – Uma abordagem através da distribuição regional de receitas fiscais”, **5**, *Prospectiva e Planeamento*, Departamento de Prospectiva e Planeamento, Ministério do Planeamento, 29-47.

Ferrão, João (2003), “Dinâmicas Territoriais e Estratégias de Desenvolvimento, Portugal 1991-2001”, *Revista de Estudos Demográficos*, **34**, Instituto Nacional de Estatística.

Instituto Nacional de Estatística (2002a), “O País em Números”.

Instituto Nacional de Estatística (2002b), “Estudo sobre o Poder de Compra Concelhio”.

Ministério da Economia (2003), “Relatório – Programa de Recuperação de Áreas e Sectores Deprimidos”.

Pincus, Holly, and Liora Schmelkin (2003), “Faculty Perceptions of Academic Dishonesty: A Multidimensional Scaling Analysis”, *The Journal of Higher Education*, March/April, **74**, **2**, 196-209.

Appendix 1 -- The Correlation Matrix

	PP 1995	PP 1997	PP 2000	PP 2002	Dim.1 1995	Dim.2 1995	Dim.1 1997	Dim.2 1997	Dim.1 2000	Dim.2 2000	Dim.1 2002	Dim.2 2002	longitude	latitude
PP 1995	1.000													
PP 1997	0.971	1.000												
PP 2000	0.968	0.967	1.000											
PP 2002	0.944	0.954	0.942	1.000										
Dim. 1 1995	0.932	0.896	0.882	0.922	1.000									
Dim. 2 1995	0.699	0.698	0.650	0.736	0.595	1.000								
Dim. 1 1997	0.921	0.940	0.901	0.951	0.967	0.631	1.000							
Dim. 2 1997	0.530	0.567	0.510	0.559	0.359	0.864	0.407	1.000						
Dim. 1 2000	0.919	0.915	0.939	0.944	0.954	0.595	0.964	0.380	1.000					
Dim. 2 2000	0.603	0.615	0.603	0.626	0.442	0.882	0.479	0.919	0.471	1.000				
Dim. 1 2002	0.893	0.899	0.881	0.971	0.947	0.650	0.969	0.413	0.956	0.490	1.000			
Dim. 2 2002	0.371	0.387	0.335	0.384	0.212	0.793	0.246	0.906	0.213	0.864	0.236	1.000		
longitude	-0.407	-0.433	-0.439	-0.495	-0.452	-0.277	-0.488	-0.156	-0.500	-0.200	-0.524	-0.038	1.000	
latitude	-0.276	-0.305	-0.239	-0.331	-0.325	-0.219	-0.361	-0.087	-0.305	-0.039	-0.364	-0.004	0.195	1.000