

Analysis of peripheral industrial areas via multidimensional scaling: the EU case

Paolo Chirico

chirico@econ.unito.it

Dip. "Diego de Castro", Università degli studi di Torino

Anna Lo Presti

lopresti@econ.unito.it

Riassunto. Nel presente lavoro viene proposta la tecnica del multidimensional scaling non metrico come strumento per evidenziare aree industriali dell'Europa dell'est che per ragioni logistiche ed infrastrutturali sono particolarmente decentrate rispetto a quelle dell'Europa occidentale

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1. Introduction

After the end of socialistic systems, the countries of Eastern Europe began an economic integration with EU-countries. Importations and exportation have been progressive growing and in the last 12 years several EU-companies have started joint venture and factories in east Europe. In May 2004 Hungary, Czech and Slovak Republics, Baltic republics, Poland and Slovenia got the UE-partnership and in 2007 it will be expected by Romania and Bulgaria.

However there is a great structural obstacle to a more economic integration: the lack of adequate routes between the western industrial areas and the eastern ones. This problem makes very strong and slow some links.

In the present paper we propose the application of multidimensional scaling to show graphically the problem in order to point out the most problematic links.

1.1 Multidimensional Scaling.

Multidimensional scaling (MDS) is a set of data analysis techniques that display the structure of distance-like data as a geometrical picture. Torgerson proposed the first MDS method and coined the term. MDS pictures the structure of a set of objects from data that approximate the distances between pairs of the objects. The data, which are called similarities/dissimilarities, distances, or proximities, must reflect the amount of difference between pairs of the object.

Each object or event is represented by a point in a multidimensional space. The points are arranged in this space so that the distances between pairs of points have the strongest possible relation to the similarities among the pairs of objects. That is, two similar objects are represented by two points that are close together, and two dissimilar objects are represented by two points that are far apart. The space is usually a two- or three-dimensional Euclidean space, but may be non-Euclidean and may have more dimensions.

MDS is a generic term that includes many different specific types. These types can be classified according to whether the similarities data are qualitative (called nonmetric MDS) or quantitative (metric MDS). Actually nonmetric CMDS proposals extended the distance model to the Minkowski case and generalized the relation between similarities and distances. The data could be quantitative or qualitative at the ordinal level of measurement. In addition the data could be either complete or incomplete. Symmetric or asymmetric, and similarities or dissimilarities. The model formulation:

$$m(S) = D + E \tag{1)}$$

where $m(S)$ is read "a monotonic transformation of the ordered similarities S . If S is actually dissimilarities then $m(S)$ preserves order, whereas if S is similarities, it reverses order. If the data are quantitative $m(S)$ is a linear transformation. Thus, for nonmetric CMDS, we need to solve for the monotonic (order-preserving) transformation $m(S)$ and the coordinates \mathbf{x} , which together minimize the sum of squares of the errors E (after normalization of \mathbf{x}). This exact problem is solved by several programs¹ while others like ALSCAL solve it indirectly.

In this paper we concern on a particular case of nonmetric CMDS, where:

- a) the matrix of dissimilarities is rectangular;
- b) the data are at the interval level of measurement.

We used the ALSCAL program because is very flexible (it permit data in rectangular matrix form) and is included in the principal statistics packages like SAS and SPSS. We remember that ALSCAL² is a ALSOS method and consist of a iterative procedure that alternate the estimation of the monotonic transformation m and the estimation of the coordinates \mathbf{x} . The coordinates are estimated one at a time, then it need to fix the number of dimension.

The estimation method is based on the minimization (at every step) of the S-STRESS:

$$S-STRESS = \sqrt{\frac{\sum_{i,j>i} [m(s_{ij})^2 - d_{ij}^2]^2}{\sum_{i,j>i} d_{ij}^4}} \tag{2)}$$

The final S-STRESS give a evaluation of the geometrical picture:

S-STRESS	<5%	5%< <10%	10%< <20%	>20%
Evaluation	excelent	good	medium	bad

2. The transports network between Western and Eastern Europe.

To define the data referred to the transport net linking eastern and western Europe, we have taken into account the routes in existence between the main industrial and commercial centres and districts interested in trade exchanges. The distances are been analysed in term of travelling times vs. straight line distances. The routes taken into account are the ones linking most speedily the industrial areas of France, Italy, Germany and Netherlands with the 14 main eastern districts. More precisely we have take into account the routes linking Lyon, Milan, Essen, Munich, Rotterdam ad Berlin respectively with Warsaw, Prague, Bratislava, Riga, Minsk, Kiev, Budapest, Bucharest, Sofia, Istanbul, Chisinau, Ljubljana, Zagreb, Belgrade.

¹ MINISSA, KYST, and SMACOF

² by Takane-Young-de Leeuw

To determine the travelling length we have reckoned³ the time taken by a heavy vehicle, travelling at the appropriate speed according to type of roads, to cover the shortest way. So we have obtained the rectangular matrix:

Table 1: *Time distances matrix*

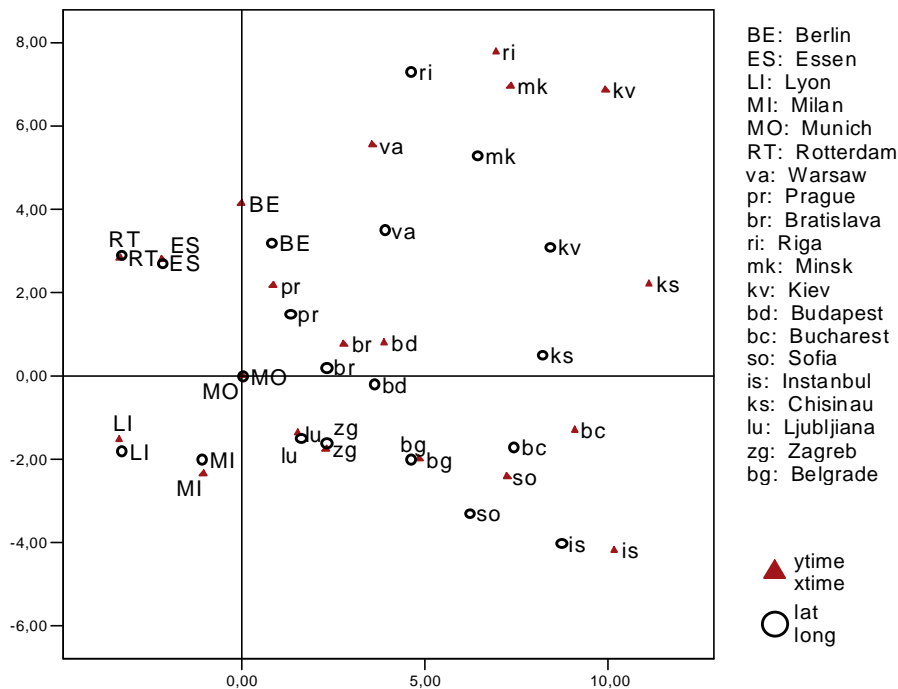
city	Warsaw	Prague	Bratislava	Riga	Minsk	Kiev	Budapest	Bucharest	Sofia	Istanbul	Chisinau	Ljubljana	Zagreb	Belgrade
Berlin	9,0	5,0	8,5	15,0	16,0	21,0	10,5	21,5	20,0	26,5	22,0	11,0	12,5	15,5
Essen	13,5	8,5	11,5	20,5	20,5	25,5	13,0	24,0	21,5	28,0	27,0	11,5	12,5	17,0
Lyon	19,5	12,0	14,5	28,0	27,0	31,0	16,0	24,5	21,0	27,5	30,0	10,5	12,0	16,5
Milan	18,0	10,0	10,5	26,0	25,0	28,5	12,0	20,0	16,5	23,0	26,0	5,5	7,5	12,0
Munich	13,0	5,0	6,0	21,0	20,5	24,5	7,5	19,0	15,5	22,0	21,5	5,0	7,0	11,0
Rotterdam	15,5	10,5	13,5	22,5	23,0	27,5	15,0	26,0	23,5	30,0	29,0	13,5	15,0	19,0

3. Results and Comments.

The data have been elaborated by ASCAL in SPSS and the output consists on the coordinates, in two dimensions, of the six western towns and the 14 eastern ones (all together are the logistic picture). The STRESS obtained is good (6,67%).

We have compared the logistic picture (triangles) with the geographical one (circles). To make it, at first we centred both pictures in a same point, Munich, and then we rotated and enlarged the logistic picture in order to let the logistic position of Essen coincide with geographical one⁴.

Figure 1: *The logistic and geographical pictures.*



³ by Microsoft Autoroute 2002©

⁴ We chose Essen for practical reasons: it permit a likely confront.

We can note that all western towns, except Berlin⁵, present quite coinciding positions. It means that in western Europe the time required to link the principal industrial areas is almost proportional to linear distances. The situation of eastern European towns is quite different.

In fact the logistic distances with western Europe are bigger than geographical distances, that is the time to link the eastern towns with western ones is proportionally bigger. In some cases it is very bigger like for Kiev, Chisinau, Minsk, Riga. Indeed their countries are the least rich in Europe.

Naturally an economic envelopment of these countries needs also an envelopment of transport ways.

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⁵ If STRESS>0, not every town can have exactly position.