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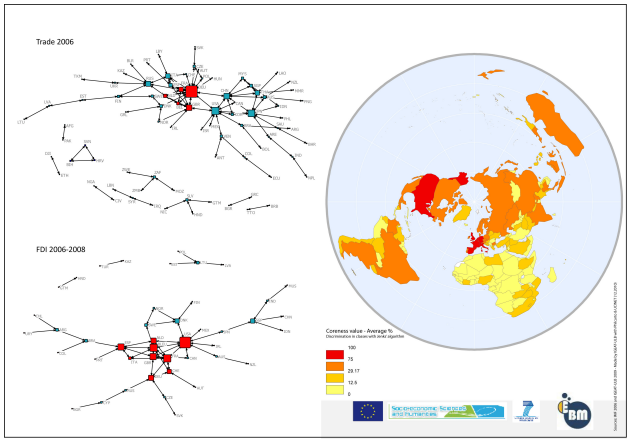
Work Package 5: Flows and Networks Synthesis

From deliverable 5.8

March 2011



Divisions of the world according to flows and networks

Gilles VAN HAMME (ULB-IGEAT, Belgium) and Claude GRASLAND (CNRS, UMR Géographie-cités) (coord.)

Edited by Laurent Beauguitte

Abstract: This EuroBroadMap working paper presents the synthesis obtained by the work package Flows and Networks. Starting from several matrices describing the international system at different periods and from different perspectives (economical, political, financial, etc.), the aim is firstly to produce a relevant partition on a world scale and, secondly, to search if an entity that could be named Europe appears. Results obtained with different methods (dominant flows, Intramax, structural equivalence, centre/periphery) are then compared.

Key-words: EuroBroadMap, Centre/periphery, dominant flows, Intramax, structural equivalence, world-system

Contributors: This working paper, coordinated by Gilles Van Hamme (work package 5 leader) and Claude Grasland (EuroBroadMap coordinator), and edited by Laurent Beauguitte, benefited of the inputs of the following persons: Geoffrey Pion (ULB-IGEAT, Belgium) Clarisse Didelon and Sophie de Ruffray (CNRS-UMR IDEES), Françoise Bahoken and Maude Sainteville (CNRS-UMR Géographie-cités), Diogo de Abreu and Nuno Marques da Costa (IGOT, Portugal)

Introduction

In the era of globalization, flows have dramatically increased across the world. Trade and FDI flows have reached unprecedented levels, beyond what had been achieved after the first wave of globalization before WWI (Chase-Dunn 1999). This new wave of globalization is also characterized by the growing importance of financial flows across the whole world, since the 80s. We cannot be sure migratory flows have reached higher levels than ever in the past but mobility has been increasingly complex and globalized. Hence, the literature points to different structural changes breaking up with the past: flows have become more global, connecting more intensively all parts of the world; flows have become more complex, notably in their spatial configuration; flows connect places and cities, not only countries.

In this report, we analyse global flows in different areas: economy, migrations, diplomacy, transportation, finance. Through different approaches, we aim at highlighting spatial structures in the complex world of flows and networks. We thus answer to fundamental questions such as:

- Can we still identify power relations in the world of flows?
- Can we find intermediate levels of organization between the state and the global?
- Can we identify a spatial configuration that can be associated to Europe as usually defined? If yes, what are the characteristics of this part of the world according to different approaches and themes?

Basically, we thus aim at fulfilling the objective C of defining a functional Europe through the production of a framework sketching the divisions of the world following the different types of flows and structures.

Several approaches relying on different theoretical frameworks are used to deal with the world of flows in order to answer these questions. Different methods are used resulting in different divisions of the world and different perspectives on how to position Europe in the world of flows. The first approach is based on the dominant flows method. State is the fundamental unit of power relations and the world can be divided between dominant and dominated states. The world-system approach shares this view of dominance and dependence by supposing the existence of asymmetric and unequal relations between core and peripheral states within a unique world-system. Finally, the third approach supposes the existing of intermediate levels of organization between the states and the world.

In this paper, we rely on the state level to analyse flows across the world. Since a large body of literature interrogates the relevance of states in the spatial organization of the world-system (Taylor 2000; Castells 1996), we stress that point here. In particular, the network/globalization paradigm

insists on the importance of cities connecting economic actors (transnational, economic elite, finance, etc.) all over the world. Another literature puts the emphasis on the regionalization process. Hence, the power of states is supposed to decrease in favour on infra-national and international levels of organization. We will not enter into this debate here and our analyses are not aimed at demonstrating the pertinence of states nowadays. We rather highlight the importance of states in structuring the world of flows, though it may have decreased, as well as the possibility to get statistics at world level and build complete matrices of flows at state level in different areas.

In the first part, we present the databases we use on the different areas. In the second part, we apply the different methodological and theoretical approaches to these databases in order to produce several divisions of the world. In the third part, we focus on answering the question about whether Europe is a relevant structure in different themes: trade, migrations, diplomatic relations. In the last part, we come back to the basic questions we have introduced and give elements of response in the light of the analyses developed in this report.

1 Data

We use here different databases in three major fields: economy, demography and policy. The main sources are mentioned in the table. In this part, we briefly describe the main databases used in the analysis of flows across the world. For each database, we present the following elements: Field, Type of flows, Statistical unit, Source, and Period.

Economic flows:

- Trade (products), Country, CHELEM & IMF, 1967-2007
- FDI, Country, UNCTAD, 1998-2002 & 2006-2008
- Financial flows (stock exchanges), City, stock exchanges, 2007

Political relations:

- Embassies, Country, Embassies websites, 2009

Demographic flows:

- Migrations by stock of migrants, OECD countries $\times$ all other countries, OECD, 1995 & 2005.

1.1 Economic flows

Trade flows

The CHELEM database developed by the CEPII provides a country *vs* country *vs* merchandises matrix for each year since 1967. Some countries are

grouped together in this database resulting in 80 blocks of countries before 1990 and 94 after the communist fall. For each block, we have the destination of these flows and their structure in term of merchandises up to 147 different products according to the CITI classification. We have chosen to work on 5 different periods since 1967 at regular intervals. At each time, we have taken into account the average between three years to avoid conjuncture effects (1967-69, 1977-79, 1987-89, 1994-96 and 2004-06). The three first periods are before the fall of USSR and we chose to analyse one period just and after this major change in the geopolitical situation (1987-89 and 1994-96). The period 2004-06 signs the most recent data available on the CHELEM database.

As the CHELEM database does not consider all countries, we also use the IMF database on trade. The IMF database is an annual country *vs* country matrix which starts from 1950 and includes nearly all countries (160 countries before 1990, 179 after). We analyse the IMF data on the same dates than the CHELEM database. However, before 1990, data for communist countries had to be completed using CHELEM database. IMF database has been completed in two steps for some missing communist countries before 1980. First, we do not have data for some communist countries but we do have statistics for the rest of the world, including their trade with the missing communist countries. It means that most of the missing links can be completed easily.

FDI flows

According to FDI, we have built a nearly complete matrix of flows between countries. This matrix is based on UNCTAD FDI flows, completed by OECD, as well as national sources. All the data from these three last sources have been homogenized by using the total amount of FDI of UNCTAD. All the FDI flows have been converted in million of US$ using the annual average rate of exchange between national currency and US$. This work has been realized on two periods of five (1998-2002) and three years (2006-08) in order to avoid both conjuncture effects and incompleteness. The flow between two countries is the average per year of all the flows during the entire considered period. The result is two rectangular matrices (150 countries *vs* 100 countries in 1998-2002, 180 *vs* 80 in 2006-08) of FDI flows for both periods. The matrices are not square because data are often more complete on outward flows than inward flows. Concerning inward flows, the information is limited to 100 countries in 1998-2002 and 80 in 2006-08 while for nearly all countries we have information about outward flows. Even if only 15% of all possible links are filled in our matrix, the flows content in the matrices are equal to about 98% of all the FDI flows in 1998-2002 and 90 per cent in 2006-08. Of course, some areas such as Africa or Middle East are subject to more uncertainty in terms of origin or destination of flows but they represent very

limited parts of world FDI.

Also, we have collected some data about the structure of FDI inwards by sector of activity. This matrix has been built with data from the same institutes than the previous one: UNCTAD, OECD and national sources. Only three sectors have finally been taken into account (primary, secondary and tertiary) considering the lack of more precise data for most of the countries. This database contains the distribution per sector for about 100 countries for both periods: 1998-2002 and 2006-08. As for the origin/destination, sectoral data are the most incomplete for Africa and Middle East.

Financial flows

The financial dataset is a matrix of cross-listing flows giving the number of companies from a country i that are listed on a financial market to a country j. As far as the origin of the firm is concerned, the operational address has been chosen, which enables to get round the tax havens bias and the dummy legal addresses located in Bermuda, British Virgin Island, and so on. The data have been collected from the official listings of 123 stock markets, and more precisely from the cash markets of shares and related products. The data-gathering occurred in late 2007.

1.2 Political flows: Embassies and consulates

The consulates matrix is a directed square matrix 206×206 spatial units (mainly states plus entities like Greenland, Cook Islands or Netherlands Antilles) which includes all embassies and consulates sent by a country i to a country j. Information was gathered in 2009 in the framework of the Euro-BroadMap project. The full dataset also provides the presence of embassies and accreditations.

1.3 Migratory flows

Migratory flows are based on the OECD database on the stock of migrants according to their nationalities or their place of birth, depending on the countries. It gathers the migrants from all countries in the OECD countries in 1995 and 2005. In some cases, data have been completed by national sources.

2 Approaches to divisions of the world according to flows

We propose three approaches highlighting spatial structures in the world of flows. The first one is the dominant flows method. The second is based on the core/periphery theoretical framework, and the third is based on the idea

of the regionalization of the world. This third approach uses two different methods of regional classification.

For each approach, we present the theoretical background, the method[1] and the most relevant results. We end with a short conclusion. Only the most recent data are analysed here, which means that the evolutions are generally not included in this report, while they may be part of specific working papers within the Eurobroadmap project.

2.1 Revisiting dominant flows

This part is mainly due to L. Beauguitte, C. Grasland and M. Sainteville

The delimitation of nodal regions by the method of dominant flows was proposed for the first time by Nyusten and Dacey in 1968 but developed and popularized by Taaffe and Gauthier in their reference book, *Geography of Transportation* (1973). Many variations and improvement of the initial method has been proposed since this pioneer work, but it remains actually widely used because of the great simplicity of the solution and the general efficiency of the results obtained.

This method was initially applied to bilateral information flows between cities and it is not necessary obvious to transpose directly this method to asymmetric flows between countries. Firstly, the asymmetry of flows implies that the relation of domination is not necessary the same for in-flows and out-flows. Secondly, states are areal units and not punctual object as cities, which mean that the notion of polarization is considered here as more political than geographical.

The first part discusses the theoretical concepts that are involved in the original method and possible variations in both conceptual and methodological terms. Then the method and its variants are tested on several empirical matrices (financial and diplomatic flows). Finally, we highlight the interest and limits of this method.

2.1.1 Method

In the original formulation proposed by Nyusten and Dacey (1961), a spatial unit i is dominated by as spatial unit j if and only if two conditions are fulfilled: (a) the maximum flow send by i is directed toward j and (b) the total sum of in-flows from j is greater than the total sum of in-flows from i.

In other words:

$$(a) \quad Max_k(F_{ik}) = F_{ij}$$

[1]Methodological questions are developed in the G. Van Hamme and C. Grasland (coord.), 2011, *Statistical toolbox*, EuroBroadMap working paper, http://halshs.archives-ouvertes.fr/EUROBROADMAP/fr/.

Table 1: Symmetrise a matrix

Several options are available to symmetrise a matrix; some of the most frequently used being the minimum, the maximum or the mean. If we consider a square matrix country * country, you can calculate four probabilities: • O_{ij}: probability for i to have destination j • O_{ji}: probability for j to have destination i • D_{ij}: probability for i to have origin j • D_{ji}: probability for j to have origin i A relevant way to avoid disturbance due to exceptional and asymmetrical flows is to take the geometric mean of these four probabilities.

$$(b) \quad \sum F_{ki} < \sum F_{kj}$$

The result of the analysis is the building of directed tree (graph without any cycle or isolates where the number of links is equal to the number of nodes minus 1) that produces a strict hierarchy of countries. But two problems appear: many matrices are directed ($F_{ij} \neq F_{ji}$), and two different options can be chosen to divide the tree. Regarding the matrices' asymmetry, we chose to take into account the geographical mean of four indicators (see box 1).

Regarding the partition of the tree produced, two options exist: consider that the head of the tree is dominating all its leaves; adopt a bottom-up logic: each node receiving a flow dominates the sender, but this domination can be only a local one. Rules regarding number of in-coming flows must be decided: the partition proposed below considers that a state is locally dominant if it receives at least two flows. In both cases, the method provides a relevant tool for regionalization.

Very few studies applied the method of Nyusten and Dacey to flows between areal units like regions, because in this case the results was likely to be strongly influenced by the choice of territorial division (Madelin *et al.* 2009). The application of the method of dominant flows to the exchange between world countries is therefore not a problem if we consider that states are not arbitrary territorial units. As long as states can be considered as autonomous political actors, it seems relevant to apply dominant flows methods in order to reveal a political hierarchy based on flows.

Many authors has proposed variant of the initial method, in particular

concerning the rule (a) that is related to the choice of the first flow as criteria of domination. Basically, we can point two families of criticism that introduce different variants.

They are many situations where the difference of intensity between the first flow and the following ones is very narrow, that introduce the risk of bifurcation in the structure of the graph for minor changes that are not statistically significant. One option is to replace the rule based on rank by another rule based on a percentage of out-flows. For example, we can decide that a country is dominated if the percentage of out-flows is equal to a minimum value of x percentage. The domination graph will become a directed graph but not a tree because one country can be dominated by more than one. What is crucial, in all cases, is to introduce an objective method that can be reproduced at different period of time and/or for different types of products. It is rather the comparison of results that does matter, and not the research of an "ideal" solution.

2.2 Results

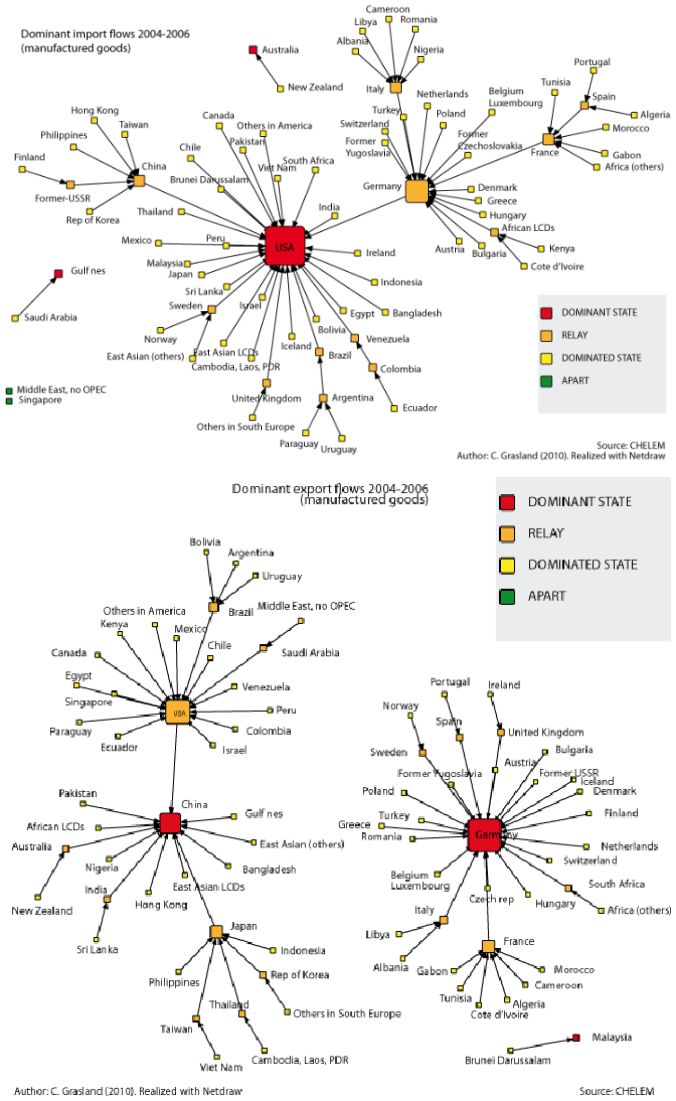
Regarding trade, we can produce two different graphs of domination according to the direction of flows.

Figure 1 (top) is related to the domination of export countries by import countries and reveals the power of the client that can decide to restrict its import by means of different tools (protection of internal market, external tariff, rules and norms, etc.). Figure 1 (down) is related to the domination of import countries by export countries and reveals the power of the supplier that can decide to restrict its export, for example in the case of high level technological products able to produce weapons. A good example of this difference is provided by Gabon. In terms of export, this country is dominated by USA because the majority of exports are based on oil that is bought by American companies. But in terms of import, the dominant country for Gabon is France that has inherited from the colonial period a strong position in the provision of manufacturing goods. The same situation appears for Southern Korea that is dominated by Japan for import but by China for export, revealing a particular position in the division of work and value chain in Eastern Asia.

On the figure 2, the dominant flows method has also been applied to the matrix of cross-listings in the framework of the global financial integration of the stock-exchange industry. Firstly, the choice of the original method seems relevant as far as it highlights the preferred choice of corporate issuers to get their shares listed on foreign markets.

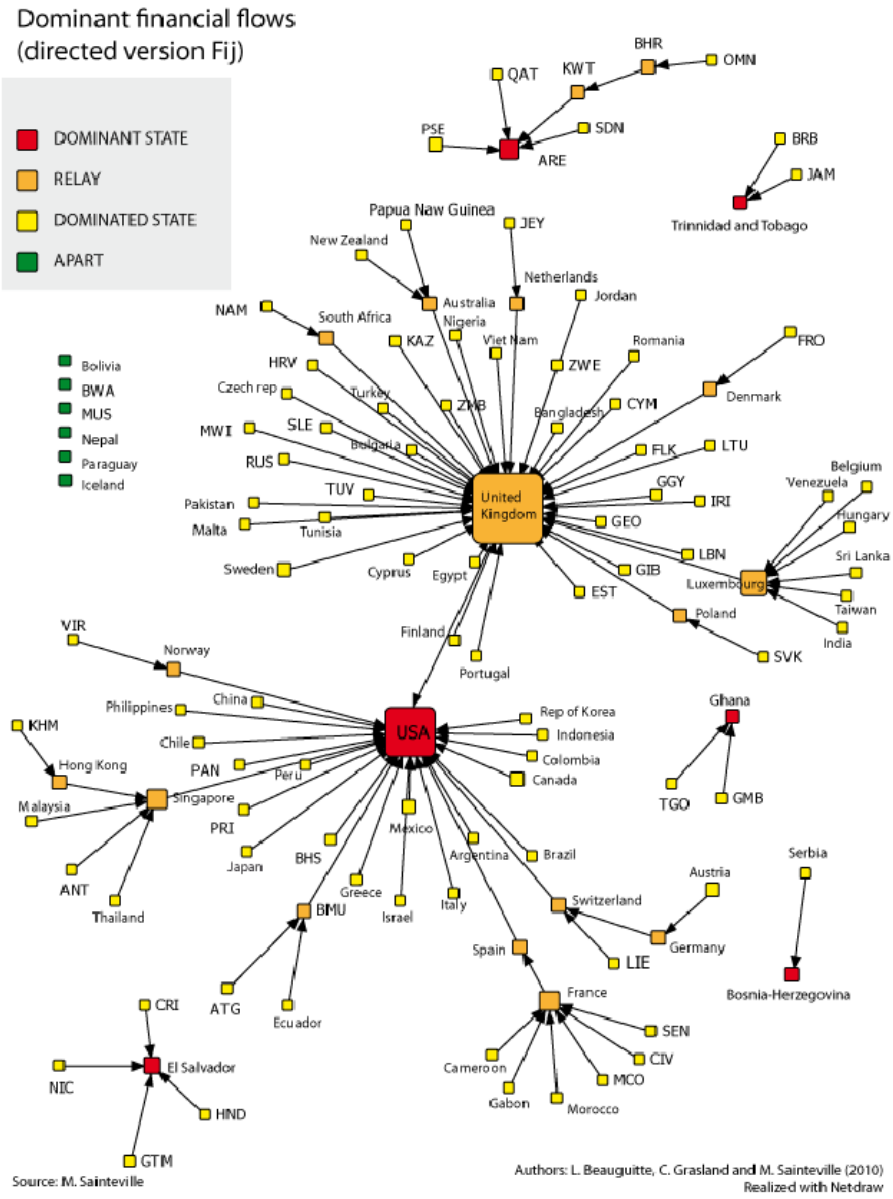
Nevertheless, the testing did not provide a perfect tree: the thirteen countries of issuers that send very few cross-listings to foreign markets often present ex-aequo dominant outflows. For instance, amongst the two Nigerian issuers that list their shares abroad, one lists its shares on South African

Figure 1: Export *vs* Import dominant flows on manufacturing goods (2004-06)



The World-System in 2004-06 gets one major consumer, the USA. Considering dominant export flows, two big world regions appear, one dominated by Germany and the second one by China. Japan has been overcome by China as dominant supplier in Easter Asia, Middle East and part of Africa. Size of nodes is related to its in-degree. Respective positions of connected sub-graphs are irrelevant.

Figure 2: Dominant directed financial flows



market (Johannesburg Stock Exchange), while the other one prefers the International market of the London Stock Exchange. To get round this bias and to get a clearer partition of the world, we decided to keep only the link sent to the country of destination gathering the highest in-degree volume of cross-listings.

As far as the results are concerned, the figure 2 points out different groups, related to six dominant states. The most important core (in-degree expressed in volume: red countries on the graph) is the USA, despite the fact that the listing place of London collects more links (in-degree expressed in links). According to this method, The UK takes then the role of a relay core. Three other relays of the USA appear: Singapore, Switzerland and Spain. Those mainly collect listings in their regional area. Singapore market quotes shares of Malaysian or Thai issuers.

As far as the other dominant states are concerned, the regional partition of the world remains conclusive, especially for El Salvador the stock market of which attracts cross-listings shares of Guatemalan, Honduran or Costa Rican firms. Similarly, the United Arabian Emirates markets list many shares of the Gulf states issuers, especially equities that are relevant to the Islamic finance.

The matrix has also been applied to the bilateral variation of the dominant flows method which includes probability indicators. On the whole, we can observe very few changes related to the fact that the probability indicators widen the financial context of relationships: Luxembourg becomes a dominant state; an inversion occurs: France becomes a relay for the USA, surpassing Spain in the hierarchy of the graph; and lastly, the regionalization process is reinforced in Southern Africa.

Conclusion

If the purpose is to propose a world partition, starting from a weighted matrix of flows, the dominant flows method appears as a performing tool. Depending on the topic examined, it seems of great interest to conduct complementary analysis on directed and on bilateral matrices. Its main limit remains in its principle itself: keeping all first flow for all spatial units, despite their discrepancy, could eventually involves non-understandable results. Variations regarding the first rule (keep all first flows greater than x%) are susceptible to provide interesting results but in this case, several methods could be appropriated. Firstly, the threshold choice can prevent to get robust results, and the risk appears to choose the threshold not for valuable reasons, but because it gives the image we had in mind before conducting the analysis.

3 Core Periphery approach

This part is due to Geoffrey Pion and Gilles Van Hamme

The world-system perspective originates in the great French Historian Fernand Braudel (1979, 1985). Its central concept is the economy-world (*économie-monde*), which can be defined as a large autarcic economic ensemble with a strong spatial division of labour with a dominating core and a weak periphery. The domination of the core toward the periphery in Europe first relies on cities (up to the XVIIIth century) but, with the spatial expansion of the capitalist world, the domination needs to rely more and more on states. Following Braudel's concept, Wallerstein (1980, 2002) focuses his analyses on the way Europe has built a worldwide economy-world (a world-system) to the interests of its ruling classes since the XVIth century. From the XIXth century onwards, the global world-system integrates nearly all parts of the world and is characterized by a strong division of labour between core, semi-periphery and peripheries.

Core and periphery at the world scale supposes the existence of asymmetric and unequal relations within a unique world-system. Hence, core and periphery are not defined by their level of development but by unbalanced relationships which explain unequal development and its persistence over the time. The nature of these core/periphery relations may have changed over the times but are still characterized by their imbalances. Indeed, the core has imposed successive economic specializations to the periphery in function of the needs of its own accumulation. One important point here is that the modern sector in the periphery often fails to have positive feedbacks toward the rest of the economy because it is integrated with the core economies rather than with the local economy, but also because most of the profits go back to the core impeding a local accumulation of capital. These sectors are like oasis disconnected from their local economic environment - except for their needs in cheap labour (Albertini 1981).

The question we raise here is whether a world of flows can still be apprehended through the world-system perspective and its basic divisions of the world space. In this perspective, the theoretical approach we adopted here is still relevant as long as unequal relations between parts of the world persist on the two following aspects:

1. An international division of labour which assigns technological segments of production and commanding function to the core areas while peripheries rely on raw materials and/or low technological segments of production based on their cheap labour force. The accumulation of capital occurs in the core from which originates most of capital investments in the world;

2. The contrast between the strong level of integration of core economies

and the disarticulation of peripheral economies in both their internal (the integration of economic sectors) and external structures (the integration with neighbour economies in particular). The centre(s) constitute integrated economies - whose trade is mainly with the centre - while peripheries mainly trade with the centre. This is related to the duality of the peripheral economies, with a modern segment which is integrated in the world economy and pre-capitalist segments which are not (Vandermotten and Marissal 2004).

Considering this, we will focus our empirical analyses trade flows and foreign direct investment (FDI). By the trade relations, we can test the position in the division of labour in function of the products a country buys or sells. Trade data allows assessing the integration *vs* disarticulation by analysing the geography of trade. Through the investment flows, we are also able to test this integration *vs* disarticulation but also to assess the concentration of capital at the world level. This will result in a division of the world between core and peripheral countries according to the world system perspective.

3.1 Method

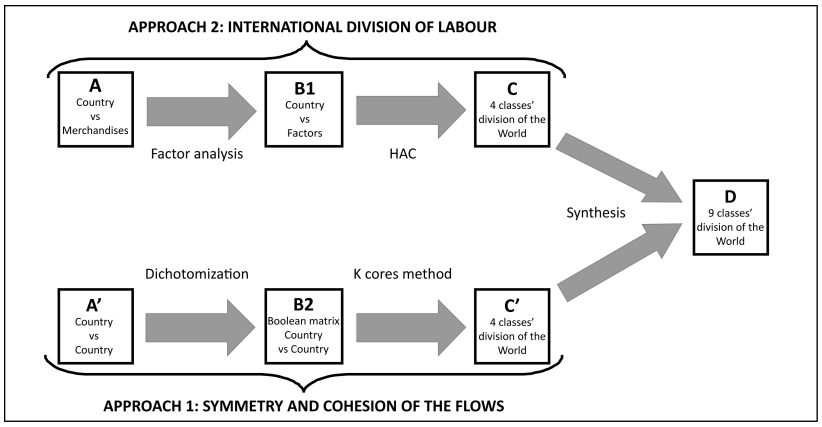
In the first section, the core/periphery division according to flows within the world-system can be defined in line with two basic assumptions: core areas are integrated while periphery mainly exchange with (specific) core countries; core areas control the capital and the technology. The question raised here is to find methods which allow highlighting those core/periphery divisions of the world according to flows.

We developed two approaches which enable us to divide the World according to these structural divisions within the world-system (Figure 3). The goal is to obtain a classification of countries (C) which separates the core countries from the other ones according to our basic assumptions.

In the first approach, we aim at dividing the world according to the opposition between integrated core *vs* disarticulated periphery. To achieve this objective, we have used graph methods which enable us to identify the integrated core, whose countries are well connected in the World system with relative symmetric relations with other countries. In contrast, peripheral countries are defined as having strong asymmetric relations with core countries and few linkages with other peripheral countries.

We start from a matrix of flows country *vs* country (A') that we dichotomize to obtain a Boolean (or binary) matrix (B2). Graph method like *K-cores* requires boolean matrix, in which 1 means the presence of a link and 0 its absence. It is important to find the suitable threshold above which the link between two countries will be considered to be effective. We propose a solution based on the geometric mean of four different probabilities of relations between two countries i and j (see table 1). Geometric mean is justified

Figure 3: The core periphery approach



to avoid the effect of exceptional values and to give an advantage to couple of countries with symmetrical values of interaction, that are more likely to reveal strong links. The geometric mean of the four probabilities creates a symmetric matrix of intensity of relation with value comprised between 0 and 100%. After different tests on threshold, the 5% one appears finally as an interesting compromise as it keeps the most important connections between the different parts of the global core, but it reveals also the different sub-part of this core and their associated periphery.

In the second step, we apply a graph method called *K-cores* to the Boolean matrix (B1) which precisely separates countries with strong internal relations (core countries) from the other ones (periphery) (C'). This method allows finding cohesive but not complete subgraphs[2] and provides a clear division between central and peripheral nodes (Wasserman and Faust 1994).

This first method will be applied on both matrices (trade and FDI) and will result in a division of the world between a well integrated and cohesive core and a periphery characterized by asymmetric relations with one or several core countries.

The second approach aims at dividing the countries of the World according to their position in the international division of labour. It intends to separate countries which produce high technological goods (core countries) from the other ones which mainly exchange primary products with high technology goods from the centre (peripheral countries). This approach can be tested with the trade matrix CHELEM which gives the information about nature of the merchandise flows between countries. However, by using data

[2]A subgraph is complete when all the possible links (between at least 3 nodes) are present. A clique is the maximal complete subgraph you can find in a graph (minimum size 3).

about the sector of FDI, we can provide additional information concerning the international division of labour.

For this method, we start with a matrix country *vs* products (A). It enables us to define the countries belonging to the core according to the sectoral structure of their exchanges. The indicator we adopt here is the asymmetry of the exchanges which is defined as the ratio between the balance and the amount of exchanges between two countries.

$$A_{ij} = \frac{E_{ij} - I_{ij}}{E_{ij} + I_{ij}} = \frac{S_{ij}}{V_{ij}}$$

A_{ij} being the asymmetry of country i for the product j.

While export structure is highly influenced by intra-sector or intra-firm trade, this indicator really allows identifying the specializations in international trade (Grasland and Van Hamme 2010). For example, some Asian countries highly specialized in electronic assembling might be considered as specialized on high technological segments through their export specializations while the asymmetry better outlines the country's position in the electronic value chain by showing limited surplus in electronic production because of imported technological components.

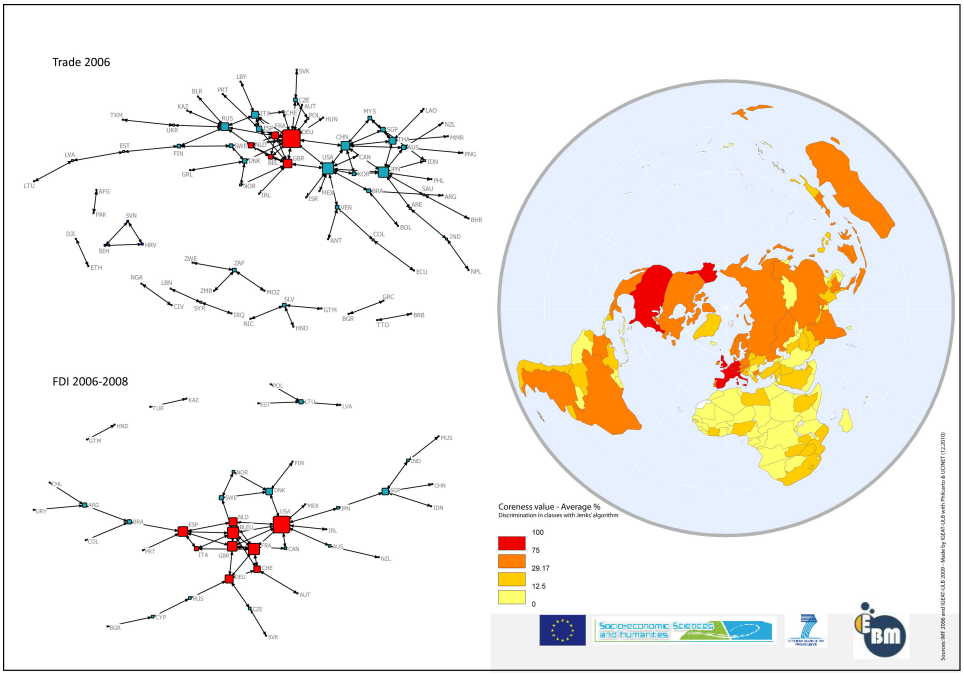
On this base, in order to achieve this classification, we first run a Principal Component Analysis (PCA) (weighted by the amount of the balance) on the products of each country or block in order to sum up the information on more than 140 products into a limited number of factors (B1). In a second step, on the basis of the selected factors, we launch a hierarchical ascendant classification with the Ward's method in order to classify the countries in a given number of classes (C). The major advantage of the Ward's method, in comparison to others hierarchical ascendant classification like single, complete or average linkage, is to minimize intra-class variance.

3.2 Results

Two matrices have been considered in order to divide the World between a well interconnected core and a disarticulated periphery: trade and investment. As explained in the methodological part, we have transformed the original matrices into Boolean ones in order to apply the *K-cores* method.

On Figure 4 (top left), we can read the spatial structure of trade flows across the world as well as the importance of the node which depends on the total number of linkages with all other nodes. In the centre of the graph, we identify a quasi-complete sub-graph (only the red nodes are part of it). This maximal quasi-clique gathers only 5 countries from Western Europe, to which other European countries aggregate in different ways, but mainly through Germany which has a very central position. Hence, those countries are not part of the central group because they only have relations with one or two countries of this group while within the quasi-clique, nearly all countries

Figure 4: A Core/Periphery division of the world according to the level of cohesion in trade and FDI flows



are connected with each other. USA is connected to the European core only through Germany and UK: the weakening of the relationship between USA and European countries explains why USA is not part of the core group. However, the central position of USA is highlighted by their intermediate position between the European core and both Latin American countries and East Asian countries. China makes the link between the European core and Asian countries but is also connected with USA. We must notice that Germany, China, USA and Japan nearly form a clique since the only missing link is German/Japan.

On the graph of FDI (Figure 4, bottom left), we can notice that, at the 5% threshold we opted for, very few links and nodes are present in comparison with the graph on trade. It is due to the extreme concentration of FDI into a limited number of countries. Indeed, the regionalization of FDI with the *K-cores* method shows a 9 members core which include USA and West European countries. It highlights the importance of intra-European and transatlantic flows of investment. In contrast with the spatial pattern of trade, Asian countries have a much more marginal position than in the graph of trade. But we must insist on the existence of links between tax havens situated in the Caribbean Islands, Mauritius or Cyprus toward many

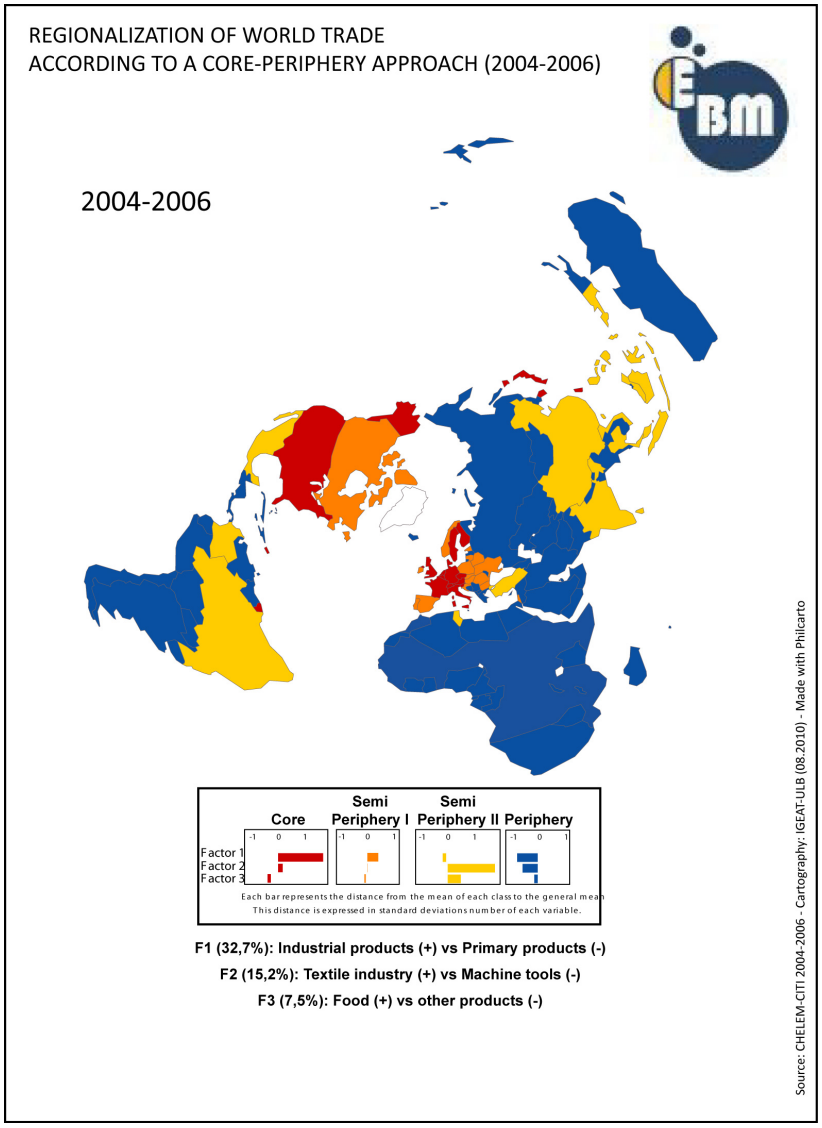
countries, especially Asian ones. Hence, it might be that some Asian countries are not included in the graph for FDI because some of their investments inwards go through financial intermediaries.

On Figure 4 (right), we have synthesized these analyses. We have taken into account the average of a standardized coreness value between trade and FDI *K-cores* regionalization. In red, we find the most central countries (USA and West European countries) well interconnected for trade and investments; in dark orange, we recognize an important aggregate of countries which are part of the core or close to it according to trade but not for FDI. This class groups together regional economic powers (Russia, India), cohesive regional area (South American countries, Eastern Asia) and countries well connected to one of the two parts of the maximal sub cliques (Central European countries, some of the Southern East Asian countries and Canada). The two yellow classes are the most marginal according to economic flows. However the darkest one put together countries which form a relatively cohesive area like Middle East around Saudi Arabia and UAE, Southern and Eastern Africa, Balkanic countries or Central America. The light yellow countries are the less cohesive and the most marginal, they have indeed very few links with countries more integrated than they are (e.g., North Korea with China, Bangladesh with India, West African countries with European countries).

We will now divide the World countries according to the countries' position in the division of labour. We have first launched a PCA on the coefficient of asymmetry of all countries (or blocks) of the CHELEM database for each CITI product in the period 2004-2006. The first factor explains about 1/3 of the total variance (32.8%) and clearly highlights the opposition between countries having a strong positive asymmetry in manufacturing goods and those which have a strong positive asymmetry in raw materials. The second explains 15.1% of the variance and distinguishes the countries with a positive asymmetry of light manufacturing industry especially textile industry (in blue) from those with a positive asymmetry on high technology goods like chemical products or machine tools (in green). These two factors have been completed by a third one in order to exceed the threshold of 50% of explained variance. It opposes countries which have a strong positive asymmetry on the food industry, either raw or transformed, from to the others. In total, the three factors account for 55% of the total variance.

In a second step, we have launched a hierarchical ascendant classification with the Ward's method on the scores on the three first factors of the PCA in order to regionalize the World countries. Each factor score has been weighted in function of its part of the variance in the PCA. We kept the threshold of 75% of the explained variance. It results in a four group classification for 2006 (Figure 5). The countries in red are the core members (Western Europe without Ireland and Iberic peninsula, Scandinavia without Norway and Iceland, USA, Japan, Korea, Taiwan and Singapore). They have a strong positive factor score on factors 1 and 2. It means that there are mainly

Figure 5: A core/periphery division of the world according to the countries' position in the international division of labour, around 1967 and 2005

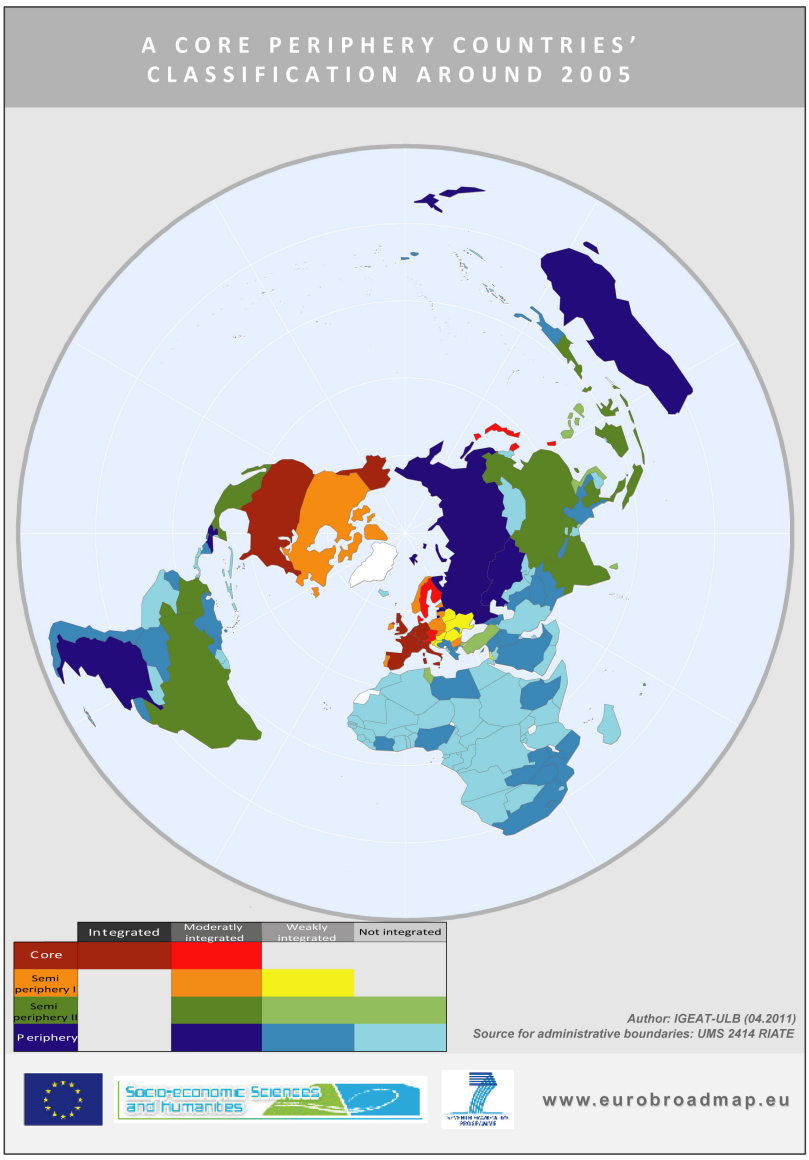


exporters of industrials products, especially high technological content. The countries in orange are what we have called the semi periphery integrated of the core or semi periphery I because they also sell industrial goods but in a less massive way than the core countries (Canada and most of the European countries except Balkanic ones). The yellow class aggregate exporters of light manufacturing goods and agricultural products, which we identify as semi periphery II. Most of the East and South Asian countries are part of this class as well as Mexico, Brazil, Colombia, Tunisia and Turkey. The countries in blue are the most peripheral ones because there are mainly raw materials producers and industrial products buyers. The same approach has been replicated for 1967.

We obtain two classifications of countries according to the criteria derived from the theory to distinguish between core and periphery. The first approach has distinguished between countries which form a cohesive and symmetrically interconnected area and the other ones. The second one has allowed classifying core and peripheral countries according to their position in the international division of labour. For each regionalization, we divided the countries into four classes. By crossing both classifications, we potentially have sixteen different classes. However, as can be seen on Figure 6, only nine cases are filled up (D). As stated by the theory, there is a relationship between both types of classification, even if the discrete classifications does not allow testing more in depth this relationship. In simple words, it means that the higher the position in the international division of labour, the more central and integrated the country is in trade or investment flows.

The dark red class is clearly the most central. Core countries (USA, France, UK, Germany, Italy, UEBL, Switzerland and Netherlands) constitute the integrated core. The red class has the same characteristics than the dark red one in the international division of work but is a bit less central than the core in terms of directions of economic flows (Spain, Finland, Sweden, Denmark, Japan, Korea and Taiwan). However, this distinction is certainly not essential in qualitative terms. Among the semi periphery I identified in the second approach, some countries are less integrated than other ones but none of them are part of the most cohesive group. In orange, we have mentioned the countries which are a little bit in the margin of the core in the international division of work but directly integrated to it. It is the case of Canada, Norway, Ireland and Central European countries. The yellow countries have a more marginal position within the semi periphery I (Israel, Portugal, Eastern European countries). There are industrial producers and sellers but are clearly in the margins of the core countries. The green classes gather countries which are light industrial goods producers and sellers. They might be considered as the factories of the world as long as consumption and low technological products are concerned. Some of these countries are relatively well connected to the core or are part of a relative cohesive group (in dark green), while others are dominated by one economic partner (light

Figure 6: A core/periphery countries' classification around 2005



green). The dark green class aggregates South-East Asian countries like China, Indonesia or Singapore, South American countries (Brazil, Colombia) and Turkey. Most of them are important economic actors and are in an intermediate position between core countries and their geographical neighbours. In many cases thus, these countries form a cohesive area of exchanges with a relative autonomy from the core countries. Light green countries only include four countries: Mexico, Tunisia, Vietnam and Sri Lanka. Each of them is strongly related to a big economic power and has a strong asymmetry in term of exchanges with it. Finally, the blue tone classes are the most peripheral ones in the international division of work. They mainly sell primary products and have negative balances for most of manufacturing goods. In dark blue, Russia, Australia, Argentina, Chile, Uruguay, Kazakhstan, Honduras and Guatemala are grouped together. They are primary and food producers but there are relatively well connected either because they are strong economic powers (Russia, Australia) or because they are part of a cohesive regional area (Southern America, CEI). The intermediate blue class presents the same pattern but with smaller economies or in smaller cohesive regional areas (Eastern and Southern Africa, Middle East). In light blue, we find the most isolated and marginal countries (Western and Central African countries and small marginal Asian countries or Caribbean Islands).

Conclusion

By using appropriate methods in line with the theoretical framework of the world system approach, we have been able to identify a deep core/periphery division in the world. Core countries are characterized by their high position in the division of labour and by their strong internal coherence. In contrast, peripheral countries appear as primary products sellers, do not make part of cohesive groups and have asymmetrical position with core countries. Between those well identified core and peripheries, we identify several types of semi-peripheries according to their position vis-à-vis core countries: on the one hand, a nearly integrated semi-periphery which mainly includes central European countries, which benefit from medium technological level off shoring; on the other hand, big countries that often lie at the heart of macro-regions (Brazil in South America; China in Eastern Asia; India in Southern Asia) and occupy intermediate position in the division of labour to be related to the endogenous development often promoted in their past. Hence, both approaches we applied allowed identifying a strong core and a deep periphery while intermediate states may change their position according to the assumption, method and flows considered.

4 Regionalization of the world

Many authors insist on the existence of intermediate levels of organization between the local/national and the global scale (Richard and Zanin 2009; Poon *et al.* 2000; Frankel *et al.* 1995). The European Union appears as the most advanced in this process of regionalization, notably because the economic integration has been accompanied by a political process of integration. Many other areas have engaged in a process of regional integration.

In this context, there has been an intense theoretical debate about whether the regionalization process has accompanied or has been antinomic to globalization. In the first hypothesis, it is argued that the regionalization favours global trade (Krugman 1991; Frankel *et al.* 1995). In the latter hypothesis, the regionalization process increases internal integration but slows down the global integration, notably through protectionism. The basic fear was that internal economic integration would be accompanied by economic protectionism, acting as a restraint to a world free trade area considered as the best way to economic progress (Richard and Zanin 2008). However, as soon as the end of the nineties those fears have seemed to decline and conceptions about free trade areas have completely changed. Indeed, several authors have demonstrated that internally integrated regions did not lead to economically protected areas (Anselin and O'Loughlin 1996; Poon 1997). On the contrary, internal and external trade were both developing at very high rates. Hence, theoretical conceptions about regionalization have progressively changed, while the objective was still the same: increasing liberalization and trade. For some authors, regionalization has thus been considered as a second rank optimum while for others as a necessary transition to a complete liberalization at the global scale (Richard and Zanin 2009; Bhagwati 1992; Mashayeki 2005; Newfarmer *et al.* 2005). Finally, the World Bank in its 2009 World development report has adopted this view of favouring regional integration as a useful step toward free trade (World Bank 2009; Van Hamme *et al.* 2010).

In this section, we propose two approaches to identify these intermediate structures of organization according to preferential bilateral relations (section 4.1) and to similar geographical patterns of flows (section 4.2).

4.1 Intramax - Functional regions 1

This part is due to Françoise Bahoken and Numo Marques da Costa

Statistical clustering procedures may have two main objectives. The first one aims to summarize spatial attributes in order to differentiate spatial types and create means profiles. The second one aims to create new spatial zoning. The use of data flows, as data input to spatial zoning, allows the definition of "Functional Areas", a key concept in spatial organization. The

area aggregation method is based on data flows using, in some cases, a contiguity criterion. The main idea of such zoning system is to define a multi-level space typically based on data flows.

The concept of Functional Areas is defined as areas in which a higher degree of mutual socioeconomic interactions exist within them rather than with other areas. Derived from the gravity model, the more interactions between spatial units, the shorter the distance. Interactions are then being observed as a measure of functional distances between spatial units: a high level of interactions indicates short functional distance; a low level of interactions indicates a higher functional distance. The spatial units that are close in terms of functional distance will be grouped together in order to create functional regions as a new zoning system.

In the context of flows, the zoning design problem is considered on the one hand as an alternative to administrative zoning systems, depending on the Modifiable Area Unit Problem (MAUP); and on the other hand, as Openshaw (1977) said, provides a zoning system that better matches theoretical requirements for gravity modelling. The functional areas analysis traditionally provides a set of different zoning possibilities for land-use and transport modelling and planning. In this approach functional areas definition concept is used to define world divisions based on different flows, as trade, direct investment and migration.

A main issue to the functional areas analysis consists in the choice of the objective function of the zone design and their effects on the scale and the aggregation method. During the 1970s, several objective functions have been discussed and defined, in order to maximize or to minimize the intra or the inter-zonal flows (Alvanides S. *et al.* 2000) and supported several methods of clustering. In this approach we will use the intramax method.

4.1.1 Method

The Intramax method is a hierarchical clustering algorithm that maximizes the proportion of the total interaction which takes place within the aggregation of basic data units (Masser and Brown, 1975). The Intramax method is concerned with the relative strength of interactions as the effect of variation in the size of the row and column totals is removed.

The interaction table, as above, could be seen as a contingency table, then the expected flow of each element are derived as the product of the column sum multiplied by the ratio of the row sum to total interaction (Mitchell and Watts 2010). So, as example, the expected flow from Region 2 into Region 1 is given as:

O/D	R_1	R_2	$\dots$	R_j	$Total$
R_1	a_{11}	a_{12}	$\dots$	a_{1j}	$\sum_{j=1} a_{1j}$
R_2	a_{21}	a_{22}	$\dots$	a_{2j}	$\sum_{j=1} a_{2j}$
$\dots$	$\dots$	$\dots$	$\dots$	$\dots$	$\dots$
R_i	a_{i1}	a_{i2}	$\dots$	a_{ij}	$\sum_{j=1} a_{ij}$
$Total$	$\sum_{i=1} a_{i1}$	$\sum_{i=1} a_{i2}$	$\dots$	$\sum_{i=1} a_{ij}$	$m = \sum_{i=1}\sum_{j=1} a_{ij}$

$$a^*_{21} = \sum_i a_{i1} \frac{\sum_j a_{2j}}{\sum_i \sum_j a_{ij}}$$

Assuming that, any difference between the observed and expected values for a given pair of places could be a measure of the relative strength of interactions between them. Two places will have a greater proximity as greater the difference between observed and expected values.

The first objective function suggested by Masser *et al.* was fully implemented by Masser and Brown (1975) to study movement data for London and Liverpool. That well-known method is the so-called Continuous Intramax Analysis developed by Masser and Scheurwater in 1977. The Intramax objective function aims to:

$$maxI = (a_{ij} - a^*_{ij}) + (a_{ji} - a^*_{ji}), \quad i \neq j$$

with

$$a^*_{ij} = \sum_{i=1}^{n} a_{ij} \left(\frac{\sum_{j=1}^{n} a_{ij}}{m} \right), \quad a_{i*} = \sum_{j=1}^{n} a_{ij}, \quad a_{j*} = \sum_{i=1}^{n} a_{ij}$$

and

$$m = \sum_{i=1}^{n} \sum_{j=1}^{n} a_{ij}$$

The methodological process merges together the N units step-by-step by maximizing the proportion of the total interaction in a hierarchical joining clustering process.

The original Intramax model has been implemented in the GIS program Flowmap© (http://flowmap.geog.uu.nl). The software is specialized in the

treatment and the analysis of flow data like migration and commuting flows, network analysis, interaction analysis and gravity modelling.

The Intramax analysis is a step-by-step procedure with no contiguity criteria which carries out a regionalization of an interaction matrix. At the first step, two spatial units are grouped together in order to create another spatial unit. At the second step, the interaction between the two areas becomes intrazonal interaction for the new resulting areas.

4.1.2 Results

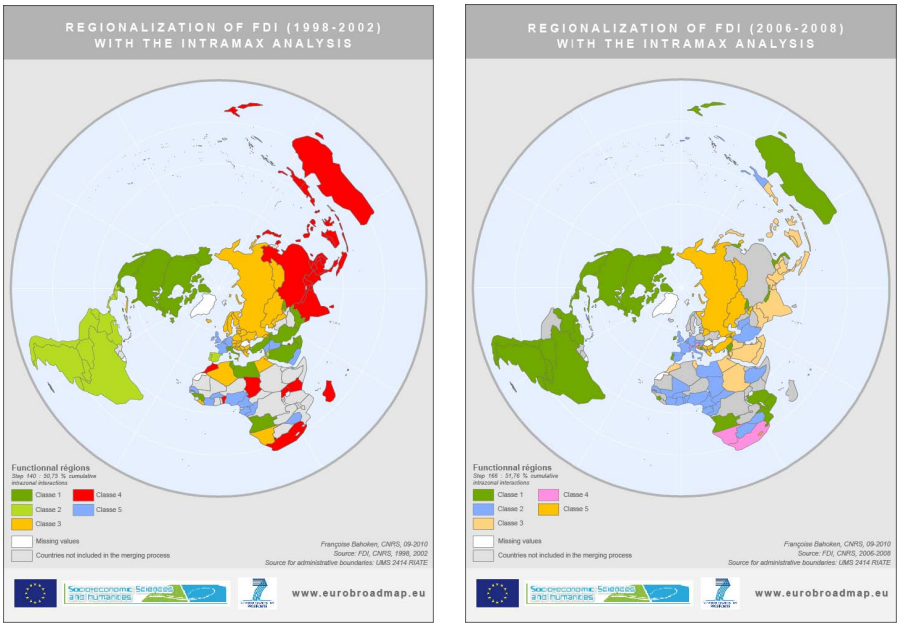
Classification of the world based on Foreign Direct Investment, Trade and Migration flows and using the Intramax spatial aggregation process show a slight different view of the world, notably because this method highlights more the relative importance of flows between pairs of countries than the absolute value of those flows. On the other hand, as a hierarchical aggregation method, is possible to see the successive formation of clusters, at different levels of aggregation, the cumulative percentage of intra-zonal interaction and the increment in each aggregation step.

The divisions of the World based on FDI flows (Figure 7), Europe reveals a distinct behaviour between western European countries and Eastern ones, but also a cluster of Iberian countries with South American ones. Special relations could be identified by the joining of Austria, Switzerland and Italy with North African and Middle East countries.

The division of the World based on inwards FDI flows reveals a complicated pattern which is not without link with the difficulty to obtain FDI data and build the database. Europe is split into three main classes: an EU6 plus old colonies in blue with gather countries where FDI mainly come from EU6 countries except Italy, especially France and UK; an Eastern and Balkanic Europe in orange where Germany, Scandinavian countries and Russia are the most important investors; and thirdly Iberian countries with are linked with South American ones. The green class is those centred on the USA as the most important investor in these countries. The red class is more difficult to understand cause it gathers countries for which USA and EU are equally important as investors as well as countries. But for some of Asian ones, the FDI come also from tax havens as well as USA and/or EU.

Intramax analyses allow giving a first answer to both questions. This method groups together countries which trade more between themselves than expected through a simple model which eliminates the size effect. Intramax analyses confirm the high level of integration of Europe: if the world is divided into 5 classes, there is only one Europe (except Serbia which remains isolated), which mean that European countries trade preferentially between themselves (Figure 11, left). This result is important because the situation was different in the recent past: in 1996, there was a north/south divide within Europe (Nordic countries *vs* the rest of Europe; see also Poon, 2000

Figure 7: Divisions of the World based on FDI flows with Intramax Analysis - 1998-2002 and 2006-08



on the same question) and some Eastern countries were not yet included in the European space of trade; in 1968, the major divide lies at the level of the iron curtain. In 2007, these intra-European divides have not disappeared but one needs to keep more typological groups to confirm they are still alive.

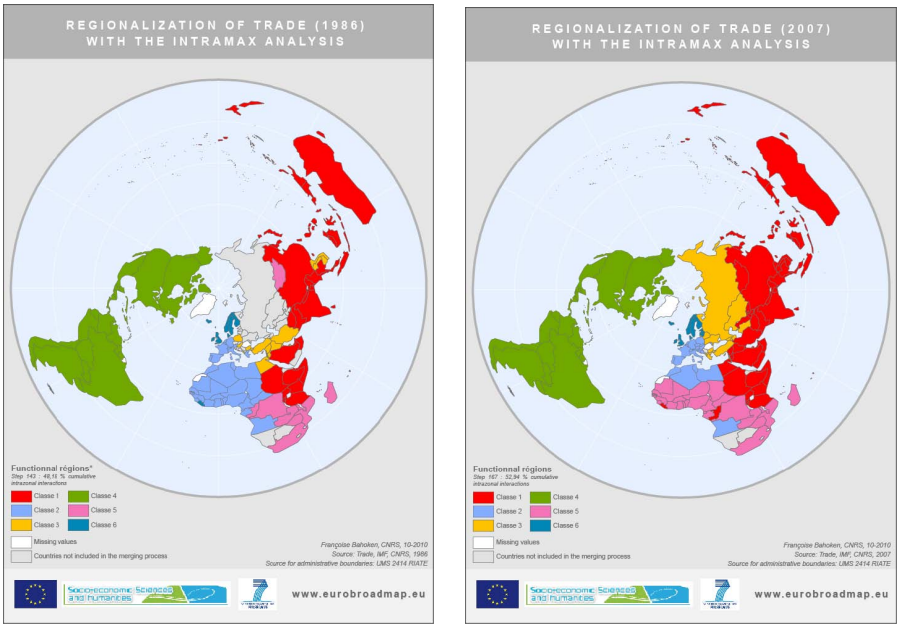
Conclusions

The methods of functional regions lead to different spatial clustering of countries than other clustering methods because it focuses on the preferential relations between pairs of countries rather than on similar structural features. Also, because it controls for the country's economic size, this technique allows highlighting the relative importance of relations between countries, sometimes hidden by the huge values of global flows.

In this case, we could see, through the relative importance of flows, that European countries have different positions in the world according to different types of flows. However the matrix used, we are far from a monolithic Europe in the World, and we can see the relative importance bilateral relations of each country, or group of European countries, with the rest of the World.

In the comparison of the Intramax method with other methods, we should keep in mind the specificities of partition with the Intramax procedure. A

Figure 8: Divisions of the World based on Trade flows with Intramax - 1986 and 2007

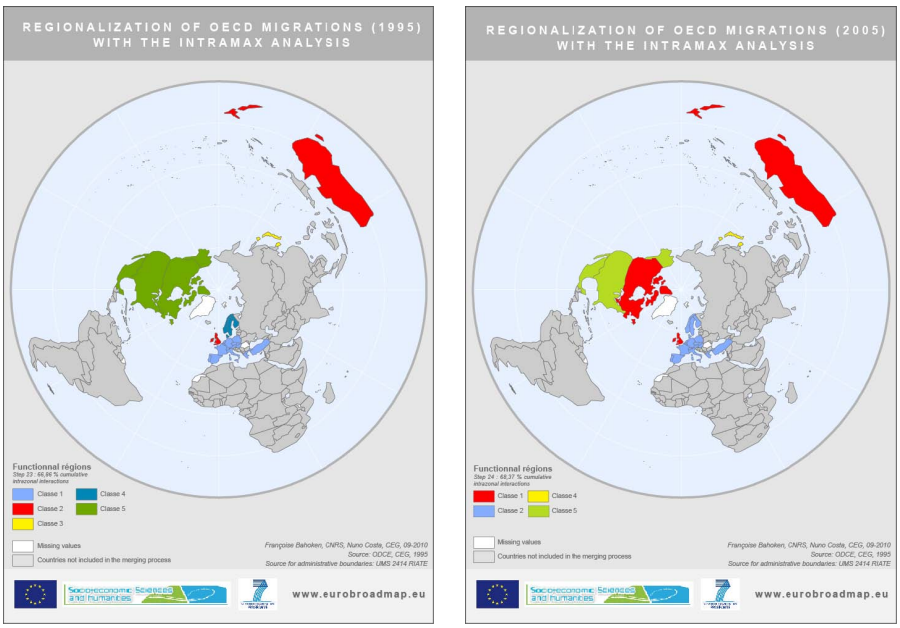


The divisions of the World based on Trade flows reveal a set of relations where contiguity and physical proximity seems to have a more important role than political and cultural proximity. Still European countries show again differential behaviours, still visible after the fall of Berlin wall. The Northern European cluster, the Central and Southern European cluster, connected to Africa, and the Eastern European cluster. At world level, is easy to identify the American cluster and the Asian, Oceania and East African cluster.

fundamental particularity of Intramax regarding the other methods of world partitions is about the determination of the k number of classes. Indeed, in contrast with the other statistical methods of world partition presented in this report (i.e. MaxCor) which require the value of k (number of classes) to be specified a priori, it should be noted that we are not able to choose a priori the k of in an Intramax partition. We rather select the number of the Intramax fusion step (i.e. the percentage of cumulative intra-zonal interaction of the regions) in order to elaborate the partition.

To conclude, we wish to point first that the Intramin and the Intramax functions are commonly used in order to create zoning systems for gravity modelling, where the requirement is to maximize the inter-zonal flows, because the intra-zonal flows are least represented in gravity modelling. This has in particular for consequence that they are mainly used at a sub-national scale or at a regional level. Secondly, we must not forget that the region-

Figure 9: Divisions of the World based on Migration flows OECD-OECD with Intramax Analysis - 1995 and 2005



The divisions of the World based on OECD migration flows show, three strong clusters USA - Mexico; Japan - South Korea; and UK - Australia - New Zealand and Canada (joined in 2005), the Commonwealth cluster. The European countries, without UK, show a Scandinavian cluster, the German-Turkey cluster, and the Austrian position as hinge between West and East. This position is also assumed by Germany and the Scandinavian, revealed at other step of hierarchical aggregation.

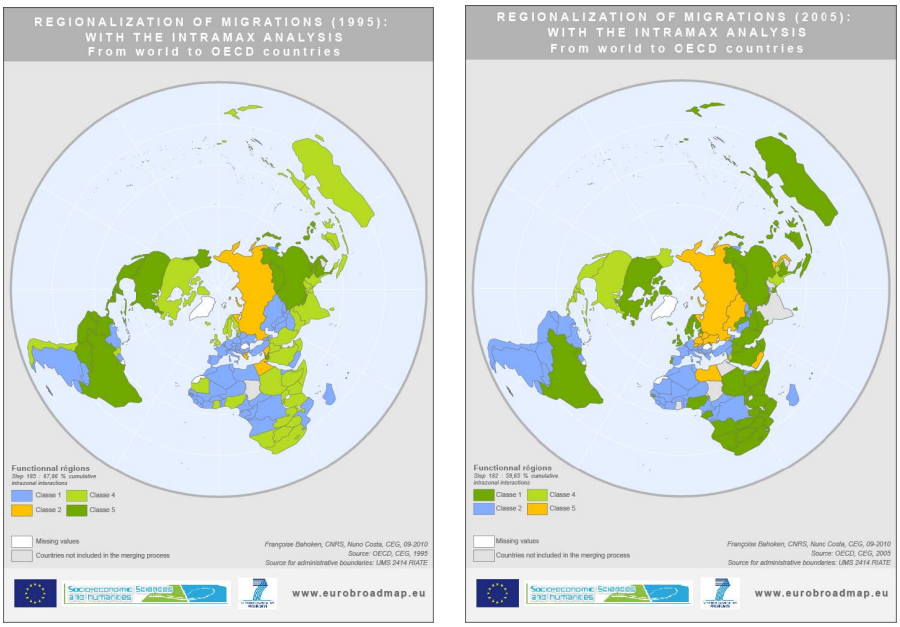
alization provides by Intramax must be heard by "functional integration" rather than "homogeneity". The different countries of one specific group are merging on the basis that the interaction between them is more important than the interaction between the countries in a separate groups. That acceptance of the regionalization concept is in fact one extension of the economic dependence which helps to create trade areas.

4.2 MaxCor - Functional regions 2

This part is due to Claude Grasland

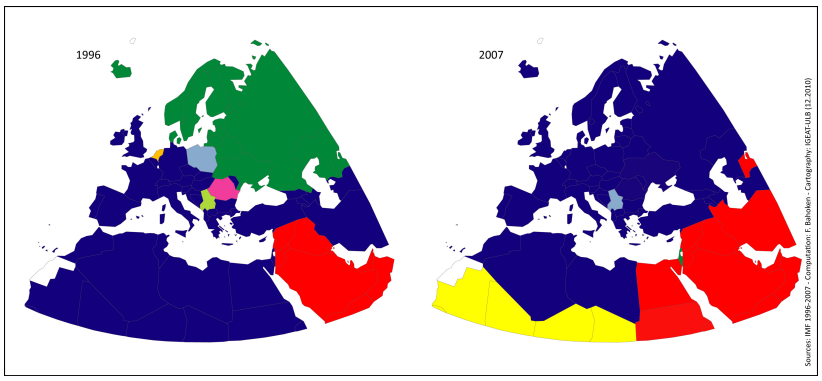
As the previous approach, the MaxCor approach aims at identifying intermediate levels of spatial organization at the regional level. But, in contrast to the Intramax method, it does not cluster countries according to their re-

Figure 10: Divisions of the World based on Migration flows World-OECD with Intramax Analysis - 1995 and 2005



The divisions of the World based on World to OECD migration flows show the role of Europe in this world division. Europe assumes three relevant positions: UK and its relation to Asia, America and Oceania; the Scandinavian with important relations to East and receiving migrants for all countries, very likely related with its asylum policy; Germany assume also a special relation to the East, as Austria that has also a relative strong relation with the Middle East countries; the southern European countries and their special relation with African and South American countries. In 1995 Brazil had relative more expressive flows with the USA, while India had special relation with the UK. In 2005 their relative position changed. Brazil has more proximity to Europe, namely with Portugal, and India assumed more relations with the USA.

Figure 11: Typology of Euro-Mediterranean countries according to the geography of their trade, using intramax method, 1996 and 2007



ciprocal bilateral relations but rather because these countries have the same geographical patterns of flows. In many cases, it highlights the strength of bilateral relations in regional areas; but it also illustrates the polarization of third countries toward the same core countries. In this perspective, the MaxCor theoretical background lies in between the regionalization process and the core/periphery approach.

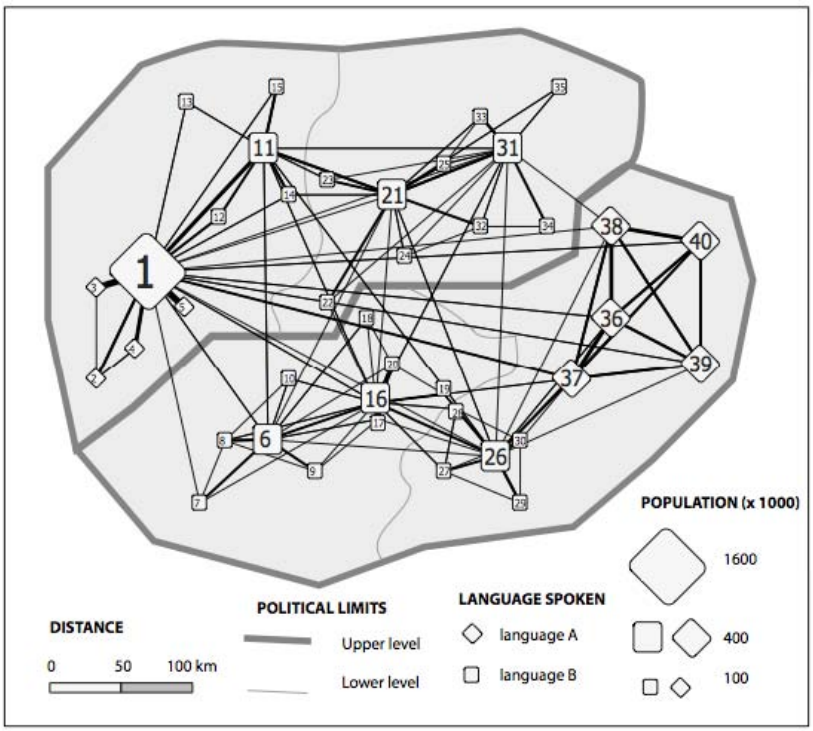
MaxCor is a systematic method of partition for matrix of heterogeneous form (square, rectangular) and heterogeneous content (boolean linkage, quantitative flows, common belonging).

4.2.1 Method

The aim of the MaxCor algorithm is to reveal hidden or complex levels of organization of flows. We propose to consider firstly a theoretical example (Figure 12) where flows have been built according to a model of spatial interaction with a combination of structural effects:

- Size effect: Flows are proportional to the population of cities of origin and destination (P_iP_j).
- Geographical Distance effect: Flows are decreasing with euclidean distance according to an inverse function ($\frac{1}{D_{ij}}$).
- Political Barrier effect 1: Flows are divided by 2 when they cross a regional border (REG_{ij}).
- Political Barrier effect 2: Flows are divided by 1.5 when they cross a national border (NAT_{ij}).

Figure 12: An example of complex organization of flows with combination of different structural effects



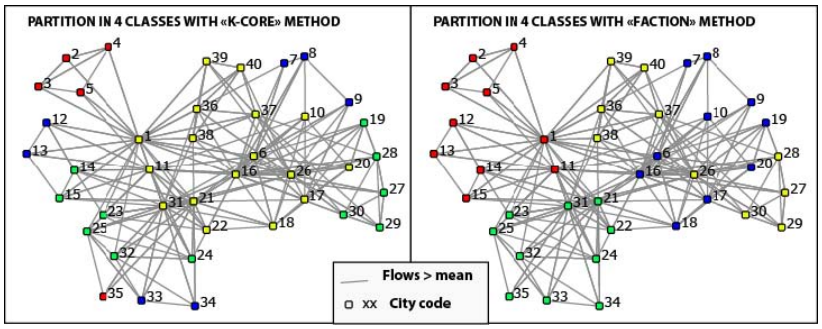
- Communication Network effect: Flows are multiplied by 2 between places with common language ($LANG_{ij}$).

As a whole, the model can be written as a spatial interaction model from gravity type, but with three additional parameters that reveals the existence of hidden levels of organization that are associated to increase of reduction of flows inside or between specific groups of places.

$$F_{ij} = k.POP_i.POP_j.(D_{ij})^{-1}.(0.5)^{REG_{ij}}.(0.67)^{NAT_{ij}} .(0.33)^{LANG_{ij}} + \epsilon_{ij}$$

It is therefore easy to understand why some places are more connected than others and to provide a full and complete explanation of all relations, except the small random noise (F_{ij}) that has been introduce in order to take into account human freedom and error of measurement. Nevertheless, the omniscient observer would explain 99.9% of the deviance of the model and conclude to the existence of 5 independent factors of explanation that are

Figure 13: Visualization of hidden structures by a network analyst observer



precisely the structures of the phenomena (Size, distance, belonging level 1, belonging level 2, common language).

Consider now the situation of two empirical observers that ignore the exact solution of the problem and try to explain the matrix of flows between cities. The first observer is a sociologist or a political scientist that use to explain linkages by models of social network analysis. The second observer is an economist or a geographer that use to explain flows with gravity models of spatial interaction.

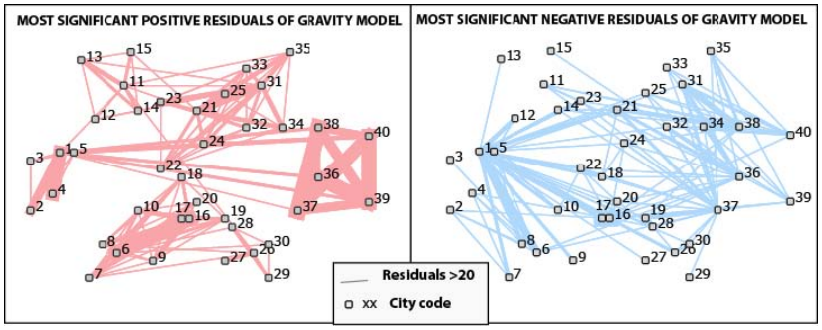
The network analyst observer will visualize the matrix of flows as presented in figure 13. S/he has firstly transform the matrix of flows into a network. S/he obtained a graph of linkages where the position of nodes is not related to geographical position but only to linkages between cities. S/he can produce different partitions of cities in clusters and try to interpret the group of cities as the effect of hidden structures (Degenne and Forsé 1994; Wasserman and Faust 1994). For example, the *K-Cores* methods reveal the existence of clusters of more and less connected cities which are mainly related in practice to the structural effect of size of cities (population) and geographical accessibility (distance).

The spatial interaction model observer will start from a different assumption and assume that flows are related to the classical gravity model of spatial interaction. S/he will therefore put cities on a map and derive from their geographical position a matrix of distances. S/he will also try to obtain a measure of city sizes but he ignores the exact population (POP) and use a proxy based for example on the number of birth (M). Then, s/he applies a deductive model where flows are supposed to depend on size and distance of cities.

$$F_{ij} = k.(M_i)^{-\alpha 1}.(M_j)^{-\alpha 2}.(D_{ij})^{-\beta} + \epsilon_{ij}$$

S/he will consider with satisfaction that the model is pretty good in terms of deviance explained ($r^2 = 89\%$, with the set of parameters: $\alpha 1 = -0.93$,

Figure 14: Visualization of hidden structures by a spatial interaction model observer



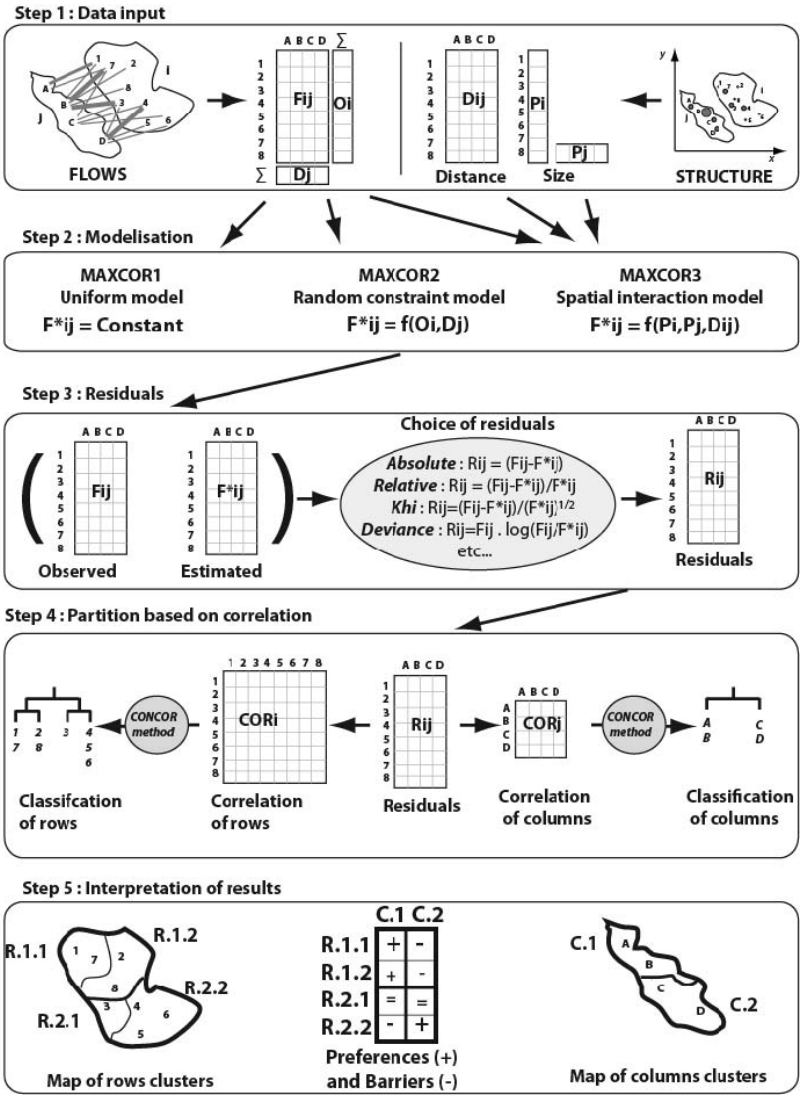
$\alpha 2 = -0.94$ and $\beta = -1.52$). But s/he will nevertheless try to analyse the unexplained part of the model through the realization of two maps describing the most significant positive residuals and negative residuals between cities (Figure 14). The positive residuals suggest the existence of clusters of cities that exchange more than expected according to their size and their distance. At the same time, the joint examination of positive and negative residuals could strongly suggest the existence of a major barrier crossing the territory from south-west to north-east. And our observer will one more time discover easily the existence of the upper level of territorial division. But at the same time, s/he will certainly not identify the existence of the lower level of territorial division (partition in 4 groups) because the effect of this lower level has been captured by the distance effects.

Both approaches have been partly successful in the research of hidden structure that govern the flows. The social network observer has caught the effect of size and the effect of political divisions of lower level but he did not identify the effect of distance, the effect of language and the upper level of political division. The spatial interaction model observer has verified the existence of distance and size effect and discovers the effect of common language and upper level of political division. But he did not capture the effect of the lower level of political division that was confused with distance effect. In both case, it was difficult to reveal all structures introduced in the model because some of them are nested (the two levels of political division) or strongly correlated (the effect of distance and lower level of political division). The control of size effects was also a problem in both cases.

The objective of MaxCor is to combine the quality of each of the alternative approach in a common procedure that can reveal hidden territorial structures with a minimum of bias.

We focus here the discussion on the conceptual choices made in MaxCor, and in particular in the variant MaxCor2 that has been adopted.

Figure 15: The MaxCor algorithm and its variants



MaxCor2 use a random model based on marginal sums of the matrix of flows and does not introduce any other external criteria of size or distance. The introduction of only some explanatory variable is dangerous because it can hide other structures that are correlated. That is the reason why we will use double constraint models that eliminate the size effect without introduction of proxies of size. In variant MaxCor2, no distance effect is introduced in the model, because a false specification of distance could create artificial clusters. The variant MaxCor3 remains nevertheless a possibility for the discoveries of preferential relation between countries excluding both size and distance effects.

MaxCor2 is an inductive approach which tries to maximize structural equivalence rather than cohesion criteria for the design of clusters of countries. It means that countries that are classified in a common cluster are not necessarily countries that exchange a lot of lows or countries with preferential relation once we have eliminated size effects (as it is the case with the Intramax procedure). Structural equivalence means that countries located in the same cluster develop the same type of relation with the rest of the world, whatever their bilateral degree of relation. For example the trade flows between Iraq and Israel are nearly equal to zero in 2006 and we can consider that the residual of their bilateral relation is negative. But at the same time, both countries are characterized for example by significant positive residuals with USA and significant negative residuals with Iran. If we examine the distribution of residuals of Israel and Iraq with the rest of the world, we find a very significant positive correlation (+0.171) which summarize a high degree of similarity of their external trade relations in terms of preferences and barriers.

MaxCor2 use a hierarchical clustering procedure that produces binary trees or in other words successive division in 2, 4, 8... classes. More precisely, we use the CONCOR algorithm which is well known in social network literature (Breiger *et al.* 1975).

4.2.2 Results

Symmetrical matrix of bilateral trade flows 2006-07

We would like to propose a model of trade relation between countries without introducing exogenous variables like GDP of countries or geographical distance. We choose therefore a random constraint model where the estimated trade flow $F*ij$ between two countries is proportional to the sum of export of the countries of origin (O_i) and the sum of import of the country of destination (D_j). As the diagonal is missing (a country cannot trade with himself) it is not possible to use the trivial solution $F*ij = (O_i x D_j)/F_{tot}$ and we are obliged to build a double constraint model with $(n-1)$ parameters a_i for origins constraints and $(p-1)$ parameters b_j for destination constraints (with

p equal to the number of countries of origin and n the number of countries of destination). The general form of the model is given by Equation 5 and solution can be easily obtained by a Poisson regression model.

$$F_{ij} = a_i.O_i.b_j.D_j + \epsilon_{ij}$$

Once we have obtained for each country the observed flow F_{ij} and the estimated flow $F * ij$, we have to decide on each form of residuals will be defined before measuring the correlation of residual exchanges. This is not a trivial question as different measure of residuals will produce different partitions of the World. We can define two opposite solutions.

The raw residual $(F_{ij} - F * ij)$ will produce a partition where the most important flows play the major role. The relative residuals $(F_{ij} - F*ij)/F*ij$ will focus on the contrary on the effect of small trade flows that can be exceptionally higher than expected. The negative residuals are equal to -1 for all countries where the observed flow is equal to zero. In other word, they do not play a significant role in the analysis.

According to Brams (1966), each solution is possible and can be used to define what he proposes to call indices of salience in internal relation. we can easily anticipate that the partition derived from raw residual will focus on the major influence area of great economic power. It will be therefore a variant of the dominant flows method. On the contrary, the use of relative residuals will focus on very specific trade preferences, like in Intramax procedure. The results will be strongly related to geographical proximity and neighbourhood effects because positive residuals plays the major role and we can anticipate the creation of clusters between near countries of central Africa. The best solution for both statistical and empirical reason is in our opinion to use an intermediate measure like deviance (which is logical if it is the criteria used in the random model) or the khi-square (which is normally related to information error). Both measure are asymptotically equivalent and we have decided to use the khi residual $(F_{ij} - F * ij)/(F * ij)^{1/2}$ in our analysis which is mathematically a perfect compromise between the advantage and inconvenient of raw residuals and relative residuals.

This matrix of khi-residual is the starting point of the CONCOR procedure which produce a hierarchical division of world countries in cluster based on their preferential relations and barriers. In the case of bilateral trade flows, only one partition is obtained because flows are symmetrical. It is therefore more easy to interpret the results provided different tables of preferences and barriers (figure 2) and by a map.

The partition in 2 clusters reveals a simple opposition between 2 macro regions of preferential trade relations (internal flows multiplied by 1.6 or 1.7) separated by a barrier (external flows divided by 2.5). All countries of EU27 belong to the same cluster 2 which include many countries of the neighbourhood in both eastern and southern direction. The partition in

Figure 16: Application of MaxCor2 to bilateral trade flows 2006-07

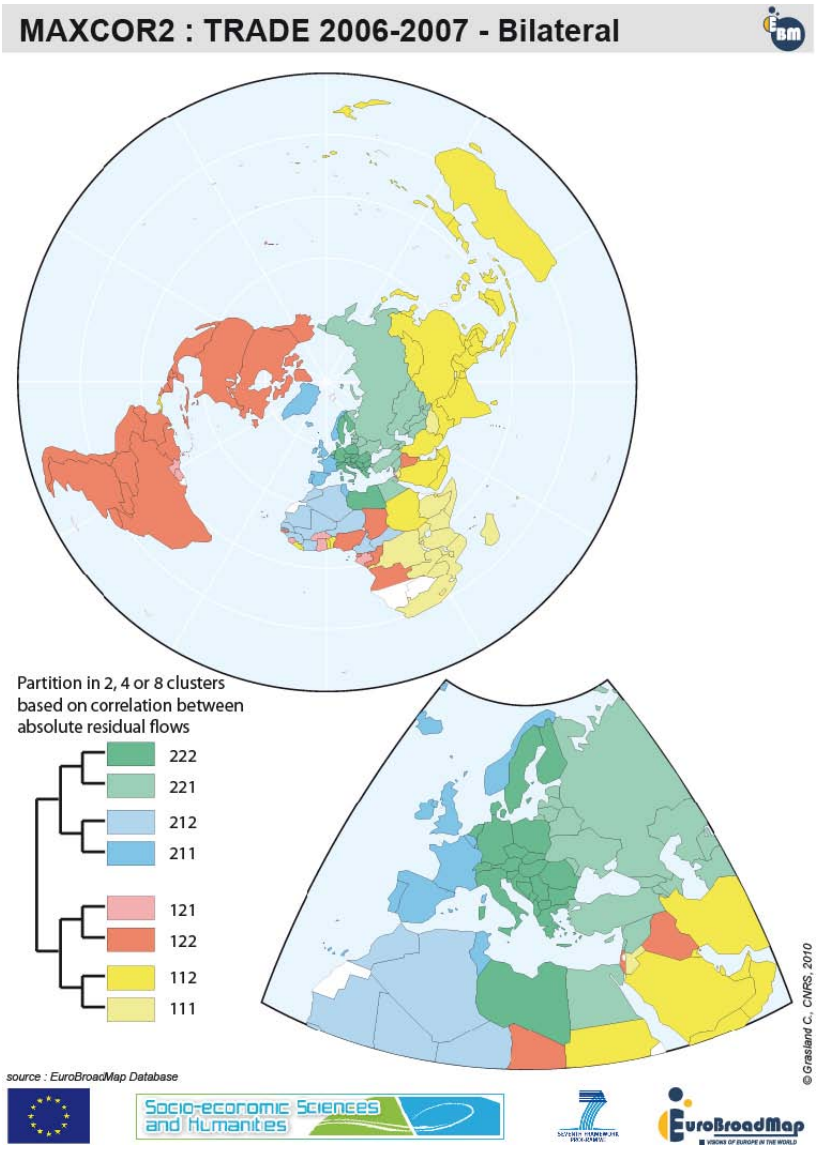


Table 2: Preferential trade relations in 2006-2007 for MaxCor2 partition in 2, 4 and 8 clusters

2 clusters

OBS/EST		Import 1	Import 2	TOT
Export	1	1,6	0,4	1,0
	2	0,4	1,7	1,0
	TOT	1,0	1,0	1,0

4 clusters

OBS/EST		Import 11	Import 12	Import 21	Import 22	TOT
Export	11	2,3	0,8	0,4	0,4	1,0
	12	0,8	3,5	0,5	0,4	1,0
	21	0,4	0,5	2,3	1,4	1,0
	22	0,4	0,4	1,4	2,0	1,0
	TOT	1,0	1,0	1,0	1,0	1,0

8 clusters

OBS/EST		Import 111	Import 112	Import 122	Import 121	Import 212	Import 211	Import 221	Import 222	TOT
Export	111	18,5	1,3	0,6	1,2	0,8	0,8	0,6	0,7	1,0
	112	1,3	2,3	0,8	0,5	0,5	0,4	0,6	0,4	1,0
	122	0,6	0,8	3,5	2,1	1,0	0,5	0,3	0,4	1,0
	121	1,2	0,5	2,1	61,2	3,9	0,9	0,3	0,3	1,0
	212	0,8	0,5	1,0	3,9	6,8	2,0	1,2	0,8	1,0
	211	0,8	0,4	0,5	0,9	2,0	2,4	0,7	1,5	1,0
	221	0,6	0,6	0,3	0,3	1,2	0,7	6,9	1,5	1,0
	222	0,7	0,4	0,4	0,3	0,8	1,5	1,5	2,1	1,0
	TOT	1,0	1,0	1,0	1,0	1,0	1,0	1,0	1,0	1,0

4 clusters provides more details on the internal structure of the previous partition and reveals 4 meso regions. The cluster 1 splits clearly between a south-eastern Asian region extended to Middle East and eastern Africa (11) and a pan American region extended to selected countries of Africa and Middle East (12). The cluster 2 divides it in two regions that cross EU27: a western part of EU associated to Maghreb and Western Africa (21); an eastern part of EU associated to Machrek, Balkans and former Soviet Union territory.

Application to a non-symmetrical matrix of flows: Migration from World to OECD countries in 2005

The matrix of migratory flows between countries of the World and OECD countries has 192 lines (countries that had sent migrants toward a minimum of 2 OECD countries) and 29 columns (the countries of OECD that has received migrants for a minimum of 2 countries in the world), and flows are not symmetrical.

The random model of flows is based on marginal sum of lows as in the case of trade but the meaning is a bit different because we ignore a part of the migratory flows between world countries. In particular we ignore the internal flows between non-OECD countries or the flows directed from OECD countries to non-OECD countries. The random model is therefore based on the assumption that migratory flows directed from the World toward OECD countries are an independent part of the world migratory system that can be analysed separately. The random model of flows is an equilibrium model that evaluate what should be the most probable allocation of migrants if the choice was made without any kind of preferences (distance, language, etc.) and without any alternative choices (migration toward the rest of the world).

On the basis of these assumptions, we can for example estimate that the 2.31 millions of migrants that have left India toward an OECD countries should be distributed according to the volume of immigrant that are present

Table 3: Preferential migratory relations in 2005 for MaxCor2 partition in 2, 4 and 8 clusters

2 clusters

OBS/EST		Destination 1	2	TOT
origin	1	1,9	0,6	1,0
	2	0,3	1,3	1,0
	TOT	1,0	1,0	1,0

4 clusters

OBS/EST		Destination 11	12	21	22	TOT
origin	11	2,5	2,7	0,3	0,6	1,0
	12	0,7	1,1	0,5	2,8	1,0
	21	1,6	0,1	1,4	0,4	1,0
	22	0,3	0,2	1,6	0,6	1,0
	TOT	1,0	1,0	1,0	1,0	1,0

4 clusters

OBS/EST		Destination 111	112	121	122	211	212	221	222	TOT
Origin	111	1,3	0,6	3,7	1,7	0,3	0,0	0,8	0,7	1,0
	112	5,6	6,4	0,4	2,1	0,5	0,0	0,6	0,3	1,0
	121	0,8	1,0	1,1	5,0	0,7	0,3	6,4	1,6	1,0
	122	0,6	0,3	0,9	0,6	0,4	0,4	0,8	3,4	1,0
	211	0,1	0,1	0,1	0,4	1,0	15,2	0,1	0,5	1,0
	212	2,3	3,0	0,0	0,9	1,1	3,8	0,3	0,3	1,0
	221	0,2	0,4	0,1	0,2	1,8	0,5	0,5	0,4	1,0
	222	0,4	0,6	0,3	0,3	1,2	2,6	1,0	1,4	1,0
	TOT	1,0	1,0	1,0	1,0	1,0	1,0	1,0	1,0	1,0

in each of the OECD countries. In practice the distribution of Indian Migrant is different and we can define preferential relations when migration is higher than expected and barriers when migration is lower than expected. It is therefore possible to establish a matrix of khi-residual and to derive from this matrix two matrices of correlations: one matrix 192x192 between world countries (according to their profile of emigration toward OECD) and one matrix 29x29 between OECD countries (according to their profile of immigration from all countries of the world, including OECD countries).

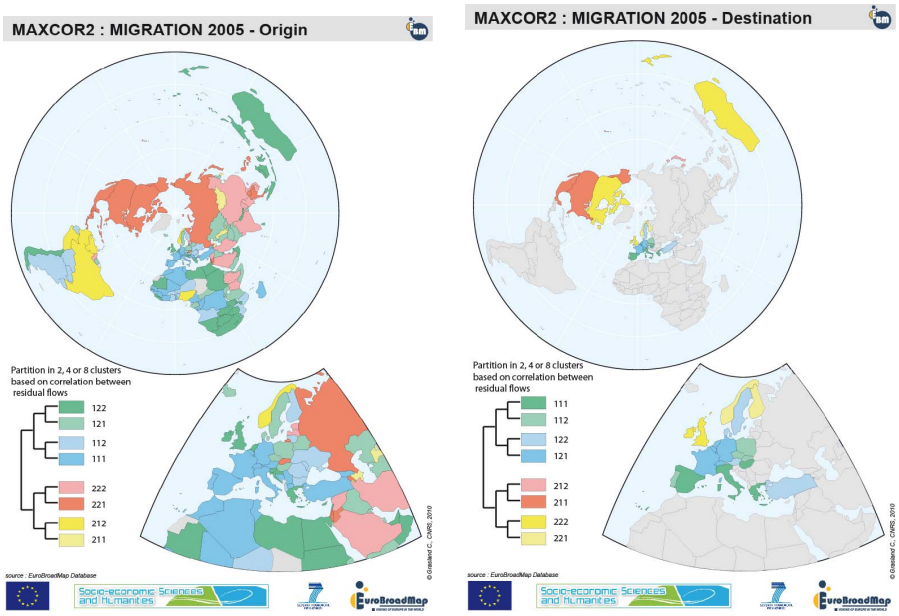
These two matrices are then transformed in two different partitions in 2, 4, 8 groups with the CONCOR algorithm and we can derive from this two maps (Figure 17) and one table of preferential relations between the groups of the two partitions (Table 3).

The interpretation of results is more complex than with trade because the clusters are different for rows and columns. For example, the preferential relation between row-cluster 1 and column-cluster 2 means that countries from European Union, Africa, southern America and Oceania that are in blue-green on the left map are characterized by preferential relations with OECD countries of EU (except UK, Norway and Finland) that are represented in blue-green on the right map. It means that UK belong to the same cluster as the majority of EU countries in terms of emigration (migrants leaving from UK are generally attracted by other EU countries) but not in terms of immigration (migrants coming to UK are not from the same origin that the other migrants that are coming to EU).

Application to a matrix of Boolean Linkage: exchanges of embassies in 2009

As third example of application, we have chosen the case of diplomatic flows measured by embassies sent by countries of the world to other countries in 2009. This example is interesting from methodological point of view because it is not about classical flows (that measure absolute quantities transmitted

Figure 17: Application of MaxCor2 to migratory flows between World and OECD countries in 2005

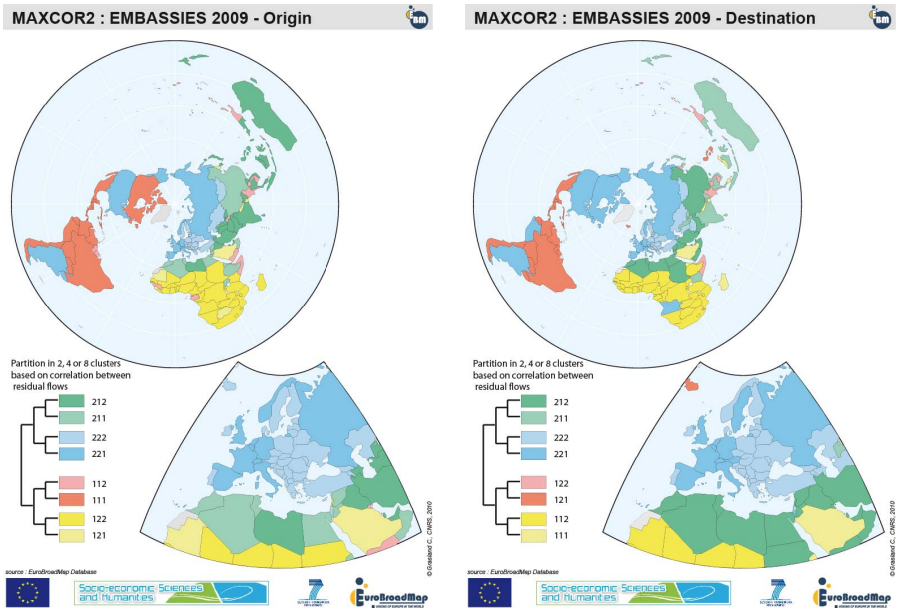


through time) but about linkages defined by a Boolean variable with value $L_{ij} = 1$ (if country i has an embassy in country j) and $L_{ij} = 0$ otherwise. The problem is also complicated by the fact that the matrix is not symmetrical.

The difficulty with this matrix is not really related to asymmetry of flows, which only implies that two different partitions will be generated for origins and destination. We could perhaps produce a symmetric matrix based on the existence of bilateral relation or the existence of at less one relation in one direction. In this case, only one partition will be produced.

The real problem is the fact that we cannot use the same model of random allocation than before because one country cannot send more than one embassy to another one. The Poisson model based on the sum of marginal flows is therefore not adapted to the present case and we have to move to another statistical approach. We decided to use a Logit model where the linkage is defined as a probability P_{ij} which depends from the number of embassies sent by country i of origin (O_i) and the number of embassies received by the country j of destination (D_j). This model does not fulfil the double constraint of conservation of the sum of origins and destination. Only the total constraint is fulfilled (i.e. the sum of estimated probabilities is equal to the total sum of embassies in the World). Once the table of estimated probability of linkage is obtained, we compute the residual as the simple difference ($L_{ij} - P_{ij}$) which measures the correspondence between observed

Figure 18: Application of MaxCor2 to diplomatic flows (Embassies) between World countries in 2009



linkage and estimated probability of linkage. The use of khi-residual does not make sense for probabilities. Alternative solutions could be the use of standardized residual, for example according to Student's law.

We can apply the same procedure CONCOR as usual and generates two diplomatic partitions of the world: one based on the embassies sent and another based on the embassies received. We produce therefore two maps of world divisions (Figure 18). The two partitions obtained for origin and destination of embassies are very similar and it is therefore relatively easy to compare the classes.

The division of the world in two diplomatic macro regions does not reproduce the common geographical pattern that was observed for Trade and Migration (i.e. EU+ eastern and southern neighbourhood versus rest of the World). The main division is rather an opposition between peripheral countries (Latin Africa and Southern America) and core countries (rest of the World). The division in 4 diplomatic *meso* regions divides the core group according to a typical historical pattern: on the one hand, the leading countries of the 19th century (Europe) and 20th century (USA, former USSR); on the other hand the emerging countries located in their southern periphery (Arab and Muslim countries, India, China, Japan, Australia...). In other words, an opposition between a traditional diplomatic network and a new emerging network. Concerning the peripheral group, the division in two sub-

groups between Latin America and Sub-Saharan Africa reveals two example of integrated diplomatic area for countries that are isolated from the central diplomatic network but well connected internally by many organizations (OUA, MERCOSUR ...)

Conclusion: a flexible method useful for comparison of heterogeneous matrices

The aim of this methodological paper was to propose a systematic method of partition for matrix of heterogeneous form (square, rectangular) and heterogeneous content (boolean linkage, quantitative flows, common belonging).

The solution is based on a variant of the CONCOR method which is normally applied to boolean matrix but is here generalized to the case of all types of matrix. It is also based on spatial interaction model approach as the correlation can be realized either on the raw matrix (MaxCor1) or on the standardized residual of an interaction model based on marginal sums of the matrix (MaxCor2). It is also possible to apply the method to the residual of a more complex model introducing both controls on margins and on distances (MaxCor3).

The result of the MaxCor2 procedure is a partition of the rows (or columns) of the matrix under investigation in 2, 4 and 8 groups of countries that are characterized by common profiles of exchanges with third party but not necessary by internal high density of flows (which is a difference with Intramax procedure). The concept behind the procedure is therefore related to structural equivalence and not to internal cohesion.

5 Europe in the world: an assessment using different approaches in several areas

Using the same data and methods as in the previous sections, we assess the position of Europe in the world as regards economy, migrations and diplomacy. This focus on Europe does not break with the demand of non Eurocentric visions of Europe because we apply methods at the global scale and, in a second step, we analyse what the results mean for Europe which is not defined *a priori*.

For each area (trade, political flows and migrations), we propose to answer the following questions:

- To what extent does Europe seem to be a coherent/integrated area? What are the internal divisions of Europe? Does it make sense to speak about one Europe or are there several Europes?

- Which is the spatial extent of Europe in the different areas?

5.1 Europe in the world trade? A long term analysis of trade flows

Integration, fractures and limits of Europe

It makes no doubt that Europe is economically integrated: since the 60s, the intra European trade - defined as Western Europe or EU-27 - account between 60% and 70% of its total trade, with a significant drop in the two last decades, from nearly 70% to about 62%. Also, EU still appears as a relatively closed economy with extra-EU exports accounting for 11% of GDP. However, it must be noted that this figure has increased in the last decades: it only reached 7.5 in 1987 and 8% in 2000. Moreover, this figure is much higher than for NAFTA, whose exports are only 4.7% of the total GDP. However, as far as NAFTA is concerned, imports are much more important than exports, due to the very negative trade balance of USA. In consequence, the taking into account of imports to asses the economic openness rate would diminish the difference between NAFTA and EU in terms of openness.

This European integration is territorially rather large: EU's influence is high toward Northern Africa and the ex-USSR space but has indeed decreased in Middle East and Sub-Saharan Africa (Figure 19). However, the integration with EU is also spatially differentiated: the highest share of trade with EU are to be found in central-Eastern European countries (Poland, Czech republic...) as well as in small West European countries (Belgium, Portugal...). In contrast, some European countries appear to be less Europe-oriented, especially UK. Concerning FDI, the picture is a bit different and more complex due to more unpredictable figures. As far as FDI inwards are concerned, there is a clear core/periphery pattern within Europe: southern and Eastern countries receive nearly all their investments from Europe, while North-Western Europe and more specifically UK, receive higher share of FDI coming from other parts of the world. For outward FDI, the picture is again different, with countries from neighbourhood having Europe as the main if not only destination for FDI, but on small amounts we should say.

This integration is further illustrated by the structure of trade. Figure 20 is extracted from the division of the world according to the structure of trade of countries. Between 1968 and 2005, there has been an enlargement of the European core toward Nordic, Eastern and Mediterranean countries. In contrast, this map shows the peripheral structure of all neighbourhood areas, including Russia which had less peripheral position in the international division of labour during the communist period. This convergence is also illustrated on Figure 20, where we can observe that the distance between European countries have decreased since the 60s and slowly converge to the average position of Western Europe in terms of trade structure.

If Europe is an economically integrated and converging continent, Figure

Figure 19: Share of EU-27 in the trade and FDI of Euromediterranean countries, around 2006

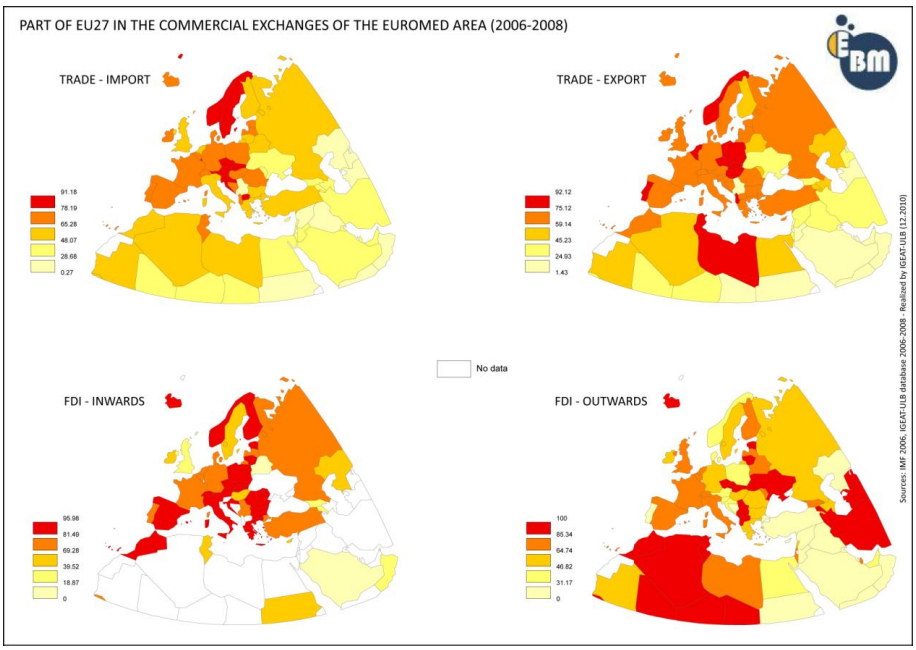
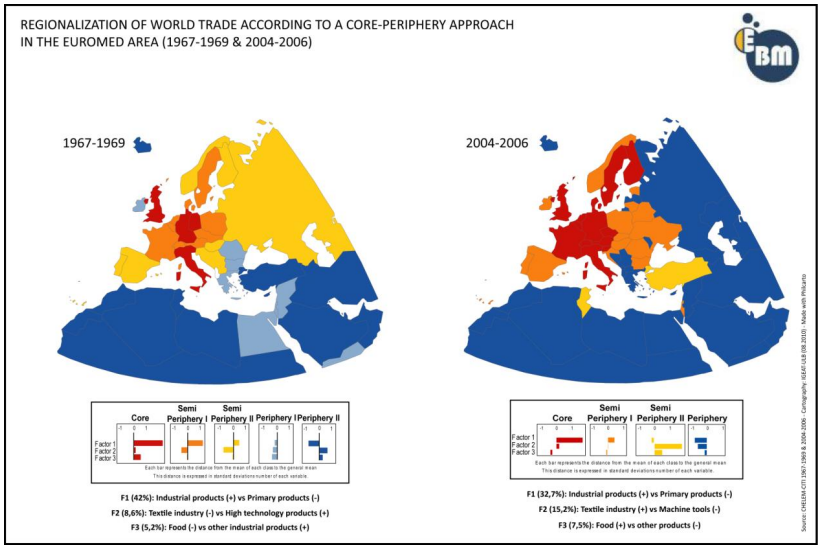


Figure 20: European and major countries in the international division of labour, 1967-2007



19 suggests internal differentiation in the geography of trade and FDI. Going further in the analysis, we propose to develop analyses to test whether we can speak about one coherent Europe? Whatever the answer to this question, it immediately raises a second one about the limits of Europe(s) and how it has evolved over the time.

Intramax analyses allow giving a first answer to both questions. This method groups together countries which trade more between themselves than expected through a simple model which eliminates the size effect. Intramax analyses confirm the high level of integration of Europe: if the world is divided into 5 classes, there is only one Europe (except Serbia which remains isolated), which mean that European countries trade preferentially between themselves (Figure 21, left). This result is important because the situation was different in the recent past: in 1996, there was a north/south divide within Europe (Nordic countries vs the rest of Europe; see also Poon, 2000 on the same question) and some Eastern countries were not yet included in the European space of trade; in 1968, the major divide lies at the level of the iron curtain. In 2007, these intra-European divides have not disappeared but one needs to keep more typological groups to confirm they are still alive.

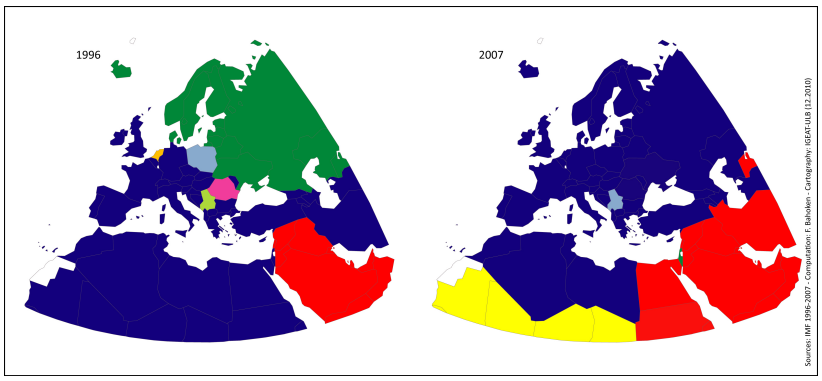
What is the limit of this unified Europe? It goes far east including nearly all ex-USSR; the southern limit has been restricted to Northern Africa, while ten years before it included most of the African continent, and near Middle East. We can thus say that functional Europe is larger than the political Europe defined by the European Union and some very close associate states. It is true that all analyses confirm Europe's influence has been shrinking but it remains indeed very high in the neighbourhood.

Europe and the rest of the world

Analyses with MaxCor2 allow shedding light on this issue since it groups together countries with similar geography of trade rather than showing the preferential links among countries. Yet, the picture is rather different than the one obtained with intramax: from 1968 to nowadays, we observe a clear east/west divide in trade (but also in FDI). However, we must note that this geographical divide has shifted to the west to include Germany and Italy with the eastern part of Europe in 2007 (Figure 22). These analyses plead for the existence of two Europe as far as the geography of trade of each country is concerned. What are the limits of these two Europe? Toward the East, the Eastern Europe type includes Russia and central Asian countries while toward the South, both Europe (East and West) see their respective area prolonging. However, especially in the last decade, we can observe that the extension of the area of both Europe has been reduced in Africa as well as in the Middle-East.

To go a step further, we consider the trade of European countries - arbi-

Figure 21: Typology of Euro-Mediterranean countries according to the geography of their trade, using intramax method, 1996 and 2007



The Intramax method has been run for all countries in the world. Classification is stopped when 50% threshold of intra-group flows is passed. Some countries are not yet grouped with others forming a class alone (e.g. Poland in 1996).

trarily defined - only with 14 regional blocks outside Europe[3], thus excluding intra-European trade. In Figure 23, European countries have been grouped according to the geography of their trade with these blocks. It allows distinguishing between three Europe: Eastern Europe, precisely east of the iron curtain, which is turned toward Russia; a northern Europe, turned to more important and dynamic areas of Northern America and Eastern Asia; an Afro-Mediterranean Europe which include Mediterranean countries, France and Belgium, which have specific relations with Middle East and Africa and, to a lower extent, with South America (mainly for Portugal).

Conclusion

Concerning Europe and economic flows, two major conclusions can be drawn. First, Europe is an integrated continent from an economic point of view, the deep divide from the cold war being now part of history. However, as far as extra-European relations are concerned, there are still big differences among European countries, with a deep East/West divide.

Second, we observe an important gap between the political Europe (EU-27) and what we call here functional Europe, that is the limits of Europe's influence across the world. All analyses have confirmed that the limits of Europe go as far as ex-USSR countries, near Middle-East and Northern Africa. This area has certainly been shrinking toward the south - and across

[3]Regional blocks have been defined according to WUTS classification from ESPON 3.4.1.

Figure 22: Typology of Euro-Mediterranean countries according to the geography of their trade, using MaxCor2 method, 1968-1996-2007

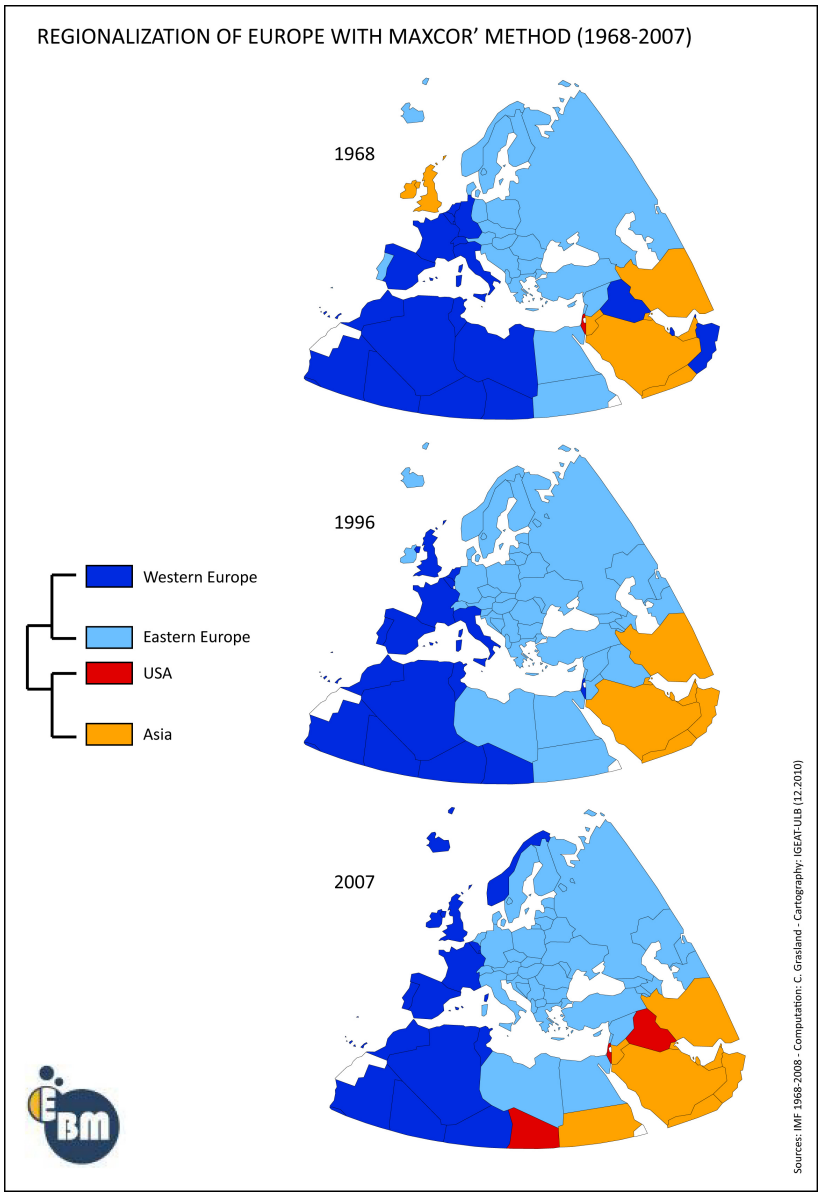
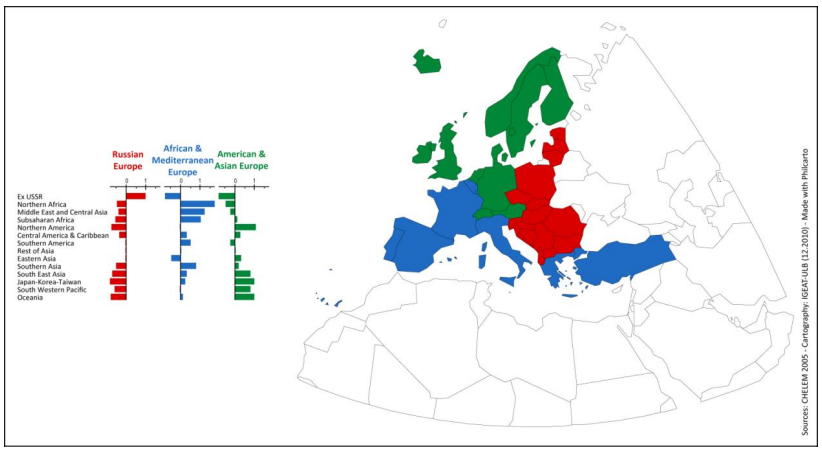


Figure 23: Classification of "European" countries according to their trade relationships with non European blocks



all other parts of the world - during the last decades but has also reinforced in the east since the fall of communism.

5.2 Europe in migratory flows

Migration movements are related to many reasons, notably higher incomes, better access to education and health, improved opportunities for the children, political and security reasons... In 2005, international migrants represented about 200 millions, nearly 3% of the world population. This share has been stable for the last decades, but the relative importance of Europe and Northern America has increased.

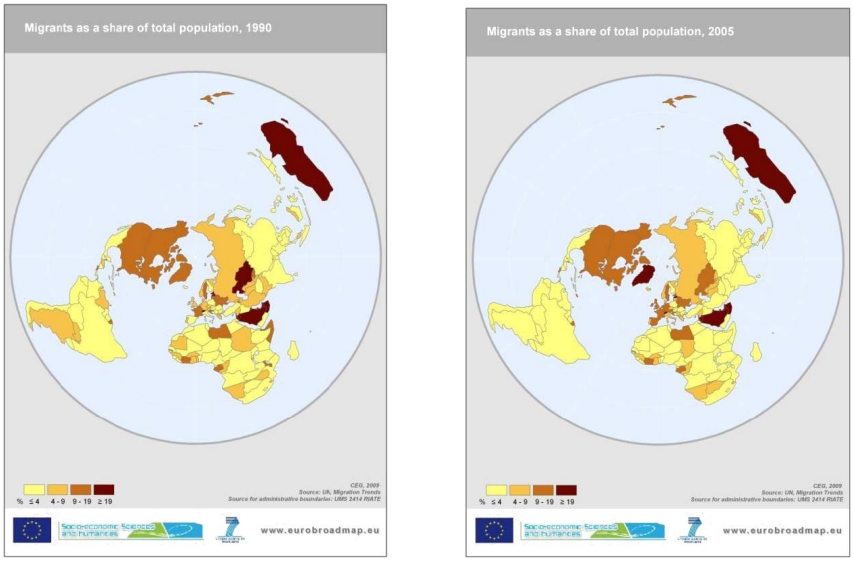
We will try to answer whether Europe is an integrated area or has internal divisions based on the intensity of migrant flows within European countries or between Europe and the rest of the world.

Europe integration and its limits

Near 70 millions of international migrants, one third of the world total, live in one European country (UN, 2009[4]). This is not only the result of Europe's attraction to the rest of the world, but also the consequence of the intense migrant flows within European countries. The EU economic and political integration has facilitated migration movements among EU countries, reinforcing the traditional relations built long ago or after World War II.

[4]UN, 2009, *Human Development Report 2009. Overcoming barriers: Human mobility and development*, New York.

Figure 24: Migrants as a share of total population, 1990 and 2005

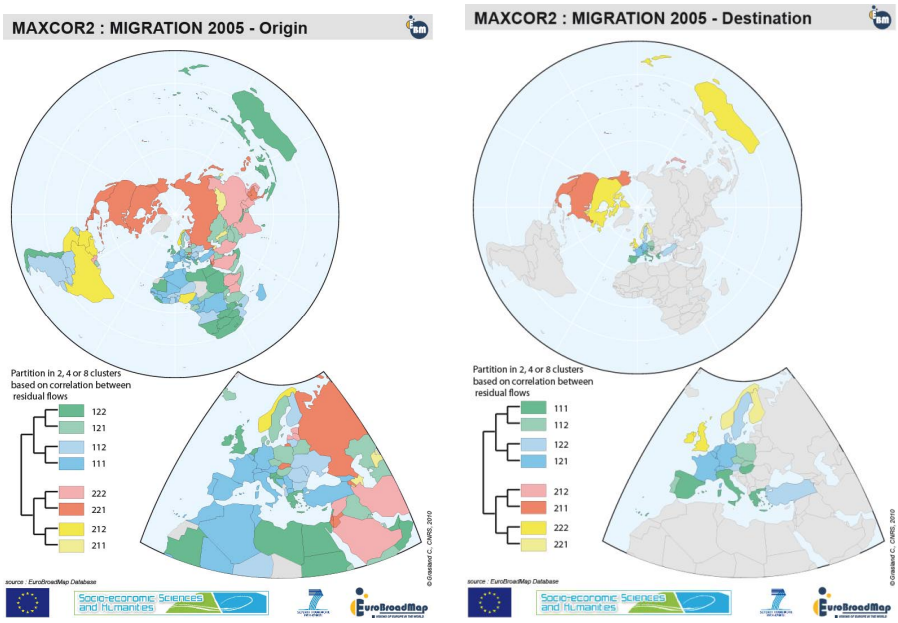


The creation of a borderless Europe, the Schengen Area, based on the Schengen Agreement of 1985, and the Convention implementing that agreement in 1990, have facilitated access and movements across Europe to third-country nationals, despite the differences in immigration laws between the signatory states.

From this point a view, Europe is on the way to a more integrated territory. The several enlargements of EU have generated an opportunity for easier movements across national borders for more European citizens and, on the other hand, have contributed to changing the migratory balance of various countries as Spain and Portugal since the 1990s, or Italy, since the second half of the 1970s.

The shift in migration from 1990 to 2005 shows that European countries have increased the share of migrants in their total population. At the same time, the USA and Canada maintained their relative position as did Australia in the Asian-Oceania region. The case of the Russian Federation and the new Baltic states is of different nature. In fact, due to the independence of the former USSR, many residents, former inter regional migrants, have become foreigners overnight. Taking into account these considerations, the maps in figure 24 - especially the 2005 map - show the relatively integrated position of Western Europe in the world's migration context.

Figure 25: Application of MaxCor2 to migratory flows between World and OECD countries in 2005



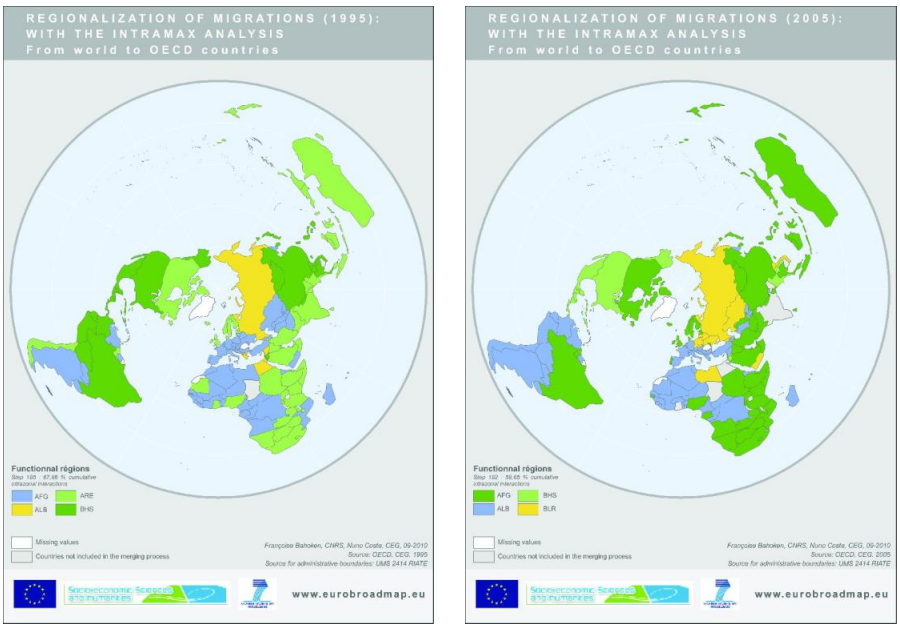
Europe - A differentiated space

Does Europe have an integrated position in migrant relations? The OECD databases allowed us to perform several methodological approaches, as MaxCor2 and Intramax. The results show a differential behaviour among European countries.

Two cluster maps were generated with the application of the MaxCor2 application, one related with the profile of emigrants toward OECD countries and a second one related with the OECD countries' profile of immigration from all countries of the world. The crossed reading of both maps allowed us to identify countries from EU, Africa, Southern America and Oceania that have preferential relations with OECD countries of EU. The UK, Norway and Finland as destinations are more closely related with Canada and Australia. In other words, migrants leaving UK and Finland are attracted by EU countries, while migrants arriving to Finland or the UK come from third countries.

A more detailed analysis reveals particular relations between the cluster of origin formed by Brazil, Peru, Colombia, Venezuela and Nigeria, have special relations with the destination clusters from southern Europe (Spain, Italy, Greece, Portugal) and eastern Asia (Japan, Korea), that are supported by the strong migrant relations between Portugal and Spain and the southern

Figure 26: Divisions of the World based on Migration flows World-OECD with Intramax Analysis - 1995 and 2005



America countries, and the strong migrant relations between Brazil and Italy and Japan.

The Intramax application was performed in two different matrices, for 1995 and 2005: one matrix 29x29, immigration between OECD countries, and another 192x29, with immigration from all world countries to OECD countries.

The divisions of the world based on OECD migration flows show, in 2005, four strong clusters: USA - Mexico; Japan - South Korea; UK - Ireland - Australia - New Zealand and Canada; and the European cluster without UK. In the 1995 division, at the same cut level, a Scandinavian cluster is identified, and Canada is joined with its American partners. Once again, the particular relations of UK and the Scandinavian countries are clearly identified.

The divisions of the world based on world toward OECD migration flows highlight the role of Europe, with four relevant positions: UK and its relations to Asia, America and Oceania; the Scandinavian countries with important relations toward the East and receiving migrants from all countries, most probably because of the asylum policy; Germany also enjoys special relations with the East, as does Austria, which also has relatively strong relations with Middle East countries; Southern European countries have special

relations with African and South American countries.

USA and Europe divide is position in the world division as expressed by the position of Brazil and India in 1995 and 2005. In 1995 Brazil had relatively more flows toward the USA, but in 2005 Brazil assumes a position in the cluster with Portugal. Another change characterizes India. In 1995 India had more expressive relations with the UK, but in 2005 switched to the USA cluster.

Conclusion

From the migration analysis two major conclusions can be drawn: first, as far as intra European migrant movements are concerned, Western Europe is a deeply integrated region, following its tradition of internal migrations; a second one is related to the relations with third countries. At this level several different positions can be identified, highlighting at least four major groups. The UK and Ireland with Australia, New Zealand and Canada; the Scandinavian countries with the Eastern countries and a set of other Middle Eastern and Asiatic ones; Southern European countries with African and Latin American countries; and Germany and Austria with special relations with Eastern and Middle East countries.

5.3 Europe in diplomatic flows

The analysis of diplomatic relations at the world level was mainly done in political sciences (Brams 1966; Snyder and Kick 1979) where the spatial dimension of diplomatic flows is rarely deepened. Some papers in geography show that the analysis of diplomatic relations is quite interesting in order to explore some hypotheses on the world system relations and organization (Neumayer 2008; Xierali and Liu 2006). When a country decides to establish or maintain a diplomatic relation, this is a convincing indicator of the existence of other types of flows between countries (trade, finance, migration etc.) (Pollins 1989).

This paper focuses on how European Union is embedded in world diplomatic flows. It analyses both the embassies and consulates that imply flows of different nature. Flows are more geopolitical regarding embassies and more correlated with migration flows in the case of consulates.

The first part presents the spatial structure of embassies and consulates flow, the second one uses the Intramax method to provide a regionalization based on all types of diplomatic flows (embassies, non-resident embassies and consulates) and the third one uses the MaxCor method to propose a world partition based on embassies flow.

Table 4: Statistical properties of diplomatic flows for the World and European Union

World	Embassies		Consulates	
	Received	Send	Received	Send
Min	0	0	0	0
Mean	42.67	42.67	50.72	50.72
Median	32.00	31.50	16.00	15.00
Max	164	175	427	973
CV	0.86	0.87	1.58	2.02
European Union				
Min	20	23	12	8
Mean	81.00	81.59	123.89	186.67
Median	76	85	79	166
Max	171	166	442	427
CV	0.51	0.43	1.07	0.64

Spatial structure of diplomatic flows

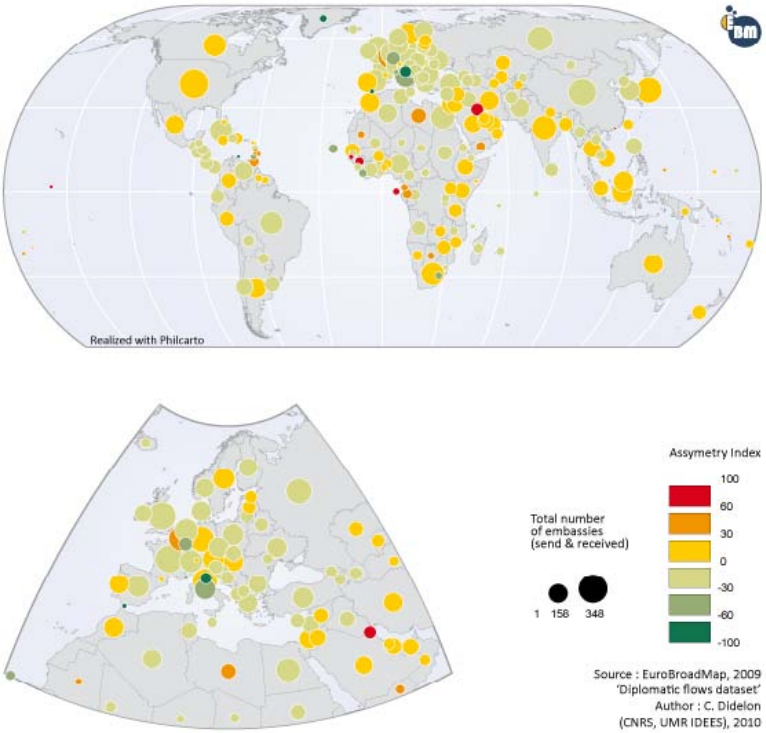
As far as embassies are concerned, the practices of European Union countries are similar to a certain extent: they are very much involved in embassies flows and are among both the greater senders and receivers of embassies (Table 4). However this high number of embassies can be interpreted as a symptom of the persistence of national diplomatic policy instead of the emergence of a coordinated European diplomatic network.

In 2009, most EU countries receive fewer embassies than they send showing a negative asymmetry index (Figure 27). It could be interpreted as the wish of each European country to maintain or to affirm a certain position in diplomatic flows through a large presence worldwide. This is particularly the case for UK, France and Spain that are former colonial powers and maintain a high number of diplomatic relations with their former colonies. Few relatively rich Northern and Central European countries show a slight positive asymmetry index: Germany, Austria, Italy, Sweden, Estonia and Latvia. This is also the case for Portugal.

The case of Belgium (high positive asymmetry index) is particular because of the specific attractiveness of Brussels where most of world countries send an embassy to the European Union that is also involved in the diplomatic relations with Belgium. This figure demonstrates the attractiveness of European Union as a political actor in the world.

The geography of embassies and consulates shows quite different patterns. Three key elements help understanding this spatial pattern: wealth, migration patterns and size of the receiving country. It is especially clear

Figure 27: Attractiveness of embassies in 2009



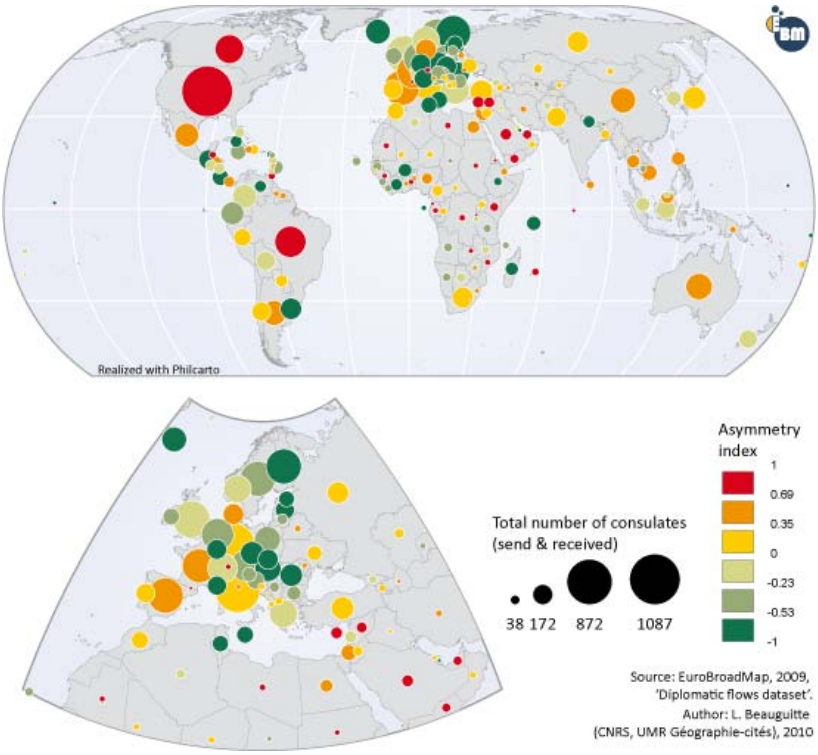
regarding USA being a country of immigration, the first economic power and a very vast country.

Four types of countries can be distinguished in Europe regarding two characteristics: volume of consulates and attractiveness. Few countries attract more than they send and the volume involved is high (France, Spain and Italy). A second type is also important regarding the volume of consulates but they receive less than they send (UK, Sweden, Finland, and Germany). EU Eastern countries are less important regarding the volume of consulates concerned and most of them receive much less than they send (Romania, Bulgaria, and Czech Republic). The last category (little volume but high attractiveness) is more heterogeneous as it concerns small states (Andorra, San Marino) and Balkan states.

A world regionalization based on diplomatic relations

The Intramax method has been tested on the valued diplomatic flows matrix taking into account embassies, non resident embassies and consulates. This method produces a partition of the world based on the intensity diplomatic flows between countries: the classification produced reveals the areas within

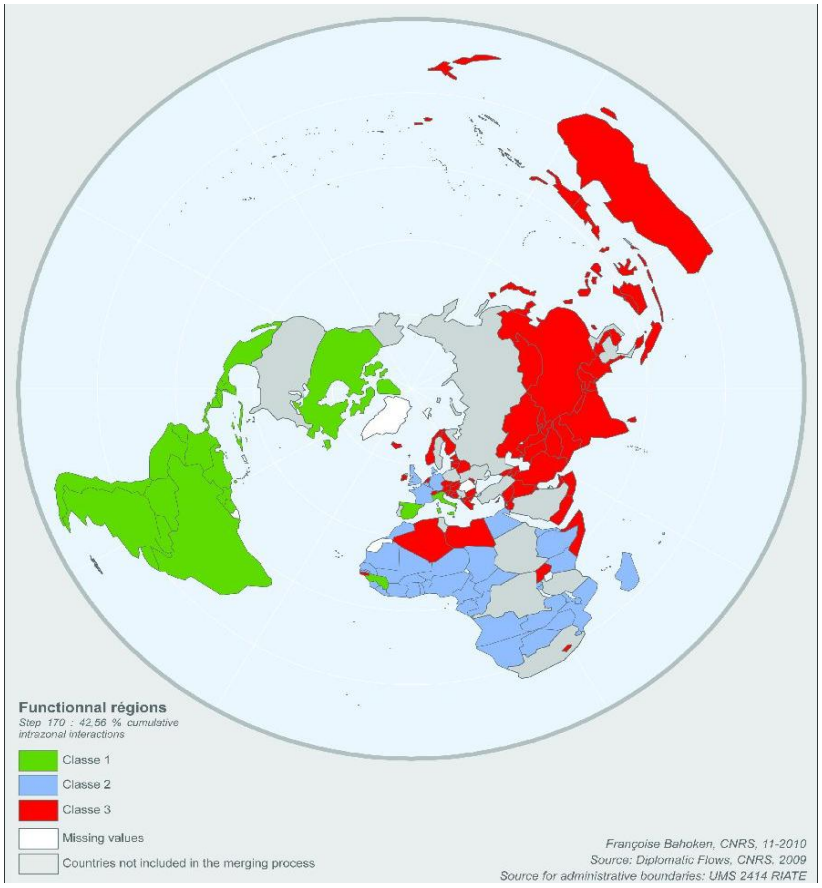
Figure 28: Consulates attractiveness in 2009



which the intensity of flows is the strongest. One problem here is that the method did not allow taking all countries into account in the aggregation. Some major diplomatic actors are not classified like USA and Russia Federation (Figure 29). The analyse produces (step 170, 42.56% of total intra-zonal cumulative interaction) three world regions that seem coherent from a spatial point of view, and also in a diplomatic perspective.

The first one is mainly concentrated on the American continent, and includes Spain and Italy (the position of Italy could be explained by the presence of a great number of migrants of Italian origin in American countries and then the presence of a great number of consulates in these countries). The second one is an African region including some rich former colonialist countries like France, UK, Germany, and Belgium that had colonies in Africa. The third one is centred on Asia, with a significant number of European states (Eastern and new member states). This region reflects to a certain extent the Non-Aligned Movement (India, Egypt, Indonesia, Malaysia, Former Yugoslavian countries, Iran, etc.) crossed with the former neutral European countries (Scandinavian countries, Austria, etc.) that always maintained relations with the NAM. What is striking in this map is that European Union

Figure 29: Regionalization of diplomatic flows (2009) with Intramax



countries are split in the three different regions which could illustrate a certain incoherence regarding diplomatic relations.

Results appear always congruent regarding partitions produced, and the EU situation based on a world perspective. The map 30 presents the results obtained with the in-flows of embassies. Results are quite similar to the outflows results, and EU in both cases is included in close classes.

On a global scale, we can note the presence of an old diplomatic network (class 221) including Western European countries, USA and former-USSR. These countries receive embassies from nearly all states and most of them were the main political actors during the Cold War. Eastern European countries are close of this class (222). All EU member states, plus candidate countries, are included in these two close classes.

A new diplomatic network (212-211) includes a large zone from Morocco to New-Zealand, including notably India, China, Japan and Australia. They

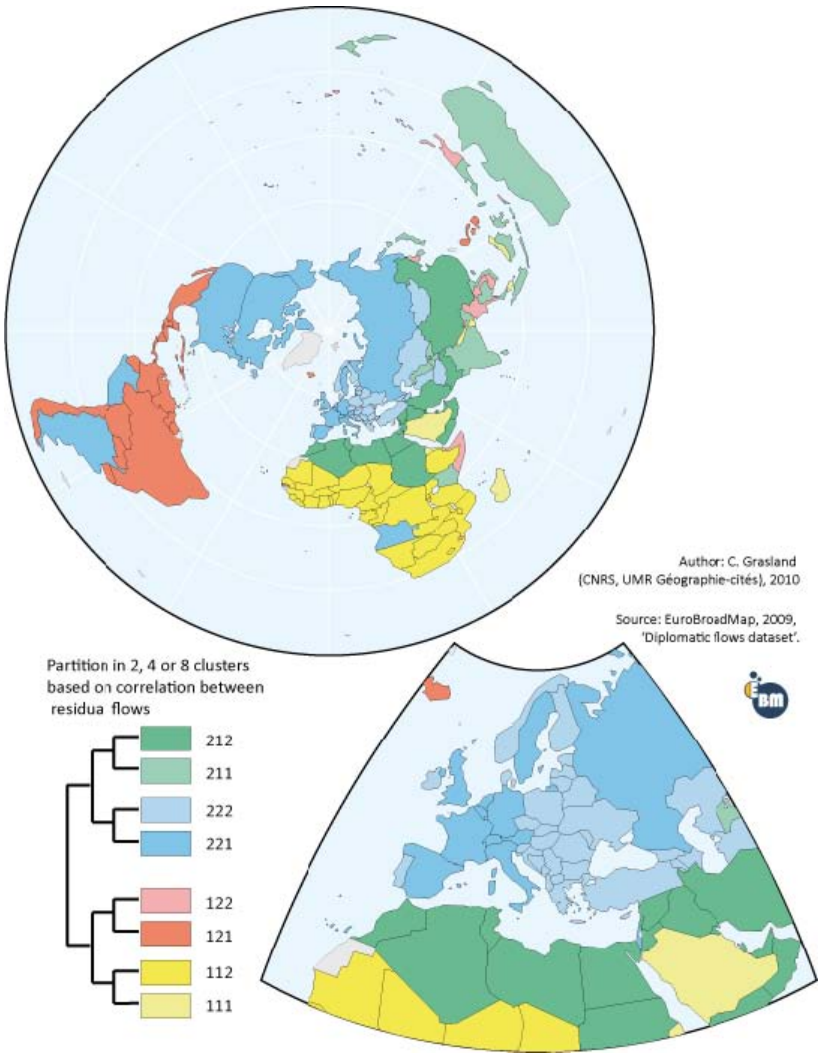
also receive embassies from numerous countries but with a profile slightly different from the previous network, with a higher balance between developed and less developed countries. Both sub-Saharan countries and Latin-American ones constitute coherent areas according to the geographical structures of their diplomatic relations. The first one (112-111) mainly exchanges with the old network and the new one, and between themselves. Latin-American countries (121) present a pattern of relations showing preferential relations with the old network and between themselves.

The last class (122) groups together countries with atypical relational patterns, including some ostracised countries like Myanmar or North Korea.

Conclusion

Methods used here are not the only ones available and many other treatments could be made on these two matrices. But, whatever the method chosen, results regarding Europe in the world are quite similar. EU is one of the most important actor on the global diplomatic scene regarding the number of diplomatic representations both sent and received, which can easily be explained regarding its economic power and its political fragmentation. This is illustrated by Belgium where the presence of EU institutions explains it appears always more attractive than expected regarding its size. From a diplomatic point of view, EU countries are similar when the number of diplomatic relations is taken into account; they are globally linked with all world countries. Yet, Europe does not appear as a coherent and delimited area. Divisions appear within Europe according to the geographical structures of countries' diplomatic networks. Firstly, a partition can be made between East and West. The main economic actors are also the main diplomatic powers, and Eastern states being in a peripheral situation from an economic point of view remain peripheral from a political one. Secondly, we also observe a partition regarding the direction of the diplomatic networks that could be due to several heritages including former colonial relations, cold war diplomatic relations or migration patterns. Unfortunately, the temporal perspective is missing and using other comparable databases could present a real interest to understand how the situation has evolved during the last decades.

Figure 30: Embassies received - the MaxCor partition



Synthesis and conclusion

Spatial structures at the world level

The main question raised in our analyses is whether we can identify strong spatial structures in the complex world of flows. More precisely, the following questions have been tackled according to the framework adopted:

- Can we still identify power relations in the world of flows?
- Can we find intermediate levels of organization between the state and the global?

The answers to these questions are highly dependent upon the method and the data used. In this report, we end with diverse classifications of the world according to the approach we follow. It does not make sense to synthesize these different results, because they start from very different and sometimes conceptually irreconcilable assumptions. However, our analyses have produced some unambiguous though partial answers to the questions raised.

First, in the space of flows that the world has become, we still identify strong spatial structures, not so different than in the past.

Second, using rather classical approaches, we could identify both power relations at the world level and a regionalization process - resulting in the integration of large areas at the continental scale. By the core/periphery approach, we highlight the permanence of the concentration of power and prosperity in core countries and the dependence of peripheries. The dominant flows' approach shares this vision. Yet, we highlight major evolutions with the empowerment of Eastern Asia, especially China, but this process cannot be assimilated to the end of power/dependence and core/periphery relations in the world-system. By using clustering methods, we also clearly highlight the existence of intermediate levels of organization, of integrated area at the continental or sub-continental scales.

Europe as a relevant spatial structure in the world

Our different analyses have certainly highlighted a spatial structure that can be associated with what is commonly named "Europe".

It means that we did identify a coherent area which gathers together core countries in structural terms, with intense flows among them. However, the limits of Europe are different according to the method used. At the minimum level, we identify only few powerful and/or prosperous countries that might be associated to the core of Europe: Germany, France, Benelux and a few other countries. At the maximum level, we identify a large area of influence associated to the European core that includes not only Central and Eastern countries, but also Balkan countries, the former-USSR area, Northern Africa, and the near Middle-East. As for the rest of Africa, its inclusion in Europe's influence area depends on the types of flows: large parts of Africa - Western

and Central Africa - still have strong human links with Europe, while the trade area of influence toward sub-Saharan Africa has completely shrunk in the last decades.

The analyses produced in this report have also shed light on the cohesion of Europe. Three related perspectives are developed in this report. First, in line with the idea of a European core, Europe can be defined as a series of circles around this structural core that can be objectively defined: Mediterranean and Northern countries belong to the first circle around that core; central and Eastern Europe, the Balkans, former USSR, Northern Africa, Western and central Africa form the following circles around that core, with a decreasing influence of European powers. Second, we can take a different perspective and highlight the spatial divides within Europe. In this perspective, many analyses show the importance of an East/West divide which largely corresponds to the Iron Curtain, although Germany might here play a role of pivot between both parts of Europe. However, Central and Eastern European countries do not necessarily show a strong internal coherence but are highly polarized by West European countries, though maintaining some privileged relations with their big Eastern neighbour. Many analyses also highlight the coherence of Northern countries (Denmark, Finland, Norway and Sweden). Inversely, the Euro-Mediterranean area is never identified as such in our analyses. Third, many analyses highlight a sort of dual Europe. On the one hand, Europe is a rather strongly integrated area in terms of economic, human, and even diplomatic flows. On the other hand, Europe appears as much less coherent when it comes to external flows of European countries: cultural and historical links, economic links, common diplomatic interests illustrate a very diverse Europe concerning its extra-European relations.

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