Measuring Economic Globalization:

Exploring methods to map the changing structure of world trade

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Abstract

This paper compares two methodological approaches to world trade analysis—social network analysis and an exponential distance model (combining aspects of log-linear analysis with multidimensional scaling and correspondence analysis). We examine and compare changes in the structure of world trade at two time points: 1980 and 2001. The study addresses two key questions: 1) What methods can we use to assess the impact of changes associated with economic globalization processes? and 2) Do patterns of international trade continue to conform to a core / periphery structure as world systems theorists argue; show evidence of converging as globalization theorists argue; or is there a combination revealing more delimited economic processes? The findings yield some important generalizations. First, we found that the hierarchical nature of the world-system has been remarkably persistent over time in terms of world system zones but that there are important modifications. The presence of Western countries including the US, Canada and many Western European states in the core has been remarkably consistent. What has changed is the number of Asian countries—including China and the four Asian tigers—that trade at high levels with core members. The pattern suggests a strong triad composed of North America, Europe and Asia form the core.

Introduction:

Interest in the phenomenon we refer to as globalization has continued to rise in the media and scholarly journals since the end of the Cold War which ended structural impediments to the spread of global capitalism. Although many researchers recognize that globalization has many dimensions—economic, political, and cultural—economic globalization has dominated the attention of many. We focus our attention on economic globalization in the decades before and after the end of the Cold War. Although there are several definitions—and indicators—of economic globalization, we draw from two primary sources. The Handbook of Economic Sociology (Smelser and Swedberg, 2005) defines economic globalization as referring to at least 3 related phenomenon: extensive growth in world trade in the past 50 years; from 5% of world GDP inter-national in 1950 to 17% in 2001; increased expansion and integration of the world's financial markets as both cause and consequence of the increase in trade; and tremendous economic development in Asia, especially Korea, Thailand, Indonesia, Philippines, and now China and India.

The second source is CSGR Globalization Center which has created an Index to measure economic globalization.[1] The index consists of four variables: trade (exports plus imports of goods and services as a proportion of GDP—data from the World Bank-World Development Indicators); FDI (inflows plus outflows of foreign direct investment as a proportion of GDP—also from the World Bank-World Development Indicators); Portfolio Investment (Inflows plus outflows of portfolio investments as a proportion of GDP—from the IMF-International Financial Statistics); and Income (Employee compensation paid to non-resident workers and investment income from foreign assets owned by domestic residents plus employee compensation paid to resident workers working abroad and investment income from domestic assets owned by foreign residents, as a proportion of GDP—also obtained from the World Bank-World Development Indicators). Their measure is intended to be complementary to the annual Globalisation Index published by Foreign Policy magazine (see http://www2.warwick.ac.uk/fac/soc/csgr/index/guide/variables/ and Lockwood, 2004).

The focus of this paper is twofold. First, we review some of the competing theories of post-Cold War economic structures through an empirical examination of the changing structure of world trade. Second, we examine some of the developments in methodology used to measure large scale datasets typically required by studies of global processes.

Economic Globalization:

Most theorists agree that the dissolution of the Soviet Union has resulted in the universalism of capitalism but recognize that some barriers remain, notably Iran, China and a few other smaller communist countries (Mann 2004; Held

[1] Their measure incorporates three dimensions of globalization: economic, social and political and they have created several indicators to measure each dimension.

and McGrew 2000). Several theorists believe that "capitalist activity is more 'trilateral' than global, being concentrated in the three regions of the advanced or 'global north': Europe, North America and East Asia" (Held and McGrew 2000:139). These three areas "contain over 85 percent of world trade, over 90 percent of production in advanced sectors like electronics, plus the headquarters of all but a handful of the top 100 multinationals (including banks)" (Held and McGrew 2000:139). Other theorists disagree whether more delimited processes such as Northernization, trilateralism, regionalization, or internationalization best describes current economic divides. Whereas world systems theory focuses on economic relationships to include political, cultural and military relationships. There is also a tradition of scholars who focus on the importance of global cities or multinational enterprises (MNEs) in the world economic structure. We discuss these theories and derivative hypotheses below.

Theories of the Structure of World Trade:

World systems theory. World-systems theory has produced the most extensive empirical accounts of the structure of the world economy in the field of sociology. The world-systems perspective argues that a country's role and position in a hierarchically organized world economy determined its subsequent developmental trajectories. Thus, in its early renditions that were closely coupled with dependency theory, the world-systems perspective held that the world could easily be classified into three role groups: Core, Semi-Periphery and Periphery. The roles these three groups play in the world economy were determined by their position in the international division of labor. Core countries' production regimes are primarily capital intensive, while peripheral countries' regimes are primarily labor intensive or based on the export of raw materials. Conceptually, the core/periphery distinction is one of a continuum.

Given this classical schematic from world-systems theory, many studies sought to establish the existence of core, peripheral and semi-peripheral states in the world economy (Snyder and Kick, 1979; Arrighi and Drangel, 1986, Nemeth and Smith, 1985; Smith and White, 1992; Van Rossem, 1997; Kick and Davis, 2001; Mahutga, 2006). There is a remarkable level of consistency in that every study "discovered" a hierarchically organized world-system, with fairly distinct zones in the hierarchy despite nuanced variations.

Recent renditions include Kick and Davis (2001), who confirmed that the core was comprised of Western industrial countries and these countries dominated the world system in economic, transportation, communications, sociocultural, political and military networks. The authors also find "differences in trajectories between countries in terms of overall economic well-being," from 1960 to 1970 (Kick and Davis 2001: 1570). They found that the strength of international economic ties impacted domestic (national) economies with countries in the socialist semicore faring worse in economic growth (Kick and Davis 2001:1573).

The most recent research explores the impact of changes associated with globalization and NIDL on structural inequality in the world economy from 1965 to 2000. Mahutga (2006) found that unequal levels of processing continue to create structural inequality through the reproduction of a segmented international division of labor. Mahutga concludes by arguing that while upward mobility is certainly possible in the world-system, it was rare through a period that many conceptualize as a massive restructuring, and that the globalization era (1980-2000) was associated with less structural change than the prior period (1965-1980). Therefore, the processes associated with globalization and the NIDL have not reversed structural inequality despite the ability of a few semi-peripheral countries to move up the value added hierarchy and thereby increase the standard of living within these countries.

H1: If world systems theory remains the best explanation of current global economic structures, we expect to see little change in the prior composition of core, periphery and semi-periphery, with wealthier countries of the global North occupying the core, less developed countries from the global South occupying the periphery, and limited mobility between the two.

Globalization. In contrast to the hyper-pessimistic world-systems proponents, some theorists cite the new international division of labor (NIDL) as evidence of globalization, ushering in a new era of prosperity for the global south as core / periphery relations erode. In its earliest renditions (Frobel, Heinrichs and Kreye, 1980) the NIDL thesis suggested that underdeveloped countries were increasingly targeted as export platforms by multinational corporations in search of cheap and vulnerable labor, resulting in rising manufacturing exports from the south. Whereas the original NIDL thesis suggested that labor-intensive manufacturing was a "dead-end" for true development, many scholars increasingly argue that it is just the "first rung on the ladder of rising skills and income…" (Sachs, 2005: 12). In sum, globalization and NIDL theorists increasingly suggest that the structure of the world economy should tend to converge as globalization proceeds (Firebaugh, 2003; Harris, 1986; Sachs, 2005).

H2: If globalization is the dominant global economic structure, we expect to see a reduction or softening of the core-periphery structure described by world systems theory. The structure will be less clearly hierarchical with the wealthier countries of the "global North" occupying the core and the "global South" occupying the periphery. We also expect to see more movement from the periphery to the semi-periphery and core.

Middle Range Theories.

Northernization. Mann argues that three waves of economic integration have resulted in what is more accurately called "Northernization" rather than globalization. The first wave of economic development after 1945 involved Southern

Europe, Japan and the "Little Tigers of East Asia," transforming "a privileged and fairly integrated 'West' into a privileged and fairly integrated 'North'" (Mann 2004:10). The second wave began in the late 1980s and included China and India with China absorbing over half of the Northern investment into the South. The third wave incorporated much of Asia but also several Eastern European economies (the Czech Republic, Poland and Hungary) and a few South and Central American countries like Chile and Mexico (Mann 2002:3). These countries have not really prospered as a result of integration, however, because of neoliberal policies forced on their economies and because of unequal exchange due to trade rules more favorable to the North. Debt from interest rates has resulted in structural adjustment programs which affect states expenditures, welfare programs, labor market regulation and tariffs, creating at times a negative net economic effect. Mann notes a "third tier" of Southern countries including Sub-Sahara Africa and some Middle Eastern and South American countries are essentially excluded from economic integration because they are poor credit risks for foreign investment and international trade.

H3: If Northernization is the best explanation of post-Cold War economic structures, we would expect to see a dominance of the US, Europe and Asia with a few prominent South and Central Asian countries.

Trilateralism or "triadization". The "triadization" of the world economy is represented by three core blocs (Europe, the Americas and Asia-Pacific), each with its own center and periphery, and marked by more interdependence within the three blocs than integration between them (Held and McGrew 2000:20). These (Northern) countries "provide over 80% of world production, trade and finance—and over 95% of economic research and development." Mann refers to this structure as "macro-regional trilateralism" resulting in a "Northern" economic hegemony (Mann, 2004:8).

Kenichi Ohmae identified as the triad of US, EU, and Japan; Rugman and Verbeke note that Ohmae did not anticipate the 'broad' triad of today consisting of NAFTA (1994), an expanded EU (25 countries in 2004), and Asia They believe these events will contribute to a deeper intra-regional market penetration but not global integration through multilateral negotiations (Rugman and Verbeke 2004: p. 5).

H4: If trilateralism or triadization is the dominant global economic structure, we expect to see EU-led Europe, US-led North America (including Mexico as part of NAFTA), and Japan led East Asia with China and India increasingly prominent in 2001. There should be strong intra-regional trade among these three blocs with strong regional trade agreements but also more trade among these three blocs than with any other countries or trading blocs.

Summary:

The above theoretical considerations make network analysis uniquely suited to the study of international trade because of the empirical implications for the structure of international trade. Mathematical modeling to capture dynamic aspects of change and the complexity inherent in multidimensional relationships has also increased in popularity. We attempt to incorporate these aspects in a model we describe as a geometric representation, combining aspects of log-linear analysis with multidimensional scaling and correspondence analysis. Because we are interested in change and because of the limitations in global trade data in earlier decades, we focus on two time points—1980 and 2001—representing the decades before and after the dissolution of the Soviet Union, ending the Cold War, and opening up the barriers to global capitalism. We expect to see changes in global structures, particularly those in international trade, as new alliances and international agreements flourished during this time period.

Data:

There are multiple indicators of economic globalization, with global trade data being only one source but as the purpose of our paper is to explore recent methodological advances to study large scale relational data, we limit our focus to global trade data.

Trade data:

The primary dataset used for this study comes from the World Trade Analyzer (WTA).[2] Countries report their exports and imports to the United Nations using various commodity classification schemes and with varying levels of detail. Statistics Canada then organizes the data. They begin with exports as the base data, estimate missing values through mirror statistics, and, wherever possible, distribute highly aggregated regions or commodity categories to more detailed countries or categories. The end product is a non-symmetrical, square matrix for each year and commodity type which is distributed though World Trade Analyzer, and available by paid subscription. The classification system the World Trade Analyzer uses is SITC rev. 2. Current versions of WTA contain data from 1985 to 2003. The version released in 2001 included data from 1980 to 1999; earlier versions also included data beginning with 1980. [3]

Regional designations are those used by WTA (same as those for UN Comtrade). To incorporate a dynamic aspect of the changing structure of world trade, we used two different time points—1980 and 2001—intended to capture the major transformations resulting from the end of the Cold War. There were 164 countries in 1980 and 181 in 2001, for a total of 187 unique countries. We did not feel the need to keep the same set of countries for each year, because it was

[2] We used an online version of WTA. There are several academic portals; we accessed the data through Princeton University: http://trademeasures.com:8185/welcomeprinceton.htm.

[3] The UN does not report data for Taiwan for political reasons (e.g. China's "One Nation" policy), and often the data for China includes Taiwan's information. The UN Comtrade database incorporates Taiwan as a trading partner by adding it to "Other Asia, not elsewhere specified" (code 490) which could in principle contain trade other than from Taiwan but is generally considered Taiwan. In general, using reporter data to represent Taiwanese trade reasonably matches the data actually reported by Taiwan (although never a perfect match). WTA is presumed to use the Comtrade data directly and do not supplement it with OECD data. Hong Kong re-exports are another problematic reporting area. These issues reflect a need for the ITRB to compile a sifted, documented and transparent set of estimates. Taiwan's reported data is therefore not included in Comtrade; data for Taiwan in the WTA is taken from other countries' reported trade with Taiwan (e.g., "mirror flows"). We thank Ronald Jansen, UN Stats division, and Scudder Smith, WTA, for their help in answering the questions related to preparing the data for analysis.

important to capture major transformations such as the realignment of former Soviet satellite countries with Western states.

Methods:

Several methods are appropriate for studying global economic data. Social network methods have increased in popularity across disciplines as a method to infer structure among a full array of relational data. Mathematical modeling to capture dynamic aspects of change and the complexity inherent in multidimensional relationships has also increased in popularity. We attempt to incorporate these aspects in a model we describe as a geometric representation, combining aspects of log-linear analysis with multidimensional scaling and correspondence analysis.[4] Thus, we conduct several network analyses on these data: a role / position analysis and a new model we call an exponential distance model. Each of the methods has a unique approach to visualization of structural data which we compare and evaluate.

Role and Position Analysis:

There are many ways to find similarity in relations among states using standard social network methods. Here we choose an approach that was first applied to international trade by Smith and White (1992). This analytical strategy draws from the substantive concerns of the world-system perspective, along with the methodological tradition of *Positional and Role Analysis* of Social Networks. As Wasserman and Faust (1994) note, "There are two key aspects to the positional and role analysis of social networks: identifying social positions as collections of actors who are similar in their ties with others, and modeling social roles as systems of ties between actors or between positions" (Wasserman and Faust 1994: 351). As will become clear later, this present analysis is largely confined to the first task—the identification of collections of actors who are similar in their ties with others—but the results make the other task—modeling systems of ties between positions—possible.

World-systems theory studies informed by the world-systems perspective attempt to measure the extent to which the structure of international trade is organized hierarchically, and more importantly to uncover the subgroups that correspond to Core, Semi-Periphery and Periphery. Our network analysis therefore follows this tradition by 1) applying a regular equivalence algorithm that measures the similarity of each actors trade profile to each other actors trade profile; 2) determining which groups of actors are relatively equivalent to each other vis-à-vis everyone else by a) performing a hierarchical clustering routine to the matrix of regular equivalencies and b) scaling the matrix of regular equivalence into a two dimensional Euclidian space; then 3) superimposing steps 2a and 2b above onto each other and 4) using a

[4] We are still developing this model but show some preliminary results here.

somewhat subjective method of agreement between 2a and 2b to produce a set of relatively equivalent positions in the structure of international trade.

Regular Equivalence. The first step in this analysis calculates the degree of regular equivalence for each pair of countries with the following algorithm.[5] The regular equivalence (M_{ij}^{t+1}) between countries *i* and *j* at iteration t+1 is:

$$M_{ij}^{t+1} = \frac{\sum_{k=1}^{g} \max_{m=1}^{g} \sum_{r=1}^{R} M_{km}^{t} \left({}_{ijr}M_{kmr}^{t} + {}_{jir}M_{kmr}^{t} \right)}{\sum_{k=1}^{g} \max_{m}^{*} \sum_{r=1}^{R} \left({}_{ijr}Max_{kmr} + {}_{jir}Max_{kmr} \right)} \quad (1)$$

where the denominator is the maximum possible value of the matches between the profiles of *ik* and *jm* that would occur if all of the ties between *i* and its alters (*k*) were perfectly matched to the ties between *j* and its alters (*m*), and all of *k* and *m* were regularly equivalent. The numerator determines the *best matching* of the ties between *j* and *m* for *i's* ties to *k* weighted by the regular equivalence of *k* and *m* from the previous iteration (Wasserman and Faust, 1994). Thus, the algorithm determines the best possible matching of ties between *i* and *j* weighted by the equivalence of their alters, and divides that value by the maximum possible value of the numerator. It is important to remember that the equivalence of each pair of actors is revised after each iteration $(t+1)$. We have specified three iterations, with the third serving as the measure of regular equivalence for each pair of countries. It is highly unlikely that any two nations would be exactly equivalent, so applying a regular equivalence algorithm to three matrices including the sum of all the traded commodities for countries that report their trade in 1980 and 2001 produces an equivalence matrix in which the *ij* cell equals the regular equivalence between *i* and *j* that measures between maximally dissimilar (0) and regularly equivalent (1).

Hierarchical Clustering. In this analysis, we use the matrix of regular equivalencies as input for a single link hierarchical clustering routine for each year. Since the matrix of regular equivalencies gives a measure of equivalence between each pair of actors, the hierarchical clustering routine is well suited to finding "cut points" that minimize the between group variance in regular equivalence (or maximize the within group similarity). Hierarchical clustering starts by putting each actor in an NxN matrix into its own cluster so that the similarity between clusters equals the similarity between each actor. The procedure then finds the most similar pair of actors and merges them into one cluster. The third step computes similarities between the new cluster and each of the other actors. The second and third steps are carried out until all actors have been merged into a single cluster of size N (Borgatti, 1994). In principle, an analyst could start out with some α criterion whereby actors *i* and *j* would be considered regularly equivalent if $RE_{ij} \geq \alpha$. However, there is no a-

[5] The original trade matrices were transformed with the base 10 logarithm to reduce skew. For an overview of the method, see Borgatti 1994; and Borgatti and Everett, 1992, 1999.

priori theory that favors one level of alpha over another, and large real world data sets are rarely broken down into discrete homogenous groups at any single threshold level. Thus, we use the hierarchical clustering results in conjunction with correspondence analysis to determine the boundaries of each equivalence group.

Correspondence Analysis. Correspondence Analysis is one of a family of techniques that draw on a common computational foundation: the Singular Value Decomposition (SVD). In the context of our present analysis, correspondence analysis is simply a singular value decomposition preformed on a matrix H in which the cells of the original matrix have been transformed so that the row / column marginals are approximately 1, with the following equation:

$$(2) \qquad h_{ij} = f_{ij} / \sqrt{f_i \cdot f_j \cdot},$$

where h_{ij} is the transformed value in H, f_{ij} is the original value in the ij^{th} cell of the regular equivalence matrix, $f_i.$ is the row marginal, and $f_j.$ is the column marginal.

At a basic conceptual level, correspondence analysis represents the basic structure in a set of data by decomposing the transformed matrix into its three component parts: a matrix U that summarizes the information in the rows; a matrix V that summarizes the information in the columns, and a diagonal matrix of singular values d that weights each UV vector by its importance to the overall structure. The matrix d of singular values is always arranged from largest to smallest, where large singular values explain much variation, and small singular values explain less (Weller and Romney,). The third step in a classic correspondence analysis rescales the information in U and V to obtain "optimal," or "canonical" scores by multiplying both U and V by the square root of the ratio of the total marginals to the row / column marginals, respectively:

$$(3) \qquad X_i = U_i \sqrt{f.. / fi.} \text{ and } Y_i = V_j \sqrt{f.. / f.j}$$

The final step incorporates the singular value "weights" so that each dimension of X and Y is multiplied by the square root of its respective singular value. In sum, correspondence analysis begins by generating H, which is a transformation of the original matrix (in this case, a matrix of regular equivalencies) so that the marginals (or expected values) are removed. It then performs a singular value decomposition on H to produce three matrices, UV and d. As a third step, correspondence analysis rescales U and H with equation 3 to produce the X and Y matrices. Finally, correspondence weights each X and Y dimension by their associated singular values to produce a multidimensional representation of the similarity between actors (in this case country regular equivalencies) in which each dimension is successively "less important" to the overall structure.[6] These results can be easily visualized by plotting successive dimensions of either X or Y, or X and Y. Thus, correspondence analysis allows us to represent actors in a multi-dimensional Euclidian space by assigning coordinates (weighted dimensions of X and Y) to actors that place them close to those with whom they are similar and far from those with whom they are dissimilar (Weller and Romney,). Since our matrix of regular equivalencies is symmetric, e.g., X = Y, we can simply plot one or the other. Finally, one can evaluate the "fit" between single or multiple dimensions with the following equation:

$$(4) \qquad 100 \times \frac{\lambda_m^2}{\sum_{m=1}^{M} \lambda_m^{2'}}$$

where *M* is Singular Value 1, 2, 3, …*M*. Interpreting the results from correspondence analysis depends on the amount of variation explained by each singular value/dimension and the observed spatial pattern of objects in the Euclidian space. Thus, one can have a relatively simple structure (few significant dimensions) or a complex one (many significant dimensions).

Superimposing the hierarchical clustering results onto the Correspondence Analysis results. The final steps brings the results of the two complementary procedures—hierarchical clustering and correspondence analysis—together to derive a set of positions to describe the structure. This third step can be broken down into three stages. In the first stage, we examine the hierarchical clustering results in the form of a dendrogram to give a first approximation of the groups from that analysis (dendograms available from the authors upon request). Thus, the final stage of this procedure seeks consistency between the correspondence analysis results and the hierarchical clustering results. Because the hierarchical clustering procedure can be derived in several ways and therefore vary, while the CA results are always consistent, we rely on the block the CA analysis produces.

Role and Position Results. The graphs for Figures 1 and 2 display the results from the correspondence analysis of regular equivalence. The X axis represents the first dimension and the Y axis represents the second dimension. The resulting structure places the "core" (pink nodes) at the top right hand of the graph with semi-peripheries 1 (blue nodes) and 2 (orange nodes) directly underneath and to the left. The 3 categories of peripheral countries are farther to the left. Periphery 3 nodes are located the farthest from the core, as you might assume. Thus, the first dimension of the

[6] The reader should note that the first dimension of U and V, and the first singular value in d are considered trivial since they will always equal 1, by construction (see equation 2 above).

correspondence analysis of regular equivalence can be thought of as a measure of "coreness," where closeness to the upper right most point corresponds to the level of "coreness." Notably, there is no change in the structure over time[7].

Figure 1 shows trade ties for all countries that trade at 0.3% of total trade in 1980, colored by world system zones. It uses the coordinates from the 1980 network analysis as attributes and creates a graph that "layers" countries according to the zone or bloc they represent. Our method of regular equivalence resulted in a structure that strongly resembles world system zones described by world systems theorists. Figure 1 reveals the core to be comprised of the US, several Western European countries, England and Japan, and the periphery to be comprised of developing countries in Africa, Asia and Latin America. Figure 2 shows the results of the same analysis for 2001. Again we see the same overall hierarchy but note that there are more countries in the "core" and more movement overall between groups. In general, the countries in the core comprise the triad discussed in trilateralism and also show evidence of the impact of regional trade blocs. If the general structure of global trade remains consistent with that predicted by WST, it also incorporates a trilateral structure shaped by regionalization.

Exponential Distance Model:

Introduction. A trade table is a square matrix F with frequencies. Rows and columns of the table correspond with a number of countries, the same countries for rows as for columns. Cell f_{ij} of the table indicates how much country *i* exports to country *j,* or, equivalently, how much country *j* imports from country *i*. The diagonal of the table usually consists of missing data, because countries do not import from or export to themselves. Thus, using terminology from Haberman (1974) and Bishop et al. (1975), the diagonal of the table has structural zeroes.

Model. We suppose the f_{ij} are realizations of independent Poisson variables $\underline{f}_{ij}$, with $E(\underline{f}_{ij}) = \lambda_{ij}$. It is well known that by conditioning on the row marginals this model also covers the product multinomial model, in which rows are independent multinomials. The negative log likelihood for the Poisson model is

$$(1) \qquad \Delta = \sum\sum\{\lambda_{ij} - f_{ij}\log\lambda_{ij} \mid i \neq j\}$$

The assumption of independent Poisson cells is made for convenience, for the same reasons the assumption of normality is made in continuous multivariate analysis. Alternatively, one can simply think of (1) as a natural way to measure the distance between the observed frequencies f_{ij} and the expected frequencies λ_{ij}.

[7] Because of space constraints, we only included a sample of our analysis. We created tables to display coordinates for the country during each year of analysis to show change over time but omit them here. This information is available by request from the authors. Tables 1 and 2 (Appendix A) compare the clusters from each analysis for 1980 and 2001; they also show both abbreviations and the full names of the countries.

Base Models. The two key specifications that we shall elaborate on in this paper are the quasi-independence model, which says that

(2a) $\lambda_{ij} = \alpha_i \beta_j \qquad \forall i \neq j$

and the quasi-symmetry model, which says

(2b) $\lambda_{ij} = \alpha_i \beta_j \eta_{ij} \qquad \forall i \neq j$

where $\eta_{ij} = \eta_{ji}$. The η_{ij} are called *similarities*. Clearly quasi-independence is the special case of quasi-symmetry in which all similarities are equal. In the quasi-independence model, each country has an *export effect* α_i and an *import effect* β_j, and the amount of trade between countries is just determined by these export and import values. Export and import values will be influenced by the population of the country, but also by its wealth and trade balance. Clearly China has an exporting economy, and the US has an importing one.

In the quasi-symmetry model the trade is determined by both export and import values and the similarity. The similarity is an unobserved parameter, but it is expected to be related to geographic distance, and also political and economic affiliations. Both the quasi-symmetric and the quasi-independence model are base models, in the sense that we do not expect them to be even approximately true but we can use them as baselines with which to compare our hopefully more realistic models.

Geometric Models. We can restrict the quasi-symmetry models further by requiring that the similarities are inversely related to distances on an unknown map. In particular we assume the *quadratic Euclidean model*

(3a) $$\eta_{ij} = \exp\{-\sum_{s=1}^{p}(x_{is} - x_{js})^2\}$$

The problem is now to recover the map, along with the import and export values of the countries. Alternatively, our software can also fit the *simple Euclidean model*

(3b) $$\eta_{ij} = \exp\{-\sqrt{\sum_{s=1}^{p}(x_{is} - x_{js})^2}\}$$

but for various reasons we will initially concentrate on the quadratic case in this paper. Geometric models of the form (3a) or (3b) have been proposed many times, and in many different contexts, in econometrics, psychometrics, and socio-metrics.

Correspondence Analysis Approximation. Let us look more closely at the quadratic Euclidean model. By expanding the squared distance we have

$$\eta_{ij} = \exp\left\{-\sum_{s=1}^{p} x_{is}^2\right\} \exp\left\{-\sum_{s=1}^{p} x_{js}^2\right\} \exp\left\{+2\sum_{s=1}^{p} x_{is} x_{js}\right\}$$

If we define

$$\overline{\alpha}_i = \alpha_i \exp\left\{-\sum_{s=1}^{p} x_{is}^2\right\},$$

$$\overline{\beta}_j = \beta_j \exp\left\{-\sum_{s=1}^{p} x_{js}^2\right\},$$

and $\overline{x}_{is} = \sqrt{2}x_{is}$ then for the squared Euclidean model

$$\lambda_{ij} = \mu\alpha_i\beta_j \exp\left\{-\sum_{s=1}^{p} \left(x_{is} - x_{js}\right)^2\right\} = \mu\overline{\alpha}_i\overline{\beta}_j \exp\left\{\sum_{s=1}^{p} \overline{x}_{is}\overline{x}_{js}\right\}$$

which says that the squared Euclidean model is equivalent to the *inner product model*. Instead of fitting exponents of negative squared distances, we could also fit exponents of inner products, and obtain basically the same results (with an exactly equal goodness-of-fit). For the next step in the approximation, observe that if z is small, then exp(z) ≈1 + z. Thus if the inner products are small, then

$$\lambda_{ij} \approx \mu\overline{\alpha}_i\overline{\beta}_j \left\{1 + \sum_{s=1}^{p} \overline{x}_{is}\overline{x}_{js}\right\}$$

and this is the model used in the symmetric version of Correspondence Analysis (if one insists on interpreting Correspondence Analysis as a model fitting technique). In ordinary Correspondence Analysis one computes separate maps for rows and columns, which means that the squared Euclidean distance model is approximated by a Correspondence Analysis model with row and column scores equal. These approximations are also discussed in detail by Goodman (1991).

Fitting. Fitting the model means maximizing the Poisson likelihood. We have constructed convergent iterative algorithms, with corresponding computer implementations in the R programming language, based on the majorization principle (for example, De Leeuw, 1994). We shall not give the details of the algorithm here, but it amounts to solving a sequence of multidimensional scaling problems on transformed data.[8]

EDM Results and Analysis. The graphs for this analysis are more representative of actual distance between countries while the graphs for the CA of RE represent the Euclidean distance between the RE of each country. Figure 3 shows the results for the exponential distance model for 1980. There is a clear cluster of triad/core countries in the lower right hand corner of the table[9]. Countries that were identified as members of semi-peripheries 1 and 2 are located in closest proximity followed by the peripheries 1-3 (P1-P3). There are clear groups of small island and African countries located in P2 and P3. P1 has several countries from Central America, the Caribbean, and a few from Africa. Figure 4, the graph for 2001, has the same horseshoe shape of the 1980 graph (only upside down—placement does not matter, just clusters and distance from one another). There is a clear cluster of triad/core countries (and more of them) in the top right hand corner and a very dense group of semi-peripheral countries nearby. We see many more Asian countries (in addition to Japan, China, Hong Kong, Malaysia, Singapore, South Korea, and Taiwan), NAFTA members Canada and Mexico; and many former Eastern European countries. These are the clear global winners; the sub-Saharan African countries in the dense cluster on the left hand side of the graph are the clear global economic losers. In short, the clusters represent the same clusters we found in the social network analysis.

Tables 1 (1980) and 2 (2001) (Appendix A) compare the results from the first dimension of the correspondence analysis (with country names colored according to the world system zone it represents) with the first dimension of this exponential distance model. We correlated these two dimensions and found about a 0.8 correlation for all three years indicating high similarity in the clusters found in these two methods. Next to each column of coordinates, we include the block number from the hierarchical clustering analysis ("HC groups") to show the world system zone to which the country belongs.

Summary:

The focus of this paper was to explore the changing structure of global trade during a period of significant political transformation, e.g., the end of the Cold War and the dissolution of the Soviet Union resulting in not only many newly independent states but changing economic, military and political alliances.

Our first method, social network analysis, offers essential tools for discovering similarity in relations and uncovering the structure inherent in a number of relationships. There are also a variety of graphing programs with an

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[8] Code is available from the authors.

[9] The coordinates from this analysis are available upon request from the authors. See Table 3 for the full country names.

array of algorithms that are excellent for illustrating the structure among relationships. Our second method, the geometric representation model, offers a measure that captures similarity of trading relationships between countries while accounting for factors such as geographical distance that can be assumed to be a factor in any trade relations.

Both methods found essentially the same clusters of countries, and each suggests a structure that modifies the traditional conception of world systems zones. The overall pattern of global trade suggests a combination of several predicted patterns. The dominant pattern is clearly one of trilateralism: US-led North America with NAFTA suspected to be central to increased growth; EU-led Europe; and Japan-led East Asia with China having remarkable growth in the post Cold War time period and expected to continue following its membership into the WTO. Related to this is a Northernization with the Triad members clearly part of the global North. There is evidence of Regionalization given our knowledge of major trade agreements, and evidence of growth in the trade of countries participating in them--particularly in NAFTA and the EU—but we do not test for this. It remains to be seen what regional trade agreements will dominate in Asia and which countries will benefit the most. Trade agreements among African countries appear to have more of a local than a global affect. Rugman's (2005) study of MNEs also underlines the dominance of the triad and suggests regionalization or internationalization is a better description of the global economy.

Finally, there is the continuing persistence of world system zones, which are historically path dependent. Although we found it instructive to classify countries forming clusters or blocs of similarity according to the traditional world systems zones, we do note divergences. For example, in 2001, Mexico is included as a "core" country. Although Mexico can not be considered a core country in general, it now trades at high levels with traditional core countries. Presumably this is because Mexico is a member of a central (core) trade agreement—NAFTA. This membership has influenced its overall levels of trade and its position in the structure of global trade. Can free trade agreements account for the improved status of some countries of the semi-periphery and periphery? Why did several Latin American countries move up the global economic hierarchy while sub-Saharan African countries became even more peripheral? Is it because trade agreements do not include wealthy countries of the global North? These are questions with important policy consequences. They relate to important issues of inequality which in turn has been attached to arguments of human rights—e.g., whether there should be an economic justice component. Predictably, there is a split between the wealthy countries of the "global North" and the poor countries of the "global South."

This paper was meant as a first step to explore globalization processes and as such, to generate as many questions as it answered. Important next steps include dynamic or longitudinal models which look at change in both the structure of world trade and the position of individual countries within this structure. It is also important to look at the reasons for these changes by considering other factors such as country attributes (levels of wealth, political regime type, levels of freedom, etc.) and country memberships (important trade, security and political agreements and participation in organizations focused on these areas). We are currently working on two other methods which address these: three-way models and models incorporating external information.

Conclusion and Future Research:

The study addressed two key questions: 1) What methods can we use to assess the impact of changes associated with economic globalization processes? and 2) Do patterns of international trade continue to conform to a core / periphery structure as world systems theorists argue; show evidence of converging as globalization theorists argue; or is there combination revealing more delimited economic processes? In addition to the results from the comparison of methodologies above, we found other important generalizations and paths for future exploration. First, we will continue to expand on the model we are developing to incorporate geographical, political and economic variables. An important variable we will examine further is the effect of regional trade agreements (RTAs). There is some evidence that RTAs of core members appear to have had a positive impact on the trade growth of member countries individually and relative to overall trade. Interestingly, several Latin American countries have experienced upward mobility—some are notably members of MERCOSUR. This is in marked contrast to the further marginalization or peripheralization of African countries who are currently the global economic losers. We intend to explore the relationship between RTAs, inequality and development and their impact on globalization.

In addition, future research will explore the structure of trade of individual commodities, examining both the role of countries in global commodity chains and how this impacts the international division of labor. This study can potentially provide insights into a question posed by Michael Mann: can the pressures of comparative advantage reduce Northern domination of the global economy? (Held and McGrew 2000:140). The 1999 United Nations Development Project (UNDP) Report notes that stronger governance is needed in order for more countries to benefit from globalization (Held and McGrew 2000:341). Kick and Davis (2001) note that political and security ties among states help explain economic ties. Our study suggests the entrenchment of the global economic hierarchy is based on the strength of “interlocking” ties among the wealthy countries and their trading partners. We believe exploring the structure of multiple transactions over time can provide us with insights into the role and position of multiple entities (states and non-state actors), how these are impacted by globalization processes, and what mechanisms are involved in large scale structural changes. This information can be invaluable in exploring policy development in all dimensions of social life.

Finally, we hope this paper begins to highlight the wealth of empirical information contained in the very exhaustive international trade data disseminated by the United Nations, as well as the promise of relational types of analyses as those presented here. Indeed, in this paper we barely expose the tip of the iceberg. First, we only analyze total trade, consisting of the sum of all bilateral trade. While this is a reasonable first approach to the data, it leaves untouched the rich information available in the disaggregated trade data, which can be broken down to VERY SPECIFIC commodity categories. The huge and growing literature on global commodity chains is built upon the assumption that different kinds of goods manifest different types of power arrangements between actors, but this (and other) assumptions have yet to be tested. We encourage researchers to explore the wealth of information contained in the specific commodity categories. Second, we only analyzed two time points: 1980 and 2001. The UN has, in fact, been collecting very rich data since 1965. We all know that cross-national data analysis suffers from a dearth of reliable data. We suggest that the UN commodity trade data fills a valuable empirical gap in this regard. Finally, network analysis is becoming increasingly popular in the field of social sciences. We've presented, in a comparative way, two network approaches to trade that, by now, are widely available to scholars of globalization. This in no way exhausts the possible approaches, but it does, hopefully, point toward a very fruitful avenue for future work to pursue.

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Measuring Economic Globalization:

Exploring methods to map the changing structure of world trade

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Appendix

List of Figures:

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Figure 1: 1980, trade > 0.3%, nodes colored by WS zones, placed spatially by CA

Core = Pink; SP1=Blue; SP2=Orange; P1=Neon Green; P2=Red; P3=Dark Green

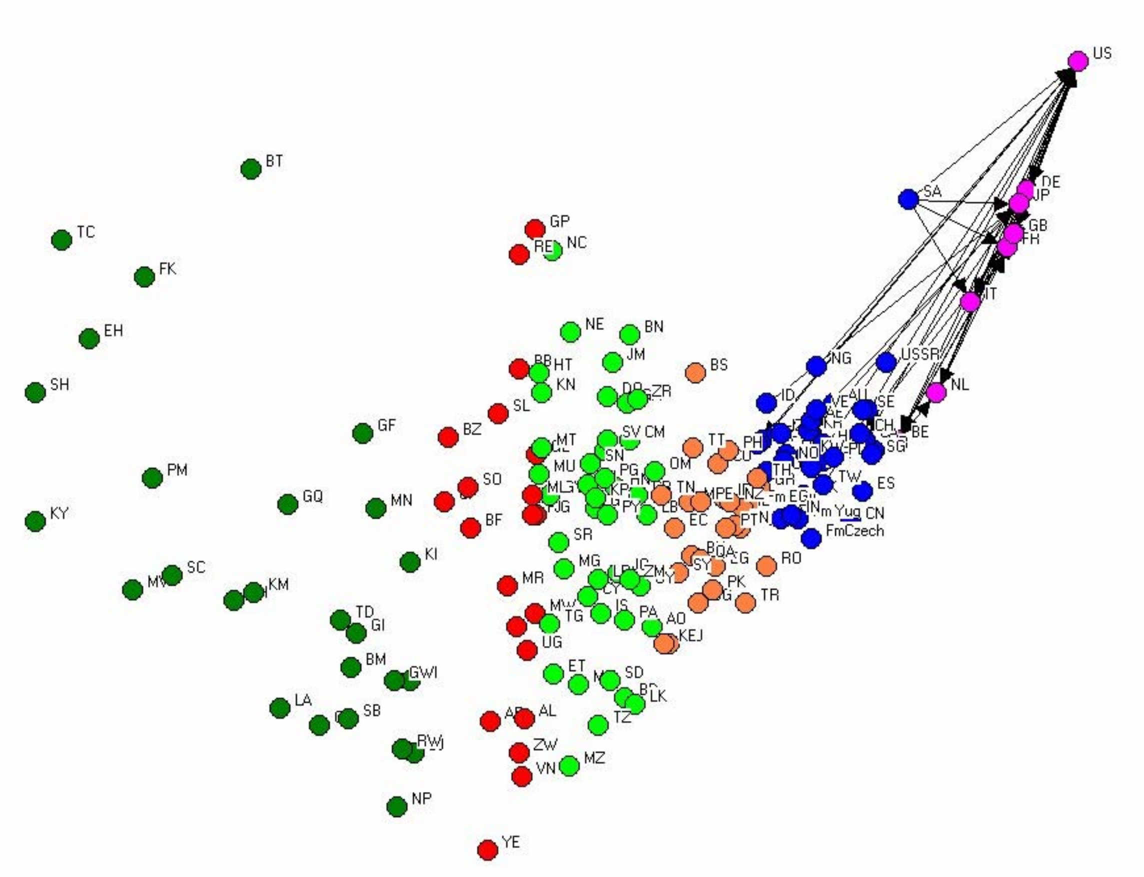

Figure 2: 2001, trade > 0.3%, nodes colored by WS zones, placed spatially by CA

Core = Pink; SP1=Blue; SP2=Orange; P1=Neon Green; P2=Red; P3=Dark Green

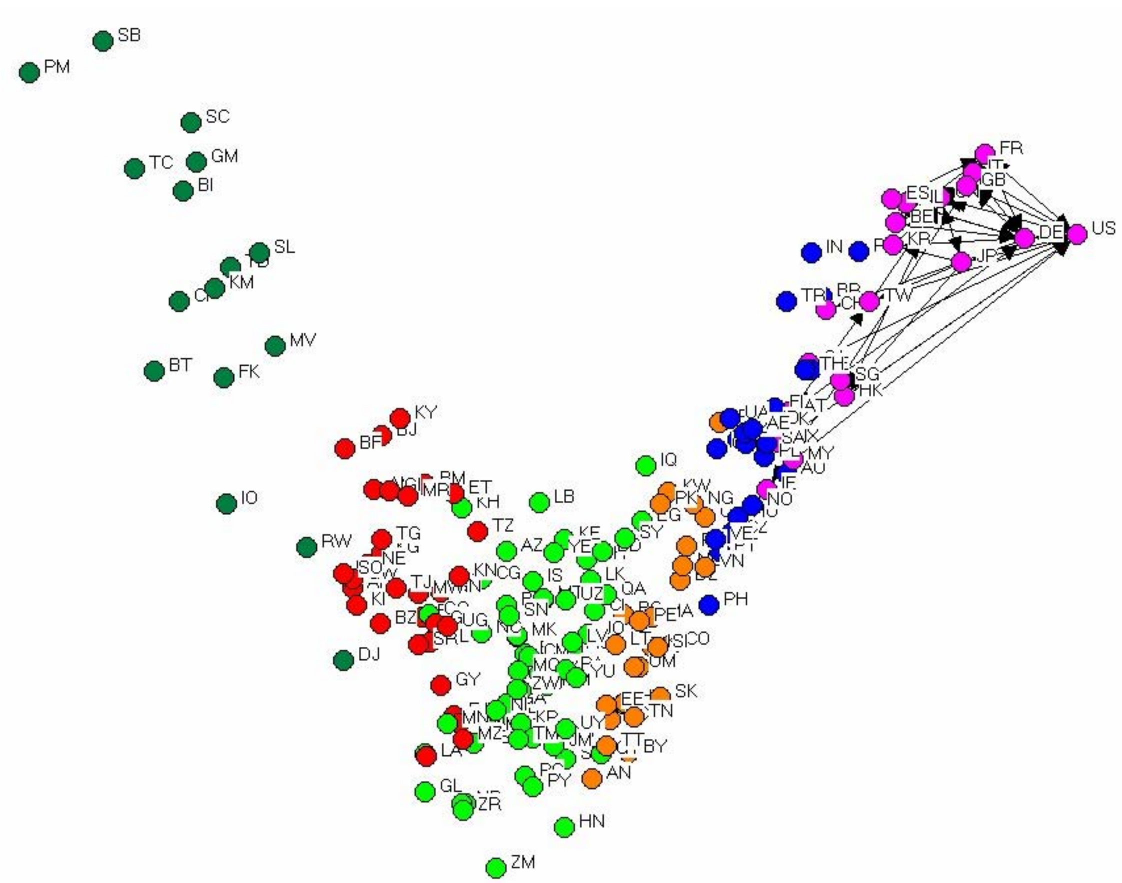

Figure 3: Exponential Distance Model, 1980

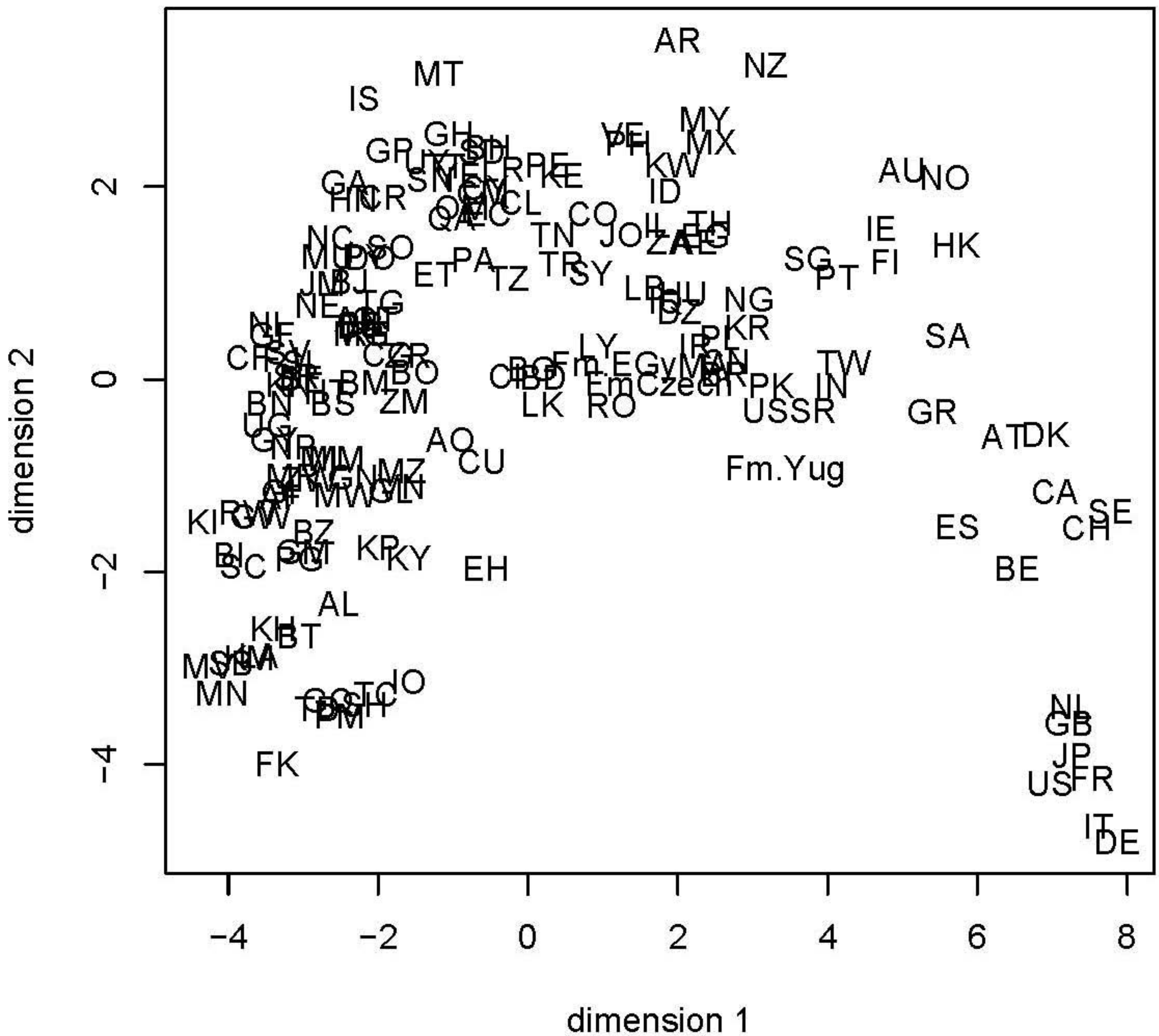

Figure 4: Exponential Distance Model, 2001

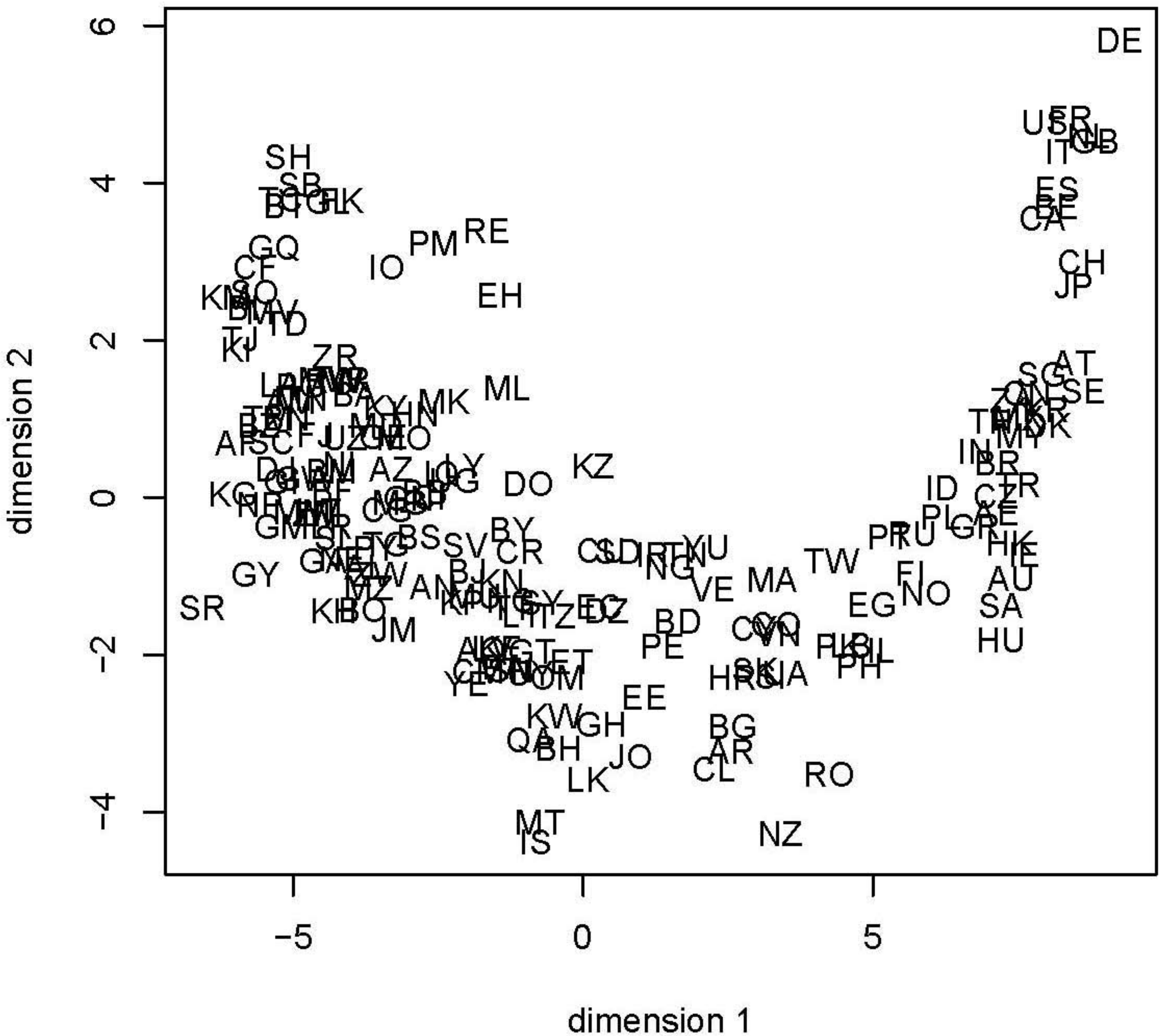

Table 1: Comparison of clusters from SNA and EDM with countries colored by CA of RE, 1980.

Countries		1980		1980	
		1st Dim SNA	HC groups	1st Dim EDM	HC groups
US	United States	0.087979369	1	6.96594185	1
GB	United Kingdom	0.075883001	1	7.22315088	1
NL	Netherlands	0.060773604	1	7.25139854	1
JP	Japan	0.0766574	1	7.26844217	1
IT	Italy	0.067338012	1	7.61185143	1
DE	Germany	0.078072414	1	7.87273497	1
FR	France	0.074196711	1	7.53151734	1
BE	Belgium-Luxembourg	0.053185284	1	6.53225801	1
VE	Venezuela	0.037851866	2	1.26732811	2
AE	United Arab Emirates	0.037072118	2	2.23200848	2
TW	Taiwan	0.039288353	2	4.20035123	2
CH	Switzerland	0.04614234	2	7.45814884	2
SE	Sweden	0.04654415	2	7.77870894	2
ES	Spain	0.046972036	2	5.73701699	2
KR	South Korea	0.036411222	2	2.9275321	2
ZA	South Africa	0.031376299	2	1.8852808	2
SG	Singapore	0.048476994	2	3.7398022	2
SA	Saudi Arabia	0.055639453	2	5.60050537	2
PL	Poland	0.04096067	2	2.56325125	2
NO	Norway	0.031817611	2	5.57068365	2
NG	Nigeria	0.037712559	2	2.95153141	2
MX	Mexico	0.026882924	2	2.44999596	2
MY	Malaysia	0.030345693	2	2.36139168	2
LY	Libya	0.037084274	2	0.90446786	2
KW	Kuwait	0.03589401	2	1.92057771	2
IQ	Iraq	0.04755177	2	1.84594868	2
IR	Iran	0.039380278	2	2.23841657	2
ID	Indonesia	0.028577687	2	1.83303462	2
IN	India	0.0334123	2	4.05437049	2
HU	Hungary	0.02856867	2	2.07414868	2
HK	Hong Kong	0.03921698	2	5.7032885	2
Fm Yug	Former Yugoslavia	0.034732718	2	3.41151831	2
USSR	Former USSR	0.051537648	2	3.48458664	2
FmCzech	Former Czechoslovakia	0.036725692	2	1.74703489	2
FI	Finland	0.032138433	2	4.76883872	2
DK	Denmark	0.035460524	2	6.89938128	2
CN	China	0.044458572	2	2.63593719	2
CA	Canada	0.047174968	2	7.04208107	2
BR	Brazil	0.048997782	2	2.61977297	2
AT	Austria	0.036750376	2	6.32300233	2
AU	Australia	0.041219782	2	4.98438191	2
AR	Argentina	0.031477261	2	2.00336752	2
DZ	Algeria	0.027772997	2	2.01826742	2
TR	Turkey	0.024314092	3	0.44561446	3
TN	Tunisia	0.008352987	3	0.33282029	3
TT	Trinidad and Tobago	0.014410322	3	-1.11045005	3
TH	Thailand	0.026749881	3	2.42622243	3
SY	Syria	0.011645009	3	0.83491762	3
RO	Romania	0.028325848	3	1.1096984	3
QA	Qatar	0.009822077	3	-1.0180232	3
PT	Portugal	0.020693131	3	4.11925438	3
PH	Philippines	0.021254975	3	1.33514253	3
PE	Peru	0.016092559	3	0.26519499	3
PK	Pakistan	0.018470356	3	3.24354762	3

Table 1: Comparison of clusters from SNA and EDM with countries colored by CA of RE, 1980.

Countries		1980		1980	
		1st Dim SNA	HC groups	1st Dim EDM	HC groups
NZ	New Zealand	0.021704281	3	3.17104529	3
AN	Netherlands Antilles	0.022608286	3	-2.25822806	3
MA	Morocco	0.013696499	3	2.35378283	3
KE	Kenya	0.009134104	3	0.44658438	3
IL	Israel	0.023906197	3	1.72679654	3
IE	Ireland	0.02034566	3	4.71849011	3
GR	Greece	0.026916089	3	5.40186079	3
Fm EGy	Former E Germany	0.025661567	3	1.1515919	3
EG	Egypt	0.018791404	3	2.35849762	3
EC	Ecuador	0.010965385	3	-0.5373676	3
CU	Cuba	0.005871079	3	-0.61586491	3
CI	Cote d'Ivoire	0.015177523	3	-0.30617041	3
CO	Colombia	0.019395711	3	0.85903845	3
CL	Chile	0.023173681	3	-0.09784979	3
BG	Bulgaria	0.015437623	3	0.04962355	3
BH	Bahrain	0.013960092	3	-0.53405826	3
BS	Bahamas	0.014953651	3	-2.60447986	3
ZM	Zambia	0.002433721	4	-1.64651039	4
ZR	Zaire	0.003700637	4	-1.59506775	4
UY	Uruguay	0.00426517	4	-1.34918029	4
TG	Togo	-0.00947507	4	-1.96712679	4
TZ	Tanzania	-0.01029746	4	-0.25940962	4
SR	Suriname	-0.01094374	4	-3.09833328	4
SD	Sudan	-0.00124551	4	-0.61522381	4
LK	Sri Lanka	0.003164059	4	0.17929988	4
SN	Senegal	-0.00496275	4	-1.30151628	4
KN	Saint Kitts and Nevis	-0.0123391	4	-3.20023984	4
PY	Paraguay	-0.00161899	4	-2.17505325	4
PG	Papua New Guinea	-0.00221563	4	-3.06167177	4
PA	Panama	0.001285773	4	-0.75850553	4
OM	Oman	0.007044808	4	-0.87885179	4
KP	North Korea	-0.00424672	4	-2.0023841	4
NE	Niger	-0.00881176	4	-2.80615747	4
NI	Nicaragua	-0.00538766	4	-3.51948572	4
NC	New Caledonia	-0.0127694	4	-2.63987262	4
MM	Myanmar	-0.00736528	4	-2.55242728	4
MZ	Mozambique	-0.02467032	4	-1.6799118	4
MU	Mauritius	-0.01503938	4	-2.66341217	4
MT	Malta	-0.01421389	4	-1.19693837	4
MG	Madagascar	-0.01855221	4	-2.22939402	4
LR	Liberia	-0.00390568	4	-0.33153945	4
LB	Lebanon	0.015894547	4	1.55539679	4
JO	Jordan	0.000244164	4	1.24961595	4
JM	Jamaica	-0.00110675	4	-2.74424973	4
IS	Iceland	-0.00335605	4	-2.18509507	4
HN	Honduras	-0.00030642	4	-2.34215695	4
HT	Haiti	-0.01500059	4	-2.69021291	4
GY	Guyana	-0.01302307	4	-3.38603823	4
GT	Guatemala	0.00834268	4	-2.04979425	4
GH	Ghana	-0.00414417	4	-1.06667599	4
GA	Gabon	0.001674838	4	-2.44185553	4
ET	Ethiopia	-0.01591077	4	-1.25016927	4
SV	El Salvador	-0.00197515	4	-3.20525251	4
DO	Dominican Republic	-0.00179837	4	-2.10666962	4
CY	Cyprus	-0.00551773	4	-0.56722567	4

Table 1: Comparison of clusters from SNA and EDM with countries colored by CA of RE, 1980.

Countries		1980		1980	
		1st Dim SNA	HC groups	1st Dim EDM	HC groups
CR	Costa Rica	0.0037226	4	-1.93846506	4
CM	Cameroon	0.002171173	4	-0.61057748	4
BN	Brunei	0.002248667	4	-3.45071869	4
BO	Bolivia	-0.00246453	4	-1.51236646	4
BD	Bangladesh	0.001398385	4	0.19781941	4
AO	Angola	0.006733294	4	-1.04303705	4
ZW	Zimbabwe	-0.0187425	5	-2.92679955	5
YE	Yemen	-0.01284931	5	-0.91662126	5
VN	Vietnam	-0.01818443	5	-1.69026314	5
UG	Uganda	-0.01720908	5	-3.48130811	5
SO	Somalia	-0.02865288	5	-1.83499858	5
SL	Sierra Leone	-0.02263829	5	-3.01456796	5
RE	Reunion	-0.00365571	5	-2.13554648	5
MR	Mauritania	-0.02093235	5	-3.14121853	5
ML	Mali	-0.01639836	5	-2.72239054	5
MW	Malawi	-0.0159214	5	-2.45383624	5
GN	Guinea	-0.01911557	5	-2.33660306	5
GP	Guadeloupe	-0.0145163	5	-1.84967666	5
GL	Greenland	-0.015392	5	-1.83797415	5
FJ	Fiji	-0.01627356	5	-3.2934677	5
CG	Congo	-0.01534327	5	-1.87418858	5
CF	Central African Republic	-0.0330161	5	-3.73411351	5
BF	Burkina Faso	-0.02822674	5	-3.03379394	5
BZ	Belize	-0.03207967	5	-2.85636566	5
BB	Barbados	-0.0187197	5	-2.22640503	5
AL	Albania	-0.01794486	5	-2.52160715	5
AF	Afghanistan	-0.02447538	5	-3.28953965	5
EH	Western Sahara	-0.1009647	6	-0.55626765	6
TC	Turks and Caicos Islands	-0.10593562	6	-2.02956897	6
PM	St Pierre and Miquelon	-0.08888923	6	-2.52174124	6
SH	St Helena	-0.11120449	6	-2.18232676	6
SB	Solomon Islands	-0.05155429	6	-3.97553265	6
SC	Seychelles	-0.08508322	6	-3.79940535	6
RW	Rwanda	-0.04116141	6	-3.76099876	6
NP	Nepal	-0.04198484	6	-3.13428441	6
MN	Mongolia	-0.04599515	6	-4.08086017	6
MV	Maldives	-0.09263924	6	-4.27854523	6
LA	Laos	-0.06460687	6	-3.59664619	6
KI	Kiribati	-0.03952023	6	-4.34563239	6
GW	Guinea-Bissau	-0.04252535	6	-3.58200275	6
GI	Gibraltar	-0.04985552	6	-3.33202595	6
GM	Gambia	-0.05682973	6	-2.99870277	6
GF	French Guiana	-0.04848155	6	-3.41581682	6
FK	Falkland Islands	-0.08953439	6	-3.35797565	6
GQ	Equitorial Guinea	-0.06306084	6	-2.66867458	6
DJ	Djibouti	-0.04603607	6	-2.27398141	6
KM	Comoros	-0.0695833	6	-3.72506548	6
TD	Chad	-0.0526502	6	-2.81473727	6
KY	Cayman Islands	-0.11130635	6	-1.59276129	6
KH	Cambodia	-0.07331332	6	-3.40089325	6
BI	Burundi	-0.03960657	6	-3.99514434	6
IO	British Indian Ocean Territory	-0.22420448	6	-1.59809801	6
BT	Bhutan	-0.07022958	6	-3.06074996	6
BM	Bermuda	-0.05065514	6	-2.19147026	6
BJ	Benin	-0.03887494	6	-2.38265071	6

Table 2: Comparison of clusters from SNA and EDM with countries colored by CA of RE, 2001

Countries		2001		2001	
		1st Dim SNA	HC groups	1st Dim EDM	HC groups
US	United States	0.075303145	1	7.96178318	1
DE	Germany	0.067585006	1	9.25498329	1
FR	France	0.06181765	1	8.40836806	1
IT	Italy	0.059984218	1	8.22403806	1
GB	United Kingdom	0.059478354	1	8.81814438	1
JP	Japan	0.058150455	1	8.46427507	1
CN	China	0.055406194	1	7.64771727	1
NL	Netherlands	0.050181668	1	8.71557744	1
BE	Belgium-Luxembourg	0.048848614	1	8.16190193	1
KR	South Korea	0.04870135	1	7.98045609	1
ES	Spain	0.048169065	1	8.18145833	1
TW	Taiwan	0.044899728	1	4.26856269	1
HK	Hong Kong	0.041303702	1	7.35102665	1
SG	Singapore	0.041087288	1	7.90816538	1
CH	Switzerland	0.038974699	1	8.59969606	1
CA	Canada	0.036242571	1	7.9181623	1
MY	Malaysia	0.034268837	1	7.57055414	1
AT	Austria	0.033474408	1	8.42923157	1
MX	Mexico	0.031865597	1	7.51821982	1
IE	Ireland	0.03023061	1	7.60723312	1
RU	Russia	0.043415394	2	5.66108692	2
BR	Brazil	0.037966833	2	7.15087383	2
IN	India	0.036790226	2	6.75922859	2
SE	Sweden	0.03663224	2	8.62087716	2
TH	Thailand	0.036073543	2	7.02899026	2
AU	Australia	0.033180222	2	7.3691091	2
TR	Turkey	0.033035602	2	7.50401694	2
FI	Finland	0.031097976	2	5.64259364	2
DK	Denmark	0.030959513	2	7.99101863	2
ID	Indonesia	0.03039318	2	6.19609724	2
SA	Saudi Arabia	0.030277481	2	7.20776927	2
PL	Poland	0.029957084	2	6.1698839	2
NO	Norway	0.028070729	2	5.91559335	2
AE	United Arab Emirates	0.027935194	2	7.12859111	2
IL	Israel	0.027132623	2	5.13417606	2
ZA	South Africa	0.026766503	2	7.41327204	2
HU	Hungary	0.025856212	2	7.206958	2
AR	Argentina	0.025701012	2	2.56121448	2
CZ	Czech Republic	0.025088035	2	7.11088661	2
UA	Ukraine	0.024905911	2	3.47695615	2
PT	Portugal	0.023343794	2	5.27597561	2
GR	Greece	0.023022786	2	6.75078216	2
VE	Venezuela	0.022550466	2	2.23032531	2
PH	Philippines	0.02183268	2	4.75976552	2
IR	Iran	0.023464797	3	1.20270243	3
CL	Chile	0.02121219	3	2.25337041	3
VN	Vietnam	0.021034624	3	3.37022482	3
NG	Nigeria	0.019406307	3	1.50233596	3
RO	Romania	0.018614186	3	4.24064019	3
NZ	New Zealand	0.017986402	3	3.4046873	3
DZ	Algeria	0.017540157	3	0.39661595	3
CO	Colombia	0.015912451	3	3.32469099	3
KW	Kuwait	0.015847342	3	-0.5230367	3
PK	Pakistan	0.014712857	3	4.39771079	3

Table 2: Comparison of clusters from SNA and EDM with countries colored by CA of RE, 2001

Countries		2001		2001	
		1st Dim SNA	HC groups	1st Dim EDM	HC groups
SK	Slovakia	0.014550762	3	2.95922645	3
SI	Slovenia	0.014283203	3	3.23660613	3
MA	Morocco	0.013601593	3	3.26837429	3
KZ	Kazakhstan	0.013587503	3	0.17706543	3
LY	Libya	0.011932023	3	-2.08438996	3
PE	Peru	0.011768655	3	1.37553599	3
OM	Oman	0.010849657	3	-0.44791844	3
TN	Tunisia	0.010666487	3	1.76974044	3
BY	Belarus	0.010469761	3	-1.22046654	3
HR	Croatia	0.009617232	3	2.57425478	3
BG	Bulgaria	0.009398478	3	2.56993061	3
LT	Lithuania	0.008279455	3	-1.08823231	3
EC	Ecuador	0.007569105	3	0.27712495	3
EE	Estonia	0.007008867	3	1.05724422	3
TT	Trinidad and Tobago	0.006955958	3	-1.23757829	3
AN	Netherlands Antilles	0.004967134	3	-2.57267246	3
IQ	Iraq	0.01256383	4	-2.43585094	4
EG	Egypt	0.012203744	4	4.97825947	4
SY	Syria	0.009458136	4	-0.71270754	4
CR	Costa Rica	0.00923528	4	-1.09489974	4
QA	Qatar	0.00692968	4	-0.90996383	4
BD	Bangladesh	0.006335309	4	1.63296312	4
GT	Guatemala	0.005970214	4	-0.89153251	4
CI	Cote d'Ivoire	0.005217993	4	-2.65799588	4
LK	Sri Lanka	0.004659537	4	0.07290272	4
JO	Jordan	0.004018508	4	0.82853836	4
BH	Bahrain	0.003905766	4	-0.42122287	4
YU	Yugoslavia	0.002472512	4	2.12732523	4
LV	Latvia	0.002133053	4	-1.60688175	4
AO	Angola	0.002078091	4	-1.75806831	4
PA	Panama	0.001050137	4	-1.39023702	4
UZ	Uzbekistan	0.001044814	4	-4.10290208	4
SV	El Salvador	0.001038332	4	-2.03982875	4
UY	Uruguay	0.001022178	4	-0.90571697	4
KE	Kenya	0.000702391	4	-1.43284636	4
HN	Honduras	0.000427309	4	-2.89337785	4
JM	Jamaica	-0.000684157	4	-3.25982548	4
YE	Yemen	-0.000804492	4	-2.0087905	4
DO	Dominican Republic	-0.000943097	4	-0.93911981	4
MM	Myanmar	-0.001485717	4	-4.84549761	4
GH	Ghana	-0.002147655	4	0.30453058	4
CU	Cuba	-0.002188565	4	0.30455292	4
MT	Malta	-0.002436372	4	-0.7452588	4
LB	Lebanon	-0.002949103	4	4.61632844	4
CY	Cyprus	-0.003082789	4	2.94672477	4
SD	Sudan	-0.00365613	4	0.59571402	4
IS	Iceland	-0.003840997	4	-0.81907885	4
PY	Paraguay	-0.003927422	4	-3.58697235	4
CM	Cameroon	-0.00464796	4	-1.80208988	4
PG	Papua New Guinea	-0.004954786	4	-4.87980288	4
BA	Bosnia and Herzegovina	-0.005006876	4	-3.93667405	4
MU	Mauritius	-0.005522094	4	-1.85461749	4
KP	North Korea	-0.00568403	4	-2.09761453	4
MO	Macau	-0.00578521	4	-3.0807204	4
TM	Turkmenistan	-0.005937994	4	-5.44283437	4

Table 2: Comparison of clusters from SNA and EDM with countries colored by CA of RE, 2001

Countries		2001		2001	
		1st Dim SNA	HC groups	1st Dim EDM	HC groups
ZW	Zimbabwe	-0.006115889	4	-3.52740834	4
LR	Liberia	-0.006144636	4	-4.33960286	4
MK	Macedonia	-0.006350426	4	-2.40463687	4
BO	Bolivia	-0.006543073	4	-3.79880905	4
SN	Senegal	-0.007270293	4	-1.24429453	4
GA	Gabon	-0.007625678	4	-4.48208966	4
AZ	Azerbaijan	-0.007759766	4	-3.30168657	4
BN	Brunei	-0.007831236	4	-5.11725663	4
ZM	Zambia	-0.009152519	4	-4.574288	4
NI	Nicaragua	-0.009186021	4	-4.20846958	4
MD	Moldova	-0.010017023	4	-3.56161673	4
CG	Congo	-0.011155108	4	-3.39182448	4
NC	New Caledonia	-0.011297552	4	-1.24210777	4
BS	Bahamas	-0.012269496	4	-2.82224114	4
AL	Albania	-0.013561629	4	-3.75821637	4
ZR	Zaire	-0.01375279	4	-4.26033766	4
NP	Nepal	-0.014354461	4	-5.57915708	4
KH	Cambodia	-0.014367787	4	-4.30139086	4
MN	Mongolia	-0.016305193	4	-4.85296974	4
GQ	Equitorial Guinea	-0.018978531	4	-5.33104447	4
GL	Greenland	-0.019521195	4	-4.40296626	4
HT	Haiti	-0.019562202	4	-4.57281689	4
TZ	Tanzania	-0.011810594	5	-0.48286082	5
MZ	Mozambique	-0.01391645	5	-3.68762947	5
MG	Madagascar	-0.014499903	5	-3.15448323	5
KN	Saint Kitts and Nevis	-0.014505981	5	-1.40688484	5
FJ	Fiji	-0.015262239	5	-4.61614433	5
ET	Ethiopia	-0.015452179	5	-0.20989237	5
UG	Uganda	-0.016499508	5	-2.22139242	5
GY	Guyana	-0.017110324	5	-5.65465892	5
GN	Guinea	-0.017255181	5	-3.01397993	5
GE	Georgia	-0.018030014	5	-3.44281847	5
ML	Mali	-0.018615888	5	-1.30704468	5
LA	Laos	-0.019227643	5	-5.22576549	5
BM	Bermuda	-0.019775562	5	-4.34276953	5
BB	Barbados	-0.020016722	5	-2.73036182	5
MW	Malawi	-0.02024666	5	-4.37273685	5
SR	Suriname	-0.020364406	5	-6.56974354	5
MR	Mauritania	-0.021607518	5	-4.11477007	5
KY	Cayman Islands	-0.023349054	5	-3.40428392	5
TJ	Tajikistan	-0.023413254	5	-5.91297263	5
GI	Gibraltar	-0.024672879	5	-5.20201956	5
KG	Kyrgyzstan	-0.025689432	5	-6.04142017	5
TG	Togo	-0.02587432	5	-3.40050789	5
BJ	Benin	-0.025920901	5	-1.99877865	5
BZ	Belize	-0.026216881	5	-5.58686967	5
AM	Armenia	-0.026943792	5	-5.03791281	5
NE	Niger	-0.027840782	5	-4.15951564	5
KI	Kiribati	-0.029314915	5	-5.97815516	5
GW	Guinea-Bissau	-0.030055981	5	-4.8088648	5
AF	Afghanistan	-0.03009871	5	-5.96247963	5
BF	Burkina Faso	-0.030975845	5	-4.31403102	5
SO	Somalia	-0.031469043	5	-5.67342924	5
DJ	Djibouti	-0.031519245	6	-5.30880045	6
RW	Rwanda	-0.037043139	6	-4.32328603	6

Table 2: Comparison of clusters from SNA and EDM with countries colored by CA of RE, 2001

Countries		2001		2001	
		1st Dim SNA	HC groups	1st Dim EDM	HC groups
MV	Maldives	-0.041322913	6	-5.35382927	6
SL	Sierra Leone	-0.043942112	6	-4.27906547	6
TD	Chad	-0.047663689	6	-5.1262307	6
IO	British Indian Ocean Territory	-0.048378333	6	-3.3875392	6
FK	Falkland Islands	-0.048818767	6	-4.17595197	6
KM	Comoros	-0.050430465	6	-6.16902499	6
GM	Gambia	-0.052651607	6	-5.19694473	6
SC	Seychelles	-0.053458467	6	-5.37542665	6
BI	Burundi	-0.054522645	6	-5.86213573	6
CF	Central African Republic	-0.055388022	6	-5.64208018	6
BT	Bhutan	-0.058763597	6	-5.14400304	6
TC	Turks and Caicos Islands	-0.061760046	6	-5.21510608	6
SB	Solomon Islands	-0.066253938	6	-4.88059246	6
PM	St Pierre and Miquelon	-0.076918438	6	-2.57459834	6
SH	St Helena	-0.094932206	6	-5.08333011	6
EH	Western Sahara	-0.109286293	6	-1.42624756	6
RE	Reunion	-0.165638104	6	-1.65969232	6