

Testing World Systems Theory in 2000s

An Application of Block Modeling Approach

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Introduction

Human society is a complex web of interactions that spurs multitude effects on the individual participants as well as the network as a whole. In sociology, there are two prevalent views of analyzing a network: interactionism and structuralism. While interactionism focuses on individual characterization, thought process and individual level relationships, structuralism focuses on the structures on the institutional level that guide individual roles. Interactionist viewpoint in network analysis theory is exemplified in works of Mark Granovetter on strength of ties and Ivan Chase who discussed interaction hierarchy through chicken pecking order. Notable thinkers that emphasized on the role of social structure on human behavior, include Karl Marx, who emphasized on two level class structure and Georg Simmel who extended the alter orientation on family.

In world economic theory, some, such as, development theorists or modernization theorists, look at nations as individual units of analysis while others, such as, world systems theorists argue that structural position of nations is important in globalization and macroeconomic studies. In this paper, I will review the background of world systems theory and a popular network analysis method, block-model approach, that is used to systematically determine the structural position of a nation. I will then replicate the approach used by Ronald Breiger to determine the positions of 1972 OECD nations in his work, *“Structures of Economic Interdependence Among Nations”*, to analyze how has the structural position of major economically contributing nations has evolved in the recent times. Considering, that new major economies, such as, China, have emerged onto the

world scene, I hypothesize to see a shift in which countries form the core nations, yet the core-periphery structure of world systems still exists.

Literature Review

World system theory, largely credited to Immanuel Wallerstein, is a line of thinking that encourages economic or social analysis from a total world wealth and event standpoint rather than using nations or isolated events for such analysis. Specifically, regarding economic development of nations, much like dependency theory, world system theory disagrees with the, “linear notion that the historical growth of Western societies represents the pathway of development for the contemporary Third World” (Nemeth and Smith 518). Instead, the inherent structure of capitalist global economy would maintain the inequality and status quo.

In the 1950s and 60s, Latin American scholars questioned the tenets of modernization theory that promoted the spread of rational thinking, capitalist ideology and democratic institutions to build the foundation for the economic advancement of all nations. They argued that countries remained underdeveloped due to the structure of international relations and not an inherent cultural or economic characteristic. While the dependence theorists emphasized on two-way relations between wealthy, advanced, imperial nations and less developed, colonized nations, the world system theorists extended this two-partition thinking into a grid of interdependence that can be divided into unequal exchange relations of necessary bulk commodities. Wallerstein theorizes that countries can be divided into three positions: “*core* states appropriate the surplus of the world economy as a whole and in particular of those states located in the *periphery*, which produce lower-ranking (labor intensive) goods, while states located in the *semiperiphery* are ‘both exploited and exploiters’” (Breiger 354).

While core-semiperiphery-periphery division of the world gained acceptance, there was a lack of unified consensus on which countries held this position. In 1979 paper by Snyder and Kick, focused on a multinet network analyses to find the structural positions of countries. They combine the world system theory with block model analysis to evaluate the structural positions that nations hold in world trade. Snyder and Kick, critique that the world systems theory, prior to their work, lacked operational rigor for classifying nation's position in the system or even structural necessity of three-tiered model in a capitalist world economy (the dominant world system for decades, according to Wallerstein). Additionally, previous regression analyses required a choice between focusing on poor countries to test the "effect of economic or cultural imperialism on economic growth" or include all available data for all nations leading to dubious arguments like Robinson's claim that, "a nation's exports and imports (as a percentage of the GDP) puts the state and its economic actors in a position of less power and control in the world economy" (Snyder and Kick 1101). These are refuted in the economic standings of countries like USA and Japan. Finally, they urge that previously utilized indicators such as investment dependence or trade concentration do not completely represent the nation's position as they "do not fully specify the institutional locus of transnational flow" (Snyder and Kick 1102). To address this, Snyder and Kick, conduct a multinet network, block-model analysis on data from 118 countries for four important networks: trade flows, military interventions, diplomatic exchanges, and conjoint treaty memberships. Their analysis strongly supported the world systems theory.

Snyder and Kick utilized the block-model approach of Breiger, White, and Boorman. Consequently, Ronald Breiger built on their work of block model analysis of world system theory, by using different international trade networks to determine a nation's structural position. Breiger proposed that, "a block-model approach to international trade assigns states to positions according

to the structural similarity of nations' imports and exports to all other states, across various types of economic exchange, rather than on the basis of definitional aggregation" (Breiger 357). Breiger's main objective was also to operationalize procedures to identify core, semi-peripheral, peripheral nations based only on trade networks and determine if the core-periphery structures allowed competing centers. Additionally, he intended to explore "the distinctive elements of core-periphery structure in contrast to other ideal type structures that might characterize international exchange" and determine if different exchange networks presented the same results (Breiger 355). Since, Breiger's approach and results from "*Structures on Economic Interdependence Among Nations*" forms the basis of this paper, the following section of this paper his method in detail.

Following Breiger's approach of using relational interaction of nations through international trade, Nemeth and Smith, also focus on international commodity exchanges in their paper, "*International Trade and World System Structure*". The authors expand on Breiger's work by using the same UN Comtrade data but include all nations with a population of over a million (86 countries in total) and do not arbitrarily pick the commodities. Instead, they use a principal component analysis on all commodities and reduce to five categories of commodity groups. Using CONCOR block-model technique, Nemeth and Smith also uncover the core countries in accordance to world systems theory. The paper ends with recommend future work on longitudinal data to test the pattern of trade in different periods but attest that the empirically method is valid for understanding world system structure. Nonetheless, they conclude that empirical analysis is a tool to understand modern world, but it should be used with in-depth comparative study.

Scholarly work refining the world systems theory, both qualitative and empirically, is extensive. However, here the focus was on key works that used the network analysis method of block-modelling to uncover the structural position of nations in world systems.

Methodological Foundation

In this paper, the method from Breiger's *Structures of Economic Interdependence Among Nations* will be replicated. He conducts a block model analysis of the import and export of 24 nations (OECD nations of 1972 and Israel) for selected commodities. In his study, Breiger formed exchange network matrix for agricultural products, raw materials, manufactured goods and energy resources. The focus of the study is to find groups of nations that are structurally like each other and "examine the possibly distinctive patterns that these blocks induce on the original network data" (Breiger 357).

Breiger creates a 24 by 24 matrix of countries import and export for each of the trade networks. He binarizes this matrix, by only considering the highest fifth of the interior cell values and then rearranges and partitions the rows and columns using block-model method. Robust block model algorithms for structural equivalence is a contribution by Harrison White, Scott Boorman and Ronald Breiger through their paper, *Social Structure from Multiple Networks. I. Blockmodels of Roles and Positions*. From this analysis, a distinct core-periphery pattern emerges that bears resemblance to the 118-country analysis of Snyder and Kick. However, he argues that world system theorist would not accept this empirical evaluation based on binarized trade data of one commodity as countries have unequal exchanges in import and export and that the results imply that the "world is bound together by a few core states" (Breiger 364).

To address this concern, Breiger uses Schwartz's technique to net out unequal exchange. For the network data, "row and column means were subtracted from each matrix, leaving residuals from an additive, two-way analysis of variance model" (Breiger 365). Positive values indicated statistical interactions, while negative values represented the opposite. This method was applied to a single correlation matrix created by multiple networks: agricultural products, raw materials,

manufactured goods. The block model algorithm used to cluster countries is, CONCOR (Convergence of Iterated Correlations), “a divisive hierarchical clustering procedure that continuously splits actors into successively smaller groups” (Nemeth and Smith 532). The eigen structure of the resulting matrix was examined and plotted to reveal geographical clustered nations with insight of historical events. Here Breiger, does urge to conduct a time series analysis to see how the positions differ in light of world economic events, such as, formal entry of UK into European Common Market. Breiger examines the correlations between the four matrices to establish that each of the trade matrices are quite different from each other. Therefore, to find any additional asymmetries, it is important to run a four block CONCOR partition to each of the networks. The correlation matrices are adjusted as previously described.

The study concludes that the core-periphery structure identified by Snyder and Kick holds but “adjusting for the total import and export levels of each country, ... [reveals] the existence of multiple competing core” (Breiger 375). In the network diagrams (from Dr. Padgett’s notes) shown below, the pattern of competing core can be seen. USA, UK and Germany form the core while countries like Japan, Sweden and France form connections with additional countries but interesting do not overlap in trade between each.

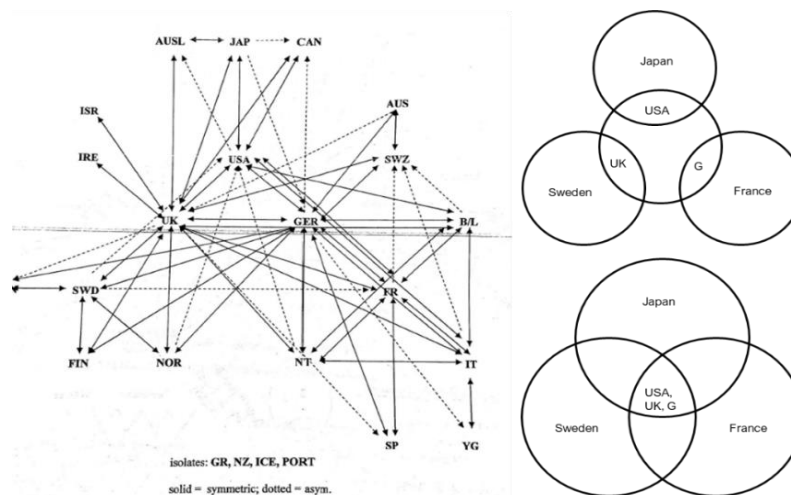
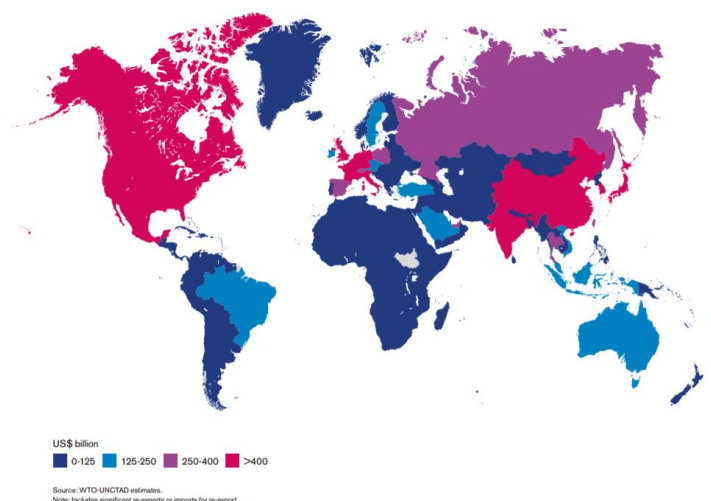


Figure 1 Network Diagram Created by Dr.Padget to Represent Breiger's 1972 Study

Data

This study will use data collected and maintained by Organization for Economic Co-operation and Development (OECD), an organization that “work[s] on establishing international norms and finding evidence-based solutions to a range of social, economic and environmental challenges” (OECD) They have a large database of international trade statistics that has been collected for more than 60 years. Beiger chose to limit his study to 24 OECD nations of 1972 and Israel, since most of the world trade was accounted by them. However, that is no longer the case. The OECD has expanded to include 13 additional countries and non-OECD countries like India, China and Brazil, participate in world trade at a scale that cannot be ignored. According to world trade statistics, the merchandise trade was valued at US\$ 19.67 trillion in 2018 and China was the leading merchandise trader (World Trade Statistics). The map shown below highlights the participation of countries in the merchandise trade. In 2018, “developing economies had a 44% share in world merchandise trade” (World Trade Statistics 14). In contrast, when Breiger conducted his study for 1972, the highly industrialized OECD nations, accounted “for over 70 percent of the world totals in 1972” (Breiger 360)

Economies by size of merchandise trade, 2018



For this study, import-export trade data is collected from UN Comtrade database for the same commodity codes that Breiger used, 0, 2, 3, 6 (whose description can be found in the table below), for the years, 1972, 2007, 2008, 2013 and 2018.

Table 1 SITC Code Description for Data Collected

Commodity SITC Section Code	Description
0	Food and live animals
2	Crude materials, inedible, except fuels
3	Mineral fuels, lubricants and related materials
6	Manufactured goods classified chiefly by material

To determine the world structure in recent times, the latest data available, year 2018, will be used. However, “world systems analysis is directed to studies of social change in which the system itself is open to dynamic alterations”, therefore, a temporal analysis is done to evaluate, “the stability or fluidity of structure” (Nemeth and Smith 556). The year 2008 gives a picture of the world ten years prior. However, given that the year 2008 marked a major global financial crisis, to account for any situational differences, years 2007 and 2013 are considered to determine the structure of world in the recent times. For the year 1972, only the original countries from Breiger’s study are considered to replicate the results that Breiger found to benchmark the analysis process and account for any discrepancy in methodology.

Method

The same steps derived from Ronald Breiger’s approach to world system analysis is applied to each of the five years of datasets. Before applying the block model analysis, a rigorous data extraction and preparation is conducted. From the UN Comtrade database, the import-export data

for each of the countries in consideration, in each of the years, is individually downloaded. Then, for each year in consideration, the data is cleaned and combined into one dataframe in Python's Jupyter notebook. The combined dataframe is then cleaned to retain the commodity exchange with only the countries in consideration. That is, only the countries in OECD and India, China, Brazil (OECD and Israel for 1972) are retained for creating the matrix of reporter and partner nation. Additionally, any data for export, re-export and re-import are removed. Nemeth and Smith point out, referring to works of Duran and Linnemann, that, "only import data are used because, as a result of number of factors, reports on imports and exports do not always match perfectly and there is reason to believe that import figures are more accurate" (Nemeth and Smith 526). This discrepancy is observed in the data extracted in this study and since, Breiger's method to address this is not clear, this study utilizes the import-data-only approach of Nemeth and Smith. Finally, all the country names are standardized.

Using Pandas Groupby command and filtering by commodity code in Python, the cleaned data is converted into a 39 by 39 (24 by 24 for 1972) matrix for each of the four international exchange networks. Additionally, since Breiger considers "only the highest fifth of interior cell values" in the first step in analysis, matrices that code 1 for the top fifth value and 0 for rest are also created. The data for each of the trade matrices is thus prepared and saved in csv format for block model analysis.

The block model analysis is conducted in a software specialized for network analysis – UCINET. The csv files are loaded into matrix editor and converted to UCINET native files and analyzed using UCINET's CONCOR block model analysis. For all the years in consideration, three types of analysis is conducted: determine the correlation among the four trade networks;

conduct block model analysis on each of the binarized trade network; and conduct multinetwork analysis on combined trade networks.

For single matrix analysis, a standard CONCOR block model with 3 part split is applied to each of the binarized trade networks to generate a block model partition and density matrix. For the multinetwork analysis, first, the rows for all four trade exchange matrices are joined and a correlation matrix is created for the combined network. The CONCOR block model analysis is run on this correlation matrix. Additionally, just as Breiger had adjusted for different intensities of trade using the method proposed by Schwartz, a matrix normalization is conducted on the rows and columns of the joined matrix using mean. A block model analysis is then also conducted on the correlation matrix of the normalized matrix.

Results

Correlation among Trade Matrices

1972 Correlation Matrix				
	raw72	man72	enr72	agr72
raw1972	1	0.868	0.795	0.683
man1972	0.868	1	0.835	0.759
enr1972	0.795	0.835	1	0.851
agr1972	0.683	0.759	0.851	1

2008 Correlation Matrix				
	agr2008	enr2008	man2008	raw2008
agr2008	1	0.724	0.591	0.415
enr2008	0.724	1	0.563	0.354
man2008	0.591	0.563	1	0.334
raw2008	0.415	0.354	0.334	1

2018 Correlation Matrix				
	agr2018	enr2018	man2018	raw2018
agr2018	1	0.703	0.694	0.348
enr2018	0.703	1	0.519	0.229
man2018	0.694	0.519	1	0.436
raw2018	0.348	0.229	0.436	1

2007 Correlation Matrix				
	agr2007	enr2007	man2007	raw2007
agr2007	1	0.757	0.605	0.509
enr2007	0.757	1	0.593	0.461
man2007	0.605	0.593	1	0.415
raw2007	0.509	0.461	0.415	1

2013 Correlation Matrix				
	agr2013	enr2013	man2013	raw2013
agr2013	1	0.718	0.674	0.318
enr2013	0.718	1	0.529	0.228
man2013	0.674	0.529	1	0.283
raw2013	0.318	0.228	0.283	1

Figure 2 Comparison of Correlations among Trade Matrices for all Years

1972

Part 1: Density Matrix for Binarized Trade Networks (See Appendix for Block Models)

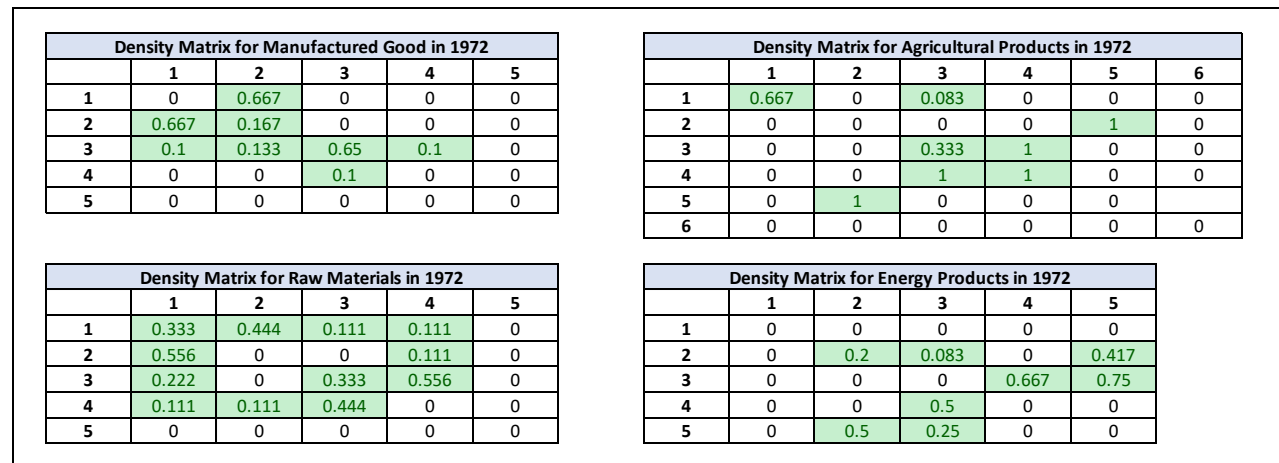
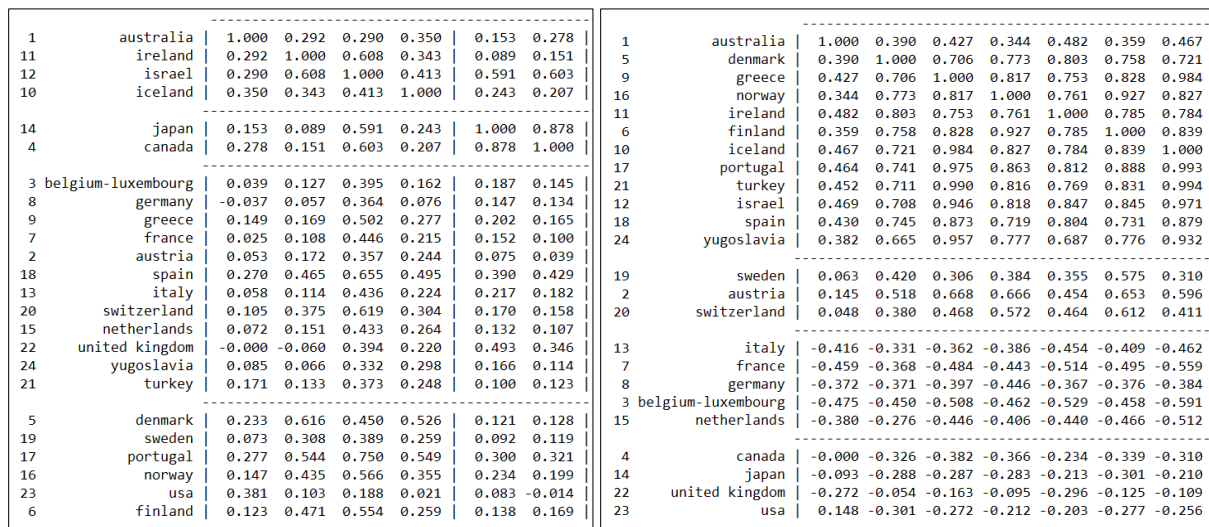


Figure 3 Density Matrix with Positive Values Highlighted (1972)

Part 2: Multinetwork Analysis (Non-Normalized and Normalized)



2018

Part 1: Density Matrix for Binarized Trade Networks (See Appendix for Block Models)

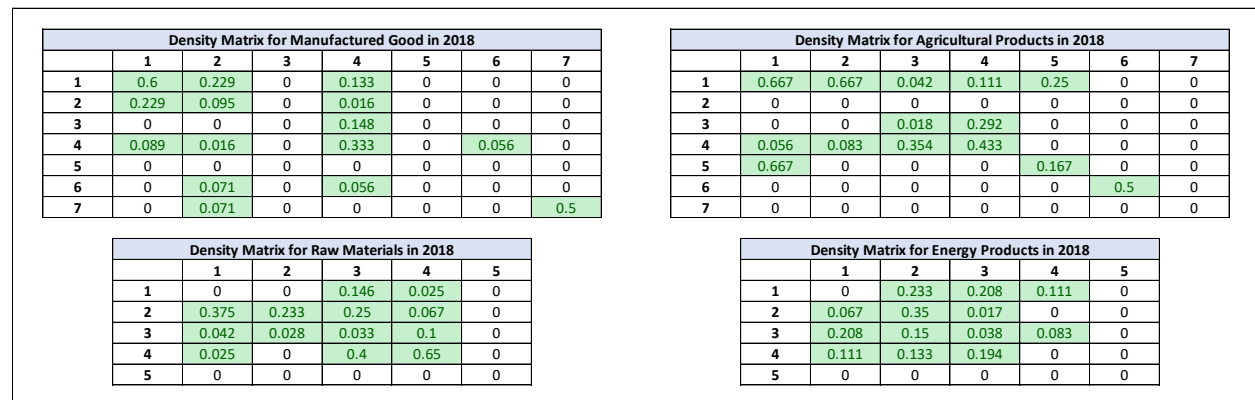


Figure 5 Density Matrix with Positive Values Highlighted (2018)

Part 2: Multinetwork Analysis (Non-Normalized and Normalized)

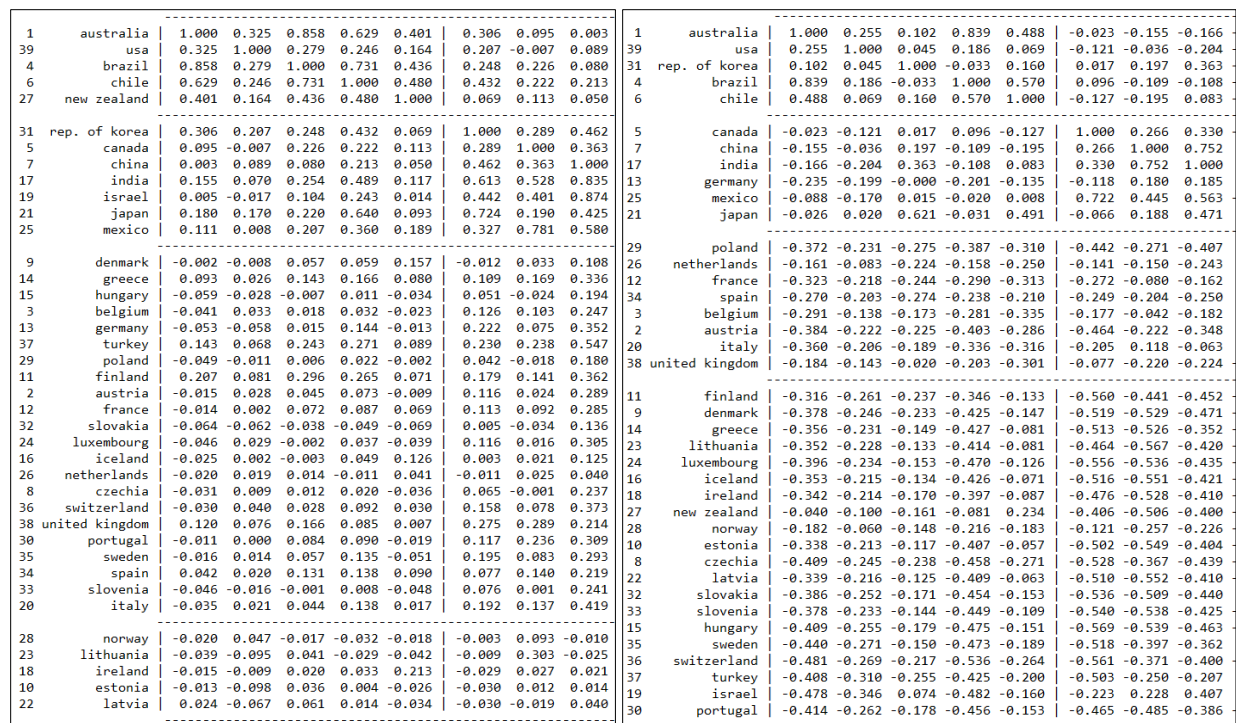


Figure 6 Part of CONCOR Blockmodel for Multinetworks (non-normalized on left and normalized on right)

2008

Part 1: Density Matrix for Binarized Trade Networks (See Appendix for Block Models)

Density Matrix for Manufactured Good in 2008							
	1	2	3	4	5	6	7
1	0.5	0	0	0	0	0	0
2	0	0	0	0	0	0.083	0
3	0	0	0	0	0	0	0
4	0	0	0	0	0.121	0	0
5	0	0.045	0	0	0.345	0.076	0.061
6	0	0	0	0.056	0.152	0.067	0
7	0.667	0	0	0	0.03	0.111	0.83

Density Matrix for Agricultural Products in 2008							
	1	2	3	4	5	6	7
1	0.05	0.133	0	0	0	0	0
2	0.6	0.333	0	0	0.417	0	0
3	0	0	0	0	0	0	0
4	0	0	0	0	0	0.119	0
5	0	0.083	0	0	0	0.036	0
6	0	0	0	0.143	0.286	0.762	0.071
7	0	0	0	0.167	0	0.143	0

Density Matrix for Raw Materials in 2008					
	1	2	3	4	5
1	0.2	0.05	0	0	0
2	0.55	0.143	0	0.063	0
3	0	0	0	0.025	0
4	0.3	0.016	0.15	0.304	0
5	0	0	0	0	0

Density Matrix for Energy Products in 2008						
	1	2	3	4	5	6
1	0.036	0	0	0.143	0	0
2	0	0	0.389	0.571	0	0
3	0	0.444	0	0.016	0	0
4	0.161	0.5	0.032	0.571	0.143	0
5	0	0	0	0	0	0
6	0	0	0	0	0	0

Figure 7 Density Matrix with Positive Values Highlighted (2008)

Part 2: Multinetwork Analysis (Non-Normalized and Normalized)

1	australia	1.000	0.134	0.225	0.637	0.642	0.421	0.273	0.240
21	japan	0.134	1.000	0.698	0.238	0.342	0.596	0.153	0.073
31	rep. of korea	0.225	0.698	1.000	0.225	0.299	0.459	0.130	0.143
4	brazil	0.637	0.238	0.225	1.000	0.811	0.576	0.310	0.291
17	india	0.642	0.342	0.299	0.811	1.000	0.555	0.287	0.226
6	chile	0.421	0.596	0.459	0.576	0.555	1.000	0.321	0.346
39	usa	0.273	0.153	0.130	0.310	0.287	0.321	1.000	0.177
27	new zealand	0.240	0.073	0.143	0.291	0.226	0.346	0.177	1.000

5	canada	0.070	0.134	0.235	0.424	0.231	0.161	-0.020	0.096
19	israel	0.015	0.328	0.374	0.235	0.534	0.294	-0.012	0.060
7	china	0.093	0.454	0.396	0.220	0.489	0.385	0.110	0.177
25	mexico	0.038	0.117	0.213	0.392	0.193	0.141	-0.020	0.108

9	denmark	-0.035	-0.004	-0.018	0.069	0.030	0.052	-0.006	0.147
14	greece	-0.000	0.086	0.098	0.203	0.259	0.285	0.045	0.174
15	hungary	-0.069	0.020	-0.008	0.055	0.080	0.116	-0.016	-0.009
3	belgium	-0.026	0.086	0.085	0.113	0.162	0.158	0.024	-0.002
13	germany	-0.071	0.156	0.137	0.058	0.194	0.186	-0.039	-0.046
18	ireland	-0.019	-0.019	-0.025	0.103	0.051	0.036	-0.001	0.271
29	poland	-0.058	0.069	0.026	0.062	0.089	0.157	0.004	0.011
11	finland	-0.008	0.154	0.164	0.150	0.223	0.204	0.033	-0.040
2	austria	-0.040	0.097	0.072	0.082	0.149	0.217	0.034	-0.003
12	france	-0.043	0.088	0.084	0.166	0.207	0.168	0.024	0.069
32	slovakia	-0.065	-0.003	-0.022	-0.033	0.028	0.034	-0.051	-0.095
24	luxembourg	-0.043	0.110	0.081	0.052	0.183	0.232	0.044	-0.024
16	iceland	-0.034	0.005	-0.015	0.065	0.059	0.105	0.029	0.214
26	netherlands	-0.008	-0.010	-0.004	0.091	0.064	0.015	0.016	0.038
8	czechia	-0.051	0.057	0.031	0.043	0.107	0.137	0.011	-0.043
37	turkey	0.166	0.192	0.195	0.375	0.527	0.372	0.113	0.119
33	slovenia	-0.044	0.050	0.037	0.038	0.123	0.198	0.015	-0.041
30	portugal	-0.034	0.052	0.064	0.104	0.150	0.163	0.020	-0.023
35	sweden	-0.047	0.140	0.130	0.090	0.168	0.176	0.013	-0.080
36	switzerland	-0.034	0.157	0.135	0.076	0.177	0.230	0.052	0.016
20	italy	-0.041	0.167	0.136	0.115	0.202	0.241	0.054	0.038
34	spain	0.049	0.056	0.036	0.247	0.234	0.240	0.059	0.109

10	estonia	-0.056	-0.033	-0.011	0.084	0.001	-0.058	-0.037	-0.119
23	lithuania	-0.055	-0.064	-0.053	0.042	-0.037	-0.095	-0.035	-0.088
28	norway	-0.002	-0.019	0.033	-0.000	0.025	-0.052	0.023	0.065
38	united kingdom	-0.010	0.097	0.126	0.185	0.176	0.091	0.062	-0.053
22	latvia	-0.060	-0.051	-0.051	-0.009	-0.017	-0.057	-0.079	-0.126

1	australia	1.000	0.028	-0.063	0.599	-0.090	-0.142	0.219	0.614
21	japan	0.028	1.000	0.283	0.025	-0.108	-0.141	0.060	0.152
7	china	-0.063	0.283	1.000	-0.052	0.209	0.123	-0.018	0.225
4	brazil	0.599	0.025	-0.052	1.000	0.210	0.150	0.213	0.711
5	canada	-0.090	-0.108	0.209	0.210	1.000	0.977	-0.161	-0.140
25	mexico	-0.142	-0.141	0.123	0.150	0.977	1.000	-0.183	-0.210
39	usa	0.219	0.060	-0.018	0.213	-0.161	-0.183	1.000	0.177
17	india	0.614	0.152	0.225	0.711	-0.140	-0.210	0.177	1.000

13	germany	-0.207	-0.005	0.135	-0.199	-0.118	-0.167	-0.155	-0.060
38	united kingdom	-0.216	-0.170	-0.100	-0.184	0.095	0.097	-0.102	-0.241
3	belgium	-0.206	-0.150	-0.022	-0.226	-0.150	-0.189	-0.125	-0.204
26	netherlands	-0.123	-0.182	-0.137	-0.126	-0.070	-0.102	-0.081	-0.201

12	france	-0.250	-0.174	-0.007	-0.196	-0.188	-0.223	-0.143	-0.181
20	italy	-0.256	-0.080	0.080	-0.283	-0.191	-0.214	-0.112	-0.206
34	spain	-0.121	-0.182	-0.216	-0.099	-0.343	-0.338	-0.096	-0.098
28	norway	-0.079	-0.132	-0.182	-0.177	-0.103	-0.100	-0.045	-0.155
2	austria	-0.223	-0.130	-0.183	-0.342	-0.544	-0.518	-0.130	-0.215

16	iceland	-0.081	-0.077	-0.500	-0.282	-0.633	-0.511	-0.088	-0.125
14	greece	-0.094	-0.085	-0.482	-0.286	-0.643	-0.524	-0.098	-0.118
11	finland	-0.217	-0.124	-0.343	-0.399	-0.591	-0.514	-0.173	-0.220
10	estonia	-0.076	-0.071	-0.500	-0.270	-0.602	-0.479	-0.089	-0.119
18	ireland	-0.098	-0.107	-0.474	-0.235	-0.584	-0.487	-0.098	-0.133
23	lithuania	-0.087	-0.088	-0.520	-0.278	-0.587	-0.460	-0.097	-0.139
24	luxembourg	-0.147	-0.103	-0.478	-0.376	-0.720	-0.612	-0.118	-0.168
6	chile	0.279	0.433	-0.110	0.248	-0.436	-0.419	0.174	0.294
22	latvia	-0.077	-0.074	-0.502	-0.277	-0.616	-0.492	-0.094	-0.121
27	new zealand	0.002	-0.060	-0.443	-0.180	-0.588	-0.468	-0.034	-0.056
9	denmark	-0.125	-0.121	-0.446	-0.259	-0.577	-0.491	-0.111	-0.176
29	poland	-0.227	-0.153	-0.381	-0.379	-0.646	-0.592	-0.161	-0.276
8	czechia	-0.195	-0.142	-0.356	-0.377	-0.643	-0.573	-0.140	-0.219
31	rep. of korea	0.110	0.624	0.101	-0.063	-0.129	-0.137	0.011	0.053
32	slovakia	-0.123	-0.104	-0.473	-0.333	-0.644	-0.536	-0.127	-0.161
33	slovenia	-0.099	-0.086	-0.492	-0.311	-0.660	-0.541	-0.100	-0.137
15	hungary	-0.133	-0.115	-0.499	-0.331	-0.689	-0.578	-0.124	-0.174
35	sweden	-0.243	-0.106	-0.288	-0.395	-0.568	-0.526	-0.173	-0.231
36	switzerland	-0.214	-0.083	-0.302	-0.406	-0.667	-0.604	-0.128	-0.206
37	turkey	-0.079	-0.111	-0.353	-0.249	-0.712	-0.616	-0.118	0.012
19	israel	-0.186	0.107	0.340	-0.218	-0.227	-0.203	-0.206	0.238
30	portugal	-0.135	-0.111	-0.431	-0.310	-0.622	-0.514	-0.116	-0.145

Figure 8 Part of CONCOR Blockmodel for Multinetworks (non-normalized on left and normalized on right)

2007

Part 1: Density Matrix for Binarized Trade Networks (See Appendix for Block Models)

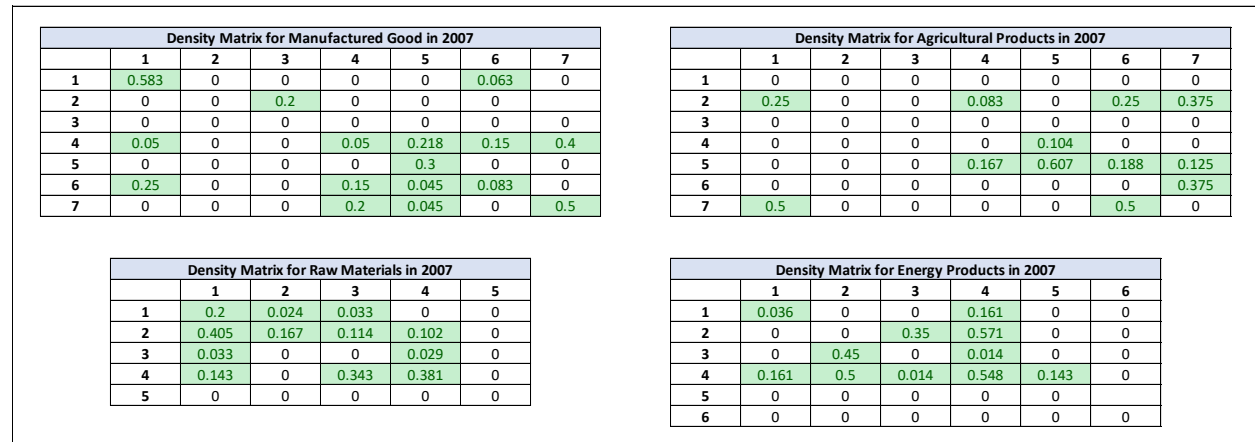


Figure 9 Density Matrix with Positive Values Highlighted (2007)

Part 2: Multinetwork Analysis (Non-Normalized and Normalized)

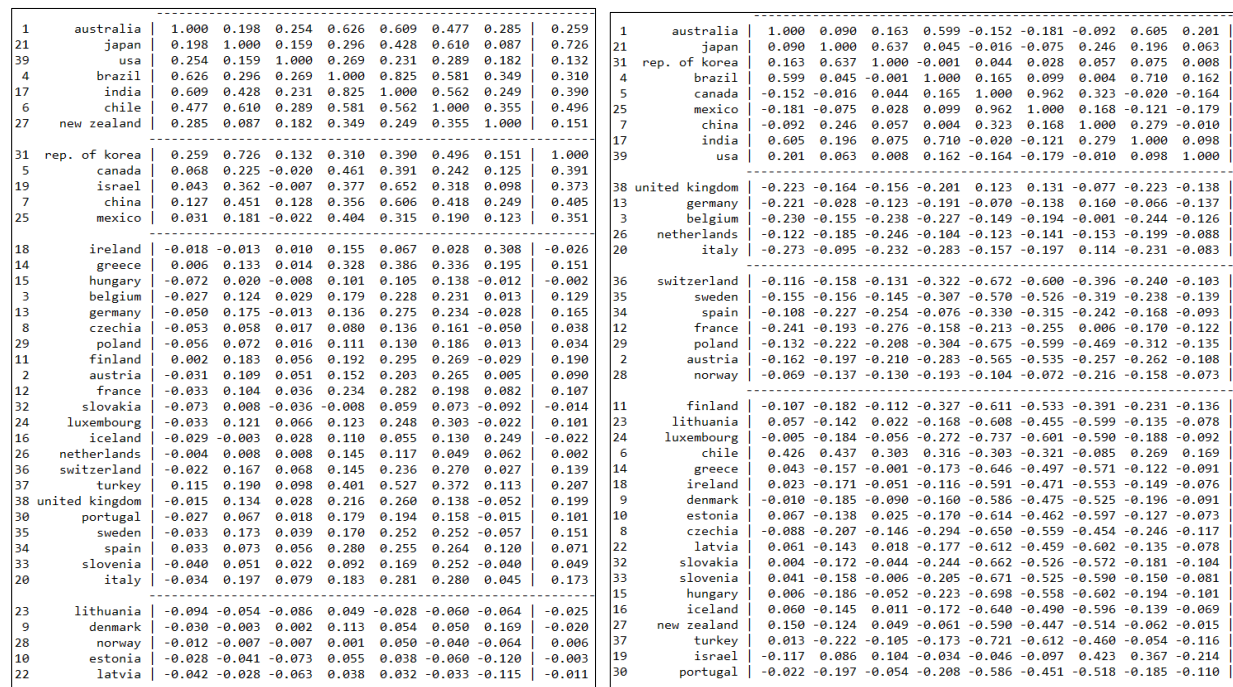


Figure 10 Part of CONCOR Blockmodel for Multinetworks (non-normalized on left and normalized on right)

2013

Part 1: Density Matrix for Binarized Trade Networks (See Appendix for Block Models)

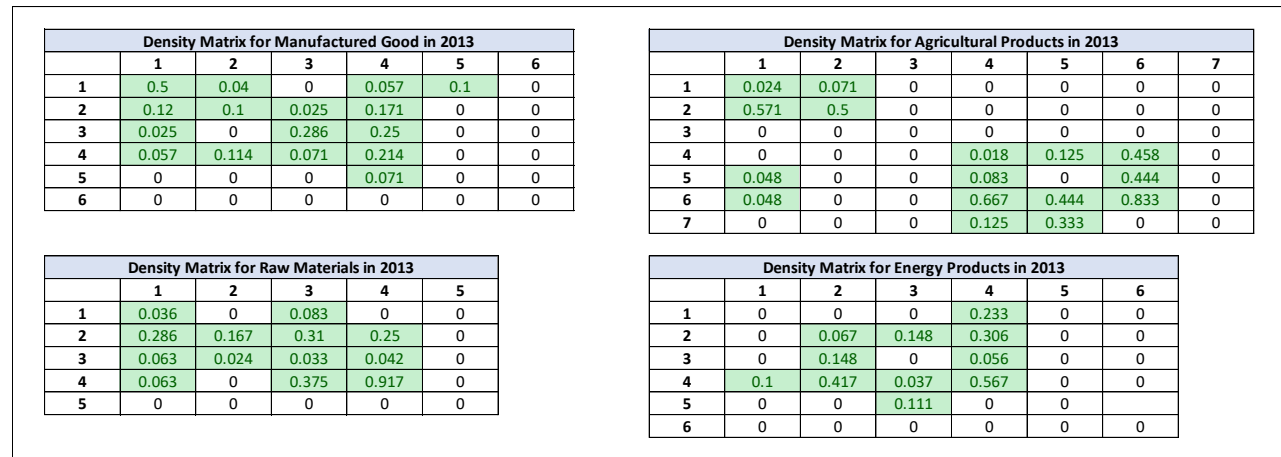


Figure 11 Density Matrix with Positive Values Highlighted (2013)

Part 2: Multinetwork Analysis (Non-Normalized and Normalized)

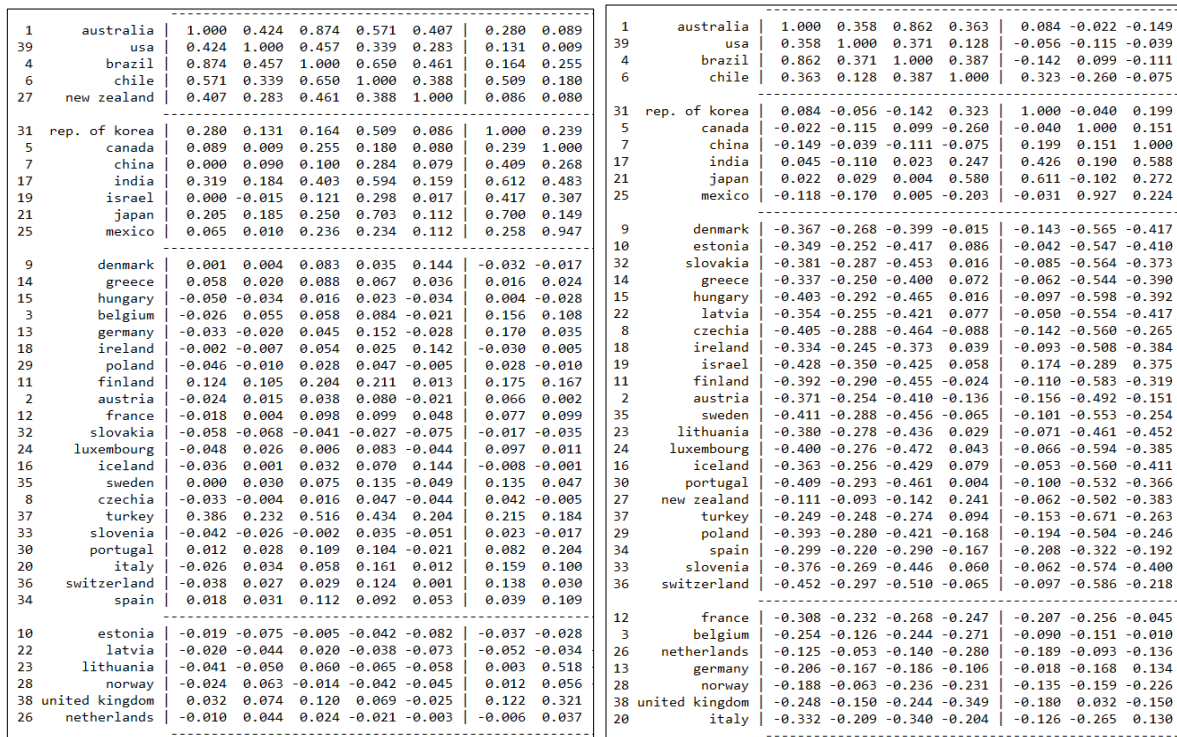


Figure 12 Part of CONCOR Blockmodel for Multinetworks (non-normalized on left and normalized on right)

Discussion

The results of this study are represented in two main ways: a block model partition and density matrix (found in the results section and appendix). The block model partition helps determine which countries are subset together based on the equivalence in their trading pattern. While the density matrix is a quick way to visualize how the partitions relate to each other. A density matrix “is a matrix that has positions rather than individual actors as its rows and columns, and the values in the matrix are the proportion of “choices” that are present from the actors in the row position to the actors in the column position” (Faust and Wasserman 13). With these results, it is possible to evaluate if the countries still form the core-periphery pattern and which countries form the core.

When the results of the benchmark study of 1972 data are compared with Breiger’s results (included in the appendix), it is evident the results are not identical. For instance, the normalized block model from the combined networks in this study groups UK with USA, Canada and Japan while Breiger’s study groups UK with Australia. The differences in subsets of partition can be observed in Figure 4 and Figure 34. This pattern is evident in other results obtained for binarized trade networks as well as density matrix: the nations are partitioned in a similar manner but not the same.

The reasons for these differences could be the choice of data or an unintentional difference in methodology from Breiger’s original work. For instance, in this study, the network of trade exchanges is created using import data to address discrepancies in values but Breiger might have used another approach that is not explicitly stated in his paper, leading to differences in outcome. Additionally, this study utilizes UCINET’s generation of correlation matrix and normalization, that could be different from the steps employed by Breiger, leading to discrepancies in calculation.

Although the resulting nations are not identical from Breiger's work and this study, the methodology applied in this benchmark analysis is deemed credible because there are limited number of countries that are partitioned differently and the density matrix for manufactured goods (Figure 3), follows a similar pattern to the mean value trade within and between blocks in Breiger's analysis (Figure 33). As seen in Figure 13, the block model image of binarized manufacturing network in 1972, the nations in core have extensive trade among themselves compared to the ones on the outside. The missing piece of information from this image is the distinction that emerges from including the values that are exports only. Nonetheless, given that the benchmark analysis indicates an existence of core-periphery pattern in density matrices and produces similar nations in core, the methodology and data is used to explore the recent data.

The results in 2018

Future Work

By looking at the

Look at intellectual transfers and control of information and financial markets

“Unequal exchange initially created and continuously maintains the structural division

Add link to github

Conclusion

Through meticulous review and application of Ronald Breiger's approach in identifying positions of OECD nations in Network analysis in sociology requires strong theoretical reasoning and methodological implications.

References

- Breiger, Ronald, Blau, Peter M., et al. "Structures of Economic Interdependence Among Nations." *Continuities in Structural Inquiry*, Sage, 1981.
- Faust, Katherine, and Stanley Wasserman. "Blockmodels: Interpretation and Evaluation." *Social Networks*, vol. 14, no. 1-2, 1992, pp. 5–61., doi:10.1016/0378-8733(92)90013-w.
- Nemeth, Roger J, and David A Smith. "International Trade and World-System Structure: A Multiple Network Analysis." Review (Fernand Braudel Center), vol. 8, no. 4, 1985, pp. 517–560. JSTOR, doi:https://www.jstor.org/stable/40241006.
- Snyder, David, and Edward L. Kick. "Structural Position in the World System and Economic Growth, 1955-1970: A Multiple-Network Analysis of Transnational Interactions." *American Journal of Sociology*, vol. 84, no. 5, 1979, pp. 1096–1126., doi:10.1086/226902.
- Wallerstein, Immanuel. "The Rise and Future Demise of the World Capitalist System: Concepts for Comparative Analysis." *Toward a Just World Order*, 2019, pp. 113–139., doi:10.4324/9780429269400-14.
- White, Harrison C., et al. "Social Structure from Multiple Networks. I. Blockmodels of Roles and Positions." *American Journal of Sociology*, vol. 81, no. 4, 1976, pp. 730–780., doi:10.1086/226141.
- "World Trade Statistical Review 2019." *World Trade Statistical Review*, 2019, doi:10.30875/7195c6e1-en.

Appendix

Table 2 Complete List of Countries in Consideration

INCLUDED BY BREIGER	COUNTRY	YEAR OF ACCESSION
*	AUSTRIA	1961
*	BELGIUM	1961
*	CANADA	1961
*	DENMARK	1961
*	FRANCE	1961
*	GERMANY	1961
*	GREECE	1961
*	ICELAND	1961
*	IRELAND	1961
*	LUXEMBOURG	1961
*	NETHERLANDS	1961
*	NORWAY	1961
*	PORTUGAL	1961
*	SPAIN	1961
*	SWEDEN	1961
*	SWITZERLAND	1961
*	TURKEY	1961
*	UNITED KINGDOM	1961
*	UNITED STATES	1961
*	ITALY	1962
*	JAPAN	1964
*	FINLAND	1969
*	AUSTRALIA	1971
	NEW ZEALAND	1973
	MEXICO	1994
	CZECHIA	1995
	HUNGARY	1996
	KOREA	1996
	POLAND	1996
	SLOVAKIA	2000
	CHILE	2010
	ESTONIA	2010
*	ISRAEL	2010
	SLOVENIA	2010
	LATVIA	2016
	LITHUANIA	2018
	BRAZIL	Not OECD
	CHINA	Not OECD
	INDIA	Not OECD

1972: Binarized for each trade networks

1	australia			1				
23	usa			1	1	1		
4	canada		1					
14	japan		1	1	1			
13	italy		1					
3	belgium-luxembourg					1	1	
15	netherlands				1	1	1	1
8	germany	1		1	1	1	1	1
22	united kingdom					1		1
7	france			1	1	1		1
11	ireland							
20	switzerland							
16	norway					1		
19	sweden					1		
6	finland							
12	israel							
9	greece							
5	denmark							
18	spain							
2	austria							
21	turkey							
10	iceland							
17	portugal							
24	yugoslavia							

Figure 13 CONCOR Block Model for Manufactured Goods - 1972

1	australia			1				
23	usa		1	1		1	1	
4	canada		1		1	1		
14	japan		1	1	1			
22	united kingdom		1				1	
16	norway		1					
3	belgium-luxembourg						1	
8	germany		1			1	1	1
13	italy		1			1		1
15	netherlands		1			1		
7	france				1	1	1	
19	sweden			1				
6	finland							
5	denmark							
12	israel							
2	austria							
9	greece							
17	portugal							
18	spain							
20	switzerland							
21	turkey							
10	iceland							
11	ireland							
24	yugoslavia							

Figure 14 CONCOR Block Model for Raw Materials - 1972

1	australia	1	1						
14	japan	1	1						
4	canada		1						
23	usa	1	1	1		1			
5	denmark						1		
11	ireland						1		
3	belgium-luxembourg				1	1	1		
15	netherlands			1		1	1		
13	italy					1	1		
7	france				1	1	1	1	
8	germany				1	1	1	1	
22	united kingdom			1	1				
6	finland								
12	israel								
9	greece								
16	norway								
2	austria								
18	spain								
19	sweden								
20	switzerland								
21	turkey								
10	iceland								
17	portugal								
24	yugoslavia								

Figure 15 CONCOR Block Model for Agriculture Products – 1972

1	australia								
5	denmark								
9	greece								
10	iceland								
11	ireland								
6	finland								
17	portugal								
21	turkey								
12	israel								
18	spain								
24	yugoslavia								
7	france			1	1				1
13	italy			1					1
2	austria								1
20	switzerland								
3	belgium-luxembourg			1		1	1		1
15	netherlands					1			1
16	norway							1	1
23	usa							1	1
4	canada						1		
22	united kingdom						1		
14	japan						1		
19	sweden								
8	germany					1	1	1	1

Figure 16 CONCOR Block Model for Energy Products – 1972

1	australia	1	1						
21	japan	1	1	1					
31	rep. of korea	1	1	1			1		
7	china	1	1	1	1		1		
39	usa	1			1	1	1	1	
<hr/>									
4	brazil	1							
6	chile	1	1						
17	india	1			1				
5	canada	1							
20	italy	1					1		
34	spain	1	1		1				
25	mexico	1							
<hr/>									
36	switzerland					1	1		
8	czechia						1		
2	austria						1		
<hr/>									
38	united kingdom	1					1	1	1
9	denmark						1		
12	france	1		1			1	1	1
28	norway								
26	netherlands	1				1	1	1	1
13	germany	1				1	1	1	1
3	belgium					1	1	1	1
18	ireland					1			
35	sweden						1		1
<hr/>									
29	poland								
24	luxembourg								
23	lithuania								
10	estonia								
33	slovenia								
14	greece								
22	latvia								
32	slovakia								
16	iceland								
15	hungary								
27	new zealand								
<hr/>									
11	finland						1		
30	portugal			1					
<hr/>									
19	israel								1
37	turkey		1						

Figure 17 CONCOR Block Model for Manufacturing – 2018

1	australia			1				
39	usa	1 1	1 1 1 1		1		1 1	
7	china	1 1	1 1 1			1 1	1	
4	brazil							
17	india							
6	chile							
27	new zealand							
3	belgium					1 1 1		
9	denmark					1		
29	poland					1		
2	austria					1		
20	italy			1		1 1 1		
34	spain					1 1 1		
8	czechia					1		
36	switzerland					1		
30	portugal				1			
13	germany	1	1	1 1 1 1 1 1	1	1 1		
26	netherlands		1	1	1	1 1 1	1	
12	france			1	1 1 1	1 1	1	
18	ireland						1	
38	united kingdom			1 1 1		1 1 1 1		
31	rep. of korea	1 1 1						
5	canada	1					1	
25	mexico	1						
21	japan	1 1 1					1	
35	sweden							1
28	norway							
23	lithuania							
10	estonia							
14	greece							
22	latvia							
24	luxembourg							
33	slovenia							
15	hungary							
16	iceland							
32	slovakia							
37	turkey							
19	israel							
11	finland							

Figure 18 CONCOR Block Model for Agriculture Products – 2018

1	australia					
11	finland					
25	mexico			1		
27	new zealand					
5	canada			1	1	
6	chile					
37	turkey			1	1	
38	united kingdom			1	1	1
31	rep. of korea	1	1 1	1 1	1	1
7	china	1 1 1 1 1 1 1	1 1 1 1 1	1 1	1	1
21	japan	1	1 1	1	1	
28	norway		1			
17	india	1	1		1	
34	spain		1	1	1	1
4	brazil					
2	austria					1
35	sweden					
39	usa	1	1	1		1
29	poland					1
8	czechia					
12	france			1	1	1
26	netherlands			1	1	1
13	germany	1		1 1 1 1 1 1	1 1	1
20	italy			1 1	1	1
3	belgium			1	1 1 1	
24	luxembourg					
23	lithuania					
9	denmark					
10	estonia					
14	greece					
22	latvia					
32	slovakia					
33	slovenia					
15	hungary					
16	iceland					
36	switzerland					
18	ireland					
19	israel					
30	portugal					

Figure 19 CONCOR Block Model for Raw Materials – 2018

1	australia		1			
25	mexico		1		1	
5	canada		1		1	
4	brazil		1			
13	germany		1	1 1 1	1 1 1 1 1 1 1 1	1 1
17	india		1 1		1 1	
31	rep. of korea		1 1			
21	japan		1 1			
7	china	1 1	1 1	1	1	
19	israel					
6	chile					
11	finland					
36	switzerland	1				
26	netherlands	1	1	1		
15	hungary	1				
3	belgium	1		1		1
8	czechia	1				
39	usa	1 1 1 1 1	1 1 1 1 1	1	1	
29	poland	1	1			
20	italy	1	1			1
2	austria	1				
34	spain	1	1		1	1
35	sweden	1				
12	france	1	1	1	1 1	
30	portugal				1	
38	united kingdom	1	1	1 1	1	
24	luxembourg					
28	norway					
23	lithuania					
14	greece					
18	ireland					
32	slovakia					
33	slovenia					
9	denmark					
22	latvia					
27	new zealand					
37	turkey					
10	estonia					
16	iceland					

Figure 20 CONCOR Block Model for Energy Products – 2018

2008: Binarized for each trade networks

[illegible]

Figure 21 CONCOR Block Model for Manufacturing – 2008

1	australia					
39	usa	1 1	1	1		
5	canada	1				
4	brazil	1				
6	chile					
<hr/>						
31	rep. of korea	1 1 1 1 1	1	1		
7	china	1 1 1 1 1	1	1 1 1 1	1	
17	india	1	1			
28	norway	1				
37	turkey	1				
21	japan	1 1 1 1 1	1			
25	mexico	1 1				
34	spain	1			1 1 1	
<hr/>						
29	poland					
8	czechia					
2	austria				1	
35	sweden					
9	denmark					
<hr/>						
12	france	1			1 1 1	
30	portugal					
13	germany	1 1 1	1	1 1 1 1 1	1	1 1 1
26	netherlands	1 1			1	1 1
3	belgium	1			1	1 1
24	luxembourg				1	
20	italy	1 1		1	1	1
38	united kingdom	1 1 1			1 1	
<hr/>						
23	lithuania					
27	new zealand					
10	estonia					
14	greece					
22	latvia					
32	slovakia					
33	slovenia					
15	hungary					
16	iceland					
36	switzerland					
18	ireland					
19	israel					
11	finland					

Figure 22 CONCOR Block Model for Raw Materials - 2008

1	australia	1						
6	chile							
25	mexico		1					
27	new zealand							
5	canada		1					
21	japan	1 1	1	1			1 1	
31	rep. of korea	1		1			1	
39	usa	1 1 1 1 1					1 1	
23	lithuania							
10	estonia							
32	slovakia							
22	latvia							
17	india							
14	greece							
15	hungary							
16	iceland							
33	slovenia							
11	finland							
19	israel							
24	luxembourg							
9	denmark							1
8	czechia							1
36	switzerland							1
28	norway							
2	austria							1
29	poland							1
18	ireland							1
4	brazil							
7	china		1					
37	turkey							
3	belgium						1	1 1
26	netherlands					1	1	1 1 1 1
20	italy				1			1 1 1 1
34	spain							1 1 1
12	france					1		1 1 1 1 1 1
13	germany				1 1 1 1 1	1 1 1 1	1 1 1 1 1	1
38	united kingdom				1	1 1	1 1 1 1 1	
35	sweden				1	1		1
30	portugal							1

Figure 23 CONCOR Block Model for Agricultural Products – 2008

1	australia					1		
21	japan	1				1 1		
31	rep. of korea	1				1		
4	brazil							
5	canada					1 1		
25	mexico					1		
17	india					1		
19	israel							
30	portugal						1	
13	germany			1 1	1 1 1 1 1	1 1 1 1 1 1 1		
26	netherlands		1			1		
2	austria		1					
9	denmark		1					
36	switzerland		1					
15	hungary		1					
35	sweden		1					
8	czechia		1					
29	poland		1					
11	finland							
12	france		1			1 1 1 1 1		
20	italy		1	1		1 1 1		
7	china	1 1	1			1	1	
39	usa	1 1 1 1 1 1 1	1			1 1 1 1		
3	belgium		1	1		1 1	1	
34	spain		1			1 1 1		
38	united kingdom		1			1 1 1 1 1		
6	chile							
24	luxembourg							
23	lithuania							
28	norway							
18	ireland							
32	slovakia							
33	slovenia							
14	greece							
22	latvia							
27	new zealand							
37	turkey							
10	estonia							
16	iceland							

Figure 24 CONCOR Block Model for Energy Products – 2008

2007: Binarized for each trade networks

1	australia								
17	india	1	1						
31	rep. of korea	1	1						
7	china	1	1					1	
30	portugal				1				
15	hungary								
14	greece								
23	lithuania								
37	turkey								
10	estonia								
33	slovenia								
22	latvia								
32	slovakia								
27	new zealand								
19	israel								
16	iceland								
8	czechia								
39	usa	1			1	1 1 1 1	1 1	1 1 1	1 1
2	austria					1			
34	spain					1			1 1
36	switzerland					1	1		
29	poland					1			
24	luxembourg					1			
3	belgium					1 1 1 1	1 1		
28	norway								
26	netherlands					1 1 1	1 1		
13	germany					1 1 1	1 1		
9	denmark					1			
11	finland								
38	united kingdom					1 1 1 1	1		
12	france					1 1 1 1	1		
18	ireland					1	1		
35	sweden					1	1 1 1		
6	chile	1	1		1			1	
21	japan	1	1 1						
4	brazil				1				
5	canada				1	1	1		
25	mexico				1	1			1
20	italy				1	1			

Figure 25 CONCOR Block Model for Manufacturing – 2007

1	australia								
6	chile								
27	new zealand								
31	rep. of korea	1						1	1
35	sweden				1				1
21	japan	1 1						1 1 1	1
32	slovakia					1			
24	luxembourg								
36	switzerland								
10	estonia								
11	finland								
22	latvia								
23	lithuania								
14	greece								
15	hungary								
33	slovenia								
17	india								
16	iceland								
19	israel								
29	poland					1			
2	austria					1			
9	denmark					1			
18	ireland						1		
37	turkey								
8	czechia					1			
34	spain					1	1 1 1 1	1	1
13	germany				1 1 1 1 1	1	1 1 1 1	1 1	
3	belgium					1	1 1		
20	italy				1	1 1	1 1		
30	portugal					1			
12	france					1 1 1 1	1 1	1	
26	netherlands					1 1 1	1	1	
38	united kingdom				1 1	1 1 1 1	1 1	1	1
5	canada								1
7	china								1
4	brazil								
25	mexico								1
28	norway	1 1 1						1 1 1 1	
39	usa	1 1 1						1 1 1 1	

Figure 26 CONCOR Block Model for Agriculture Products – 2007

1	australia						
39	usa	1 1 1	1		1		
25	mexico	1					
6	chile						
5	canada	1					
37	turkey	1					
17	india	1	1				
7	china	1 1	1 1	1 1 1 1	1	1	
31	rep. of korea	1 1	1 1	1 1	1		
28	norway		1				
21	japan	1 1	1 1	1	1		
11	finland	1				1	
34	spain	1			1	1 1 1	
29	poland						
8	czechia						
4	brazil	1					
35	sweden						
2	austria					1	
38	united kingdom	1	1		1 1	1 1	
12	france				1	1 1	1
13	germany	1	1		1 1 1 1 1	1 1 1 1	1
26	netherlands	1			1	1	1
20	italy	1			1 1	1 1	
30	portugal						
3	belgium				1	1 1 1	
24	luxembourg						
23	lithuania						
9	denmark						
10	estonia						
14	greece						
27	new zealand						
32	slovakia						
33	slovenia						
15	hungary						
22	latvia						
36	switzerland						
18	ireland						
19	israel						
16	iceland						

Figure 27 CONCOR Block Model for Raw Materials – 2007

1	australia					1	
21	japan	1				1 1	
31	rep. of korea	1				1	
4	brazil						
5	canada					1 1	
25	mexico					1	
17	india					1 1	
19	israel						
30	portugal					1	
13	germany		1 1	1 1 1 1 1	1 1 1 1 1 1 1		
26	netherlands		1			1	
2	austria		1				
9	denmark		1				
32	slovakia		1				
15	hungary		1				
35	sweden		1				
8	czechia		1				
36	switzerland		1				
29	poland		1				
11	finland						
20	italy		1			1 1 1	
12	france		1			1 1 1 1	
39	usa	1 1 1 1 1 1 1	1			1 1 1 1	
7	china	1 1	1			1	1
34	spain		1			1 1 1	
3	belgium		1	1		1 1 1	1
38	united kingdom		1			1 1 1 1	1
6	chile						
14	greece						
24	luxembourg						
18	ireland						
28	norway						
33	slovenia						
23	lithuania						
22	latvia						
27	new zealand						
37	turkey						
10	estonia						
16	iceland						

Figure 28 CONCOR Block Model for Energy Products – 2007

2013: Binarized for each trade networks

1	australia	1 1					
21	japan	1 1 1			1		
31	rep. of korea	1 1 1			1		
17	india	1	1			1	
37	turkey	1	1				
6	chile				1		
7	china	1 1	1 1		1		
4	brazil	1	1		1		
5	canada				1 1		
25	mexico			1	1		
20	italy			1	1		
18	ireland				1		
13	germany			1 1	1 1 1		
36	switzerland			1	1		
26	netherlands	1		1 1 1	1 1 1		
3	belgium			1 1 1	1 1 1		
2	austria			1			
12	france			1 1 1	1 1 1 1		
34	spain		1				
11	finland						
38	united kingdom			1 1	1 1 1		
39	usa	1 1	1 1 1	1 1	1 1		
9	denmark				1		
28	norway						
35	sweden				1 1 1		
14	greece						
30	portugal				1		
24	luxembourg						
29	poland						
8	czechia						
23	lithuania						
32	slovakia						
33	slovenia						
15	hungary						
22	latvia						
27	new zealand						
10	estonia						
19	israel						
16	iceland						

Figure 29 CONCOR Block Model for Manufacturing – 2013

1	australia	1						
6	chile							
25	mexico		1					
4	brazil							
5	canada		1					
27	new zealand							
17	india							
21	japan	1 1 1	1 1					
31	rep. of korea	1 1 1	1 1					
7	china	1 1 1 1	1					
39	usa	1 1 1 1 1 1 1	1					
10	estonia							
37	turkey							
14	greece							
15	hungary							
22	latvia							
32	slovakia							
11	finland							
19	israel							
24	luxembourg							
16	iceland							
23	lithuania							
33	slovenia							
9	denmark						1	
3	belgium						1 1 1	
20	italy				1		1 1 1	
8	czechia						1	
36	switzerland						1	
2	austria						1	
34	spain						1 1 1	
29	poland						1	
28	norway							1
18	ireland							1 1 1
26	netherlands	1			1	1		1 1 1
12	france				1 1 1 1 1	1	1 1 1	
13	germany	1			1 1 1 1 1 1 1	1	1 1 1	
38	united kingdom				1 1 1 1 1 1	1 1	1 1 1	
35	sweden				1		1 1	
30	portugal					1		

Figure 30 CONCOR Block Model for Agriculture Products – 2013

1	australia						
11	finland						
25	mexico				1		
27	new zealand						
5	canada				1		
6	chile						
37	turkey				1		
17	india	1	1		1		
7	china	1	1	1	1	1	1
38	united kingdom		1		1	1	1
31	rep. of korea	1	1	1	1	1	1
20	italy				1	1	1
21	japan	1	1	1	1	1	1
28	norway		1				
34	spain		1		1	1	
4	brazil						
39	usa	1	1	1	1		1
2	austria						
29	poland						
35	sweden						
8	czechia						
12	france				1	1	1
26	netherlands				1	1	1
3	belgium	1			1	1	1
13	germany		1		1	1	1
24	luxembourg						
23	lithuania						
9	denmark						
10	estonia						
14	greece						
22	latvia						
32	slovakia						
33	slovenia						
15	hungary						
16	iceland						
36	switzerland						
18	ireland						
19	israel						
30	portugal						

Figure 31 CONCOR Block Model for Raw Materials – 2013

1	australia					1	1	
25	mexico					1	1	
5	canada					1	1	
4	brazil					1		
37	turkey					1		
21	japan		1			1	1	
31	rep. of korea		1			1		
17	india					1	1	
6	chile							
19	israel							
13	germany			1	1	1	1	1
2	austria			1				
11	finland			1				
36	switzerland			1				
15	hungary			1				
26	netherlands			1		1		
8	czechia			1				
34	spain			1		1	1	
29	poland			1				
35	sweden			1				
20	italy			1		1	1	
12	france			1	1	1	1	
3	belgium			1	1	1	1	
7	china		1	1	1	1	1	
38	united kingdom			1		1	1	1
39	usa	1	1	1	1	1	1	1
30	portugal				1			
24	luxembourg							
23	lithuania							
28	norway							
9	denmark							
32	slovakia							
33	slovenia							
14	greece							
22	latvia							
27	new zealand							
18	ireland							
10	estonia							
16	iceland							

Figure 32 CONCOR Block Model for Energy Products – 2013

Density Matrix for All Networks for All Years

Density Matrix for all networks in 1972				
	1	2	3	4
1	0.383	0.289	0.233	0.357
2	0.289	0.878	0.186	0.158
3	0.233	0.186	0.579	0.398
4	0.357	0.158	0.398	0.499

Density Matrix for all networks in 1972 (Normalized)				
	1	2	3	4
1	0.771	0.438	-0.445	-0.231
2	0.438	0.488	-0.114	-0.302
3	-0.445	-0.114	0.392	-0.125
4	-0.231	-0.302	-0.125	0.159

Density Matrix for all networks in 2018				
	1	2	3	4
1	0.455	0.17	0.036	-0.003
2	0.17	0.543	0.163	0.02
3	0.036	0.163	0.477	0.139
4	-0.003	0.02	0.139	0.155

Density Matrix for all networks in 2018 (Normalized)				
	1	2	3	4
1	0.268	-0.015	-0.251	-0.257
2	-0.015	0.26	-0.15	-0.312
3	-0.251	-0.15	0.345	0.192
4	-0.257	-0.312	0.192	0.702

Density Matrix for all networks in 2008				
	1	2	3	4
1	0.351	0.208	0.076	-0.011
2	0.208	0.527	0.13	0.12
3	0.076	0.13	0.478	0.149
4	-0.011	0.12	0.149	0.257

Density Matrix for all networks in 2008 (Normalized)				
	1	2	3	4
1	0.131	-0.122	-0.184	-0.256
2	-0.122	0.206	0.167	-0.129
3	-0.184	0.167	0.198	0.106
4	-0.256	-0.129	0.106	0.629

Density Matrix for all networks in 2007				
	1	2	3	4
1	0.377	0.267	0.105	-0.014
2	0.267	0.5	0.148	0.052
3	0.105	0.148	0.482	0.154
4	-0.014	0.052	0.154	0.336

Density Matrix for all networks in 2007 (Normalized)				
	1	2	3	4
1	0.139	-0.136	-0.246	-0.219
2	-0.136	0.236	0.131	-0.172
3	-0.246	0.131	0.338	0.284
4	-0.219	-0.172	0.284	0.681

Density Matrix for all networks in 2013				
	1	2	3	4
1	0.485	0.187	0.044	-0.01
2	0.187	0.485	0.125	0.057
3	0.044	0.125	0.46	0.152
4	-0.01	0.057	0.152	0.29

Density Matrix for all networks in 2013 (Normalized)				
	1	2	3	4
1	0.411	-0.005	-0.257	-0.215
2	-0.005	0.272	-0.299	-0.128
3	-0.257	-0.299	0.7	0.043
4	-0.215	-0.128	0.043	0.211

Figure 33 Density Networks for Multinetwork Analysis

Breiger's Results

8. Germany	-IIIIIIIIIIIIIIII-I-
22. UK	I-I-IIIIIIIIIIIIIIII
23. USA	II-IIIIIIIIIIIIIIII
2. Austria	II-I-IIIIIIIIIIIIII
3. Belg./Lux.	III-IIIIIIIIIIIIII
7. France	III-I-IIIIIIIIIIII
13. Italy	III-II-IIIIIIIIIIII
15. Netherl.	III-IIIIIIIIIIIIII
19. Spain	I-I-IIIIIIIIIIIIII
21. Switzer.	II-I-IIIIIIIIIIIIII
24. Yugosla.	-I-IIIIIIIIIIIIIIII
5. Denmark	-I-IIIIIIIIIIIIIIII
6. Finland	II-IIIIIIIIIIIIIIII
17. Norway	III-IIIIIIIIIIIIII
20. Sweden	III-I-IIIIIIIIIIII
1. Austral.	-I-IIIIIIIIIIIIIIII
4. Canada	-II-IIIIIIIIIIIIIIII
11. Ireland	-I-IIIIIIIIIIIIIIII
12. Israel	-I-IIIIIIIIIIIIIIII
14. Japan	III-IIIIIIIIIIIIII
9. Greece	-IIIIIIIIIIIIIIIIII
10. Iceland	-IIIIIIIIIIIIIIIIII
16. New Zea.	-IIIIIIIIIIIIIIIIII
18. Portugal	-IIIIIIIIIIIIIIIIII

Mean Values of Trade Within and Between Blocks (\$ millions)

	Block 1	Block 2	Block 3	Block 4	Block 5	Block 6
Block 1	483	407	246	130	233	32
Block 2	539	319	157	44	28	14
Block 3	189	108	19	21	11	5
Block 4	177	36	24	109	11	5
Block 5	448	19	11	8	45	12
Block 6	22	8	3	6	5	0

Computed from the original (non-binarized) data and rounded. Mean values in excess of \$100 million have been circled. Compare the pattern of circled values to the 'center-periphery' pattern of Figure 1.

Figure 34 Results of Binarized Manufacture Network Data by Breiger

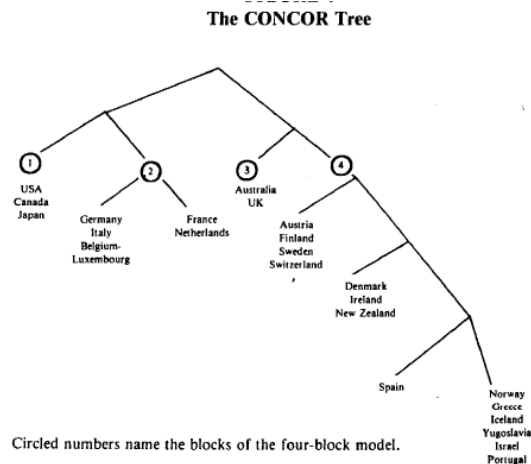


Figure 35 Concor Tree From Breiger's Result

TABLE 2
Correlations among the Trade Matrices Employed in this Study*

	Agricultural products	Raw materials	Manufactured goods	Energy resources
Agricultural products	1.000	0.579	0.591	0.470
Raw materials		1.000	0.524	0.661
Manufactured goods			1.000	0.584
Energy resources				1.000

Figure 36 Correlations Matrix from Breiger's Study