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Dependence, Independence, and Interdependence in World Politics

by

Dinsha Mistree

Submitted to the Department of Political Science
in Partial Fulfillment of the Requirements for the
Degree of Bachelor of Science and for the
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ABSTRACT

We implement techniques of graph theory to international trade in order to empirically inspect the international system of trade. Examining macro and submacro levels of the international system of trade from 1962-2003, we find the presence of a Scale-Free Network with a Multiscalar Hierarchy. Such structures are resilient to bottom-up economic collapse, but are susceptible to top-down and horizontal economic failures. Our findings are based upon an especially novel approach for examining submacro systems, applying latent community identification analysis to identify trading communities that are not necessarily formalized or institutionalized as trading blocs. Following this analysis, we examine the role of international institutions in the international trade network, specifically considering macro level institutions for stability solutions and examining the effects of joining a trade bloc. We find evidence that supports the intergovernmentalist framework, whereby certain types of trade blocs seem to succeed while others fail, leading to different results in integration and unification.

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If Behram is the father of this project, Ramy Arnaout is the mindful uncle. Ramy has been studying networks in biological systems and introduced me to much of the literature, the existing computer and GUI programs, and kept me abreast of advances in network research. Throughout the project, Ramy displayed particularly patience and understanding as I internalized, developed, and then adapted the concepts to better suit the International Relations bend of this project.

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To say that Kenneth Oye was especially instrumental in helping me refine my thoughts is an understatement. He helped me see the forest when I was oscillating between looking at the trees and the entire ecosystem. For his insights, I am tremendously grateful.

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This project would not have been possible without the generous support of the MIT Political Science Department, and the assistance has been – and still is – greatly appreciated.

Finally I would like to thank my parents, Farrokh Mistree and Janet Katherine Allen, for providing direction for me throughout my life. Growing up with two parents interested in systems analysis and multidisciplinary approaches to academic research, this thesis is the embodiment of their guidance. After reading this thesis, the reader will observe that the apple does not fall far from the tree.

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GLOSSARY

Balance of Power System: A macro level system where several Hubs interact with one another to form the upper echelon of trade partnerships. Such a system shows remarkable homophily between the traders.

Clique: Also known as a *community*, is a group of countries.

Clustering Coefficient: Given three countries, A, B, and C, where A and B trade and B and C trade, the clustering coefficient is the likelihood that A and C trade.

Contagion: Also known as *cascading failure*, refers to the spread of economic failure throughout the international economic system.

Core-Periphery Hierarchy: A Hierarchical structure with a very rigid and top-down structure.

Degrees: A measure of the number of relationships a node enjoys.

Degree of Separation: The minimum number of edges between two nodes.

Directed Edge: An edge with at least one flow traversing between two nodes.

Egalitarian Network: A network where all nodes have equal relationships and numbers of relationships.

Equal-Dependent Submacro System: A submacro system where all nodes have roughly equal relationships, and numbers of relationships.

Gatekeeper: A country that bridges a connection between two submacro groups.

Graph: Also known as a *network*, is a representation of a system.

Hierarchy: The ordering of countries in the international system. Several Hierarchies are possible; we find that a Multiscalar Hierarchy best describes the international system of trade.

Homophily: The level and strength of interconnections in a network.

Hub: A node that is more important to the structure of the network than most other nodes.

Interdependence: Interconnections between two or more countries.

k-*Clique*: Communities where all nodes satisfy a minimum threshold of partnership through their connections with other nodes in that clique.

Latent Clique: A grouping that has not necessarily been formalized or distinguished by a pact or by geographic characteristics.

Local Team Hierarchy: Contains several Gatekeepers, but nodes primarily follow a top-down Hierarchy of trade relationships.

Macro Level Approach: An approach that examines all nodes in the system relative to one another.

Micro Level Approach: An approach that examines dyadic, or bilateral, relationships in the system.

Multi-Dependent Submacro System: A submacro system with more than one Hub and more than one Spoke.

Multiscalar Hierarchy: A Hierarchy between Random, Random Interdivisional, Core-Periphery and Local Team. It is the most basic top-down hierarchical structure.

Node: Also known as a *vertex*, is a singular actor in a system.

Pure-Dependent Submacro System: A submacro system with a singular Hub and several Spoke countries.

Random Hierarchy: A Hierarchy that is not necessarily governed by top-down trade relationships.

Random Interdivisional Hierarchy: Apparent top-down relationships, but horizontal interactions are prevalent as well.

Random Network: A network with a Gaussian degree distribution. As contrasted to an Egalitarian Network or a Scale-Free Network.

Scale-Free Network: A network with a Power-Law degree distribution. A Scale-Free Network contains Hubs and Spokes and its presence suggests that subsystem relationships are important to understanding the hierarchy of the macro system. The international system of trade is a Scale-Free Network.

Spoke: A node that is less important to the system structure than a Hub.

Spring Embedding Function: A type of energy minimization for displaying graphs. A spring embedding function minimizes the visual size of the edges between the nodes while maintaining a certain amount of space between each node.

Submacro Level Approach: An approach where we examine the relationships between countries that take place between more than two nations, but fewer than all nations.

System: "An interconnection of components, devices, or subsystems" (Oppenheim, Wilsky, and Nawab, 1997: 38).

Trade Bloc: Also known as a *trade group*, is a formalized, or institutionalized group of countries that have preferential trade agreements with one another.

Undirected Edge: A simple relationship between two nodes.

CHAPTER 1: A NEW APPROACH TO EXAMINING THE INTERNATIONAL SYSTEM

Throughout the early 1990s, several countries in Eastern Asia – including Thailand, Malaysia, Indonesia, the Philippines, Singapore and South Korea – enjoyed incredibly rapid economic growth. International organizations such as the World Bank and the International Monetary Fund hailed the economic success as nothing short of a wonder, an Asian economic miracle (World Bank, 1993; Stiglitz and Yusuf, 2001).

In July of 1997, the bubble burst as an economic crisis ravaged these so-called Asian Tigers. Exports declined, foreign investment shrunk, a decline in earnings set in, and economic growth slowed (Yusuf, 2001). The causes of the economic collapse are still debated today: investors with a "herd mentality" were spooked by IMF threats to Indonesia due to asymmetric information, (Radelet and Sachs, 1998); struggles in the Thai real estate and financial sectors spread to economic problems in other areas in the region (Yusuf, 2001); even the Malaysian Prime Minister had an opinion, arguing that massive currency speculation by George Soros gutted the Malaysian economy, hurting surrounding economies (Billington, 1999). The list of causes goes on and on.

While identifying the causes of the economic crisis are well worth pursuing, what is equally interesting is the way in which policy-makers responded. Common to the mindsets of the policy-makers was that this economic down-turn needed to be contained. The governing logic was simple to understand: national economies are highly integrated with one another, and if a group of economies sputter, the decline may cause the larger economic system to sputter as well, or even collapse. In other words, depression in the international economic system is somehow contagious.

Thinking about international systems such as the international economic system is nothing new. Scholars in International Relations (IR) are purposefully engaged in working to identify and understand the structures of such international systems (Waltz, 1954; Rosencrance, 1963; Walt, 1985; Kaufman, 1997). Over the past sixty years, a rich corpus of theory has been merged with rational choice and empirical analysis to offer many insights into each dimension of world politics. Typically, analysis of the ways in which nations interact with one another has proceeded along three different levels (Berton, 1969). In the first level, countries engage in bilateral relationships, forming *micro systems*, where two countries directly interact with and influence each other. Such interactions include bilateral trade, non-alliance wars, or migration flows in which only two countries are involved. In the second level, countries join in multilateral relationships, forming *submacro systems*. In such cases, a country would interact with a community of countries, greater than two, but less than the entire population of all of the nations of the world: they would interact with a subsystem of the overall international order.[1] Examples of such submacro systems include trade blocs, military alliances, and common money markets.[2] The third level involves relationships where a nation's interactions are controlled, influenced, and determined relative to its position among the rest of the nations of the world.[3] Such international relationships are embodied in the *macro system*, or *international order*. These three levels of relationships are distinct, but not separate. Together, they influence the larger international system structure and shape the types of interactions between countries.

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[1] A submacro system is a grouping of nations. Such a grouping can be geographically regional, a trade group, or a political alliance, for example. The term comes from Berton, 1969.
[2] As the reader will soon discover, in this thesis we seek to find latent submacro systems rather than manifest subsystems such as these.
[3] Interactions among nations may also affect each other's domestic systems.

Integrative approaches across these levels tend to consider any two, but rarely all three, levels at once. Such a non-holistic perspective results from methodologies in IR typically focusing on *thesis* identification and testing where the principal goal is one of recognizing the primary cause of an effect; analyzing the international system requires *systemic theory* identification and testing, whereby one explains how changes and feedbacks in the system structure affect the conversion of inputs into outputs (Kaplan, 1960: xiii).[4] To put it more clearly, the goal of systems analysis is not necessarily to observe and test a causal theory, but it is instead intended to help the researcher observe the patterns of interactions among actors. One may be able to perform thesis testing after identifying the system structure.

While scholars in IR have investigated the international system, sociologists, scientists, and engineers have increasingly engaged in studies of systems pertinent to their own domains and disciplines (Newman, 2003). As scholars recognized the commonality of studying systems, a new mode of analysis grew out of their collaborations known as *complexity science*, or *graph theory*.[5] Graph theory now stands as a robust – but still developing – arena within academia. More importantly, graph theory offers a way of approaching the three levels of the international system at once, by using dyadic relationships to identify and explore submacro and macro system structures.

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[4] For Kaplan, both thesis and systemic theory are elements of theory, and he stresses that theory should not be contained to thesis identification alone (1957: xiii).

[5] Complexity science and graph theory are also known as network theory. While the terms are used interchangeably throughout the literature (see Newman 2003 for example), we predict that in time, network theory will come to classify relationships where flows between actors are involved, while graph theory will describe relationships between various actors. If we accept such a dichotomy, both the fundamental concepts and the mathematics of network theory and graph theory are nevertheless tremendously similar, making such a distinction a moot point. However, since we are primarily focused upon relationships of trade rather than flows of trade, we shall describe our approach as a graph theoretic approach.

Not surprisingly, one of the chief pursuits within graph theory is analyzing system stability and the spread of system instability. Albert and Barabási examine the stability of certain types of systems and networks in the context of the Internet and the World Wide Web (2002); Maslov and Sneppen investigate stability in protein networks (2002); Dunne, Williams, and Martinez consider system stability in the network of food webs (2002). Indeed, while IR scholars such as Robert E. Keohane complain that predictability is elusive as "[t]oo many factors interact in complex ways to produce the results we see," including "[r]andom shocks [that] disrupt the system," graph theorists do not shy away from this challenge (1997: 150). Instead, they embrace it. The attitude that complexity is something that needs be better understood, rather than something that needs to be avoided, guides our project.

Purposes of Project

In order to better understand system stability, system instability, and contagion conditions, we seek to identify the structure of the international system. Recognizing that the international system includes a diverse and diffuse set of relationships, we seek to identify the structure in terms of one type of interaction: international trade.[6] Further recognizing that a whole host of non-country actors – including individuals, grassroots movements, multinational corporations, and other non-governmental organizations – all affect international politics, we contain our analysis of the international system exclusively to relationships between countries. While other elements of the international system are important, nations form the backbone of international politics, and it is their

[6] In Chapter 2, we explain why we chose trade over other measures. To be clear, the Asian financial crisis was not caused by changes in trade, but rather by changes in capital and investment flows. Modeling such other economic structures would also be a useful and worthwhile project.

relationships among themselves and with the overall structure that we are chiefly interested in identifying (Gilpin, 1981: 26; Kaufman, 1997).

In order to fully understand the international system of trade, one needs to consider its subsidiary levels: the micro (relationships between two countries), the submacro (relationships between more than two countries, but fewer than all countries), and the macro (relationships between all countries). In analyzing trade, much work has already been conducted across all three levels. Micro / dyadic / bilateral relationships have been examined by several scholars, most notably by Beck, King, and Zeng (2000; 2004) and by Bennett and Stam (2000).[7] At the opposite end of the spectrum, macro relationships have been considered by Waltz (1954) and Walt (1985), to name just two of many theorists. And between micro and macro, submacro relationships have been studied in terms of geographic country groupings (Schirm, 2002), in terms of political and military alliances (Krebs, 1999), in terms of culture (Huntington, 1996), and in terms of economic bonds, especially by way of trade blocs (Mansfield and Milner, 1999).

Few studies ever examine the common nature of these submacro systems, however (Berton, 1969). These submacro systems affect their member countries, they affect the macro level, and they affect each other, and yet the best research in this arena has compared submacro groupings only within their contexts. One can find research that compares the European Union (EU) and the North American Free Trade Agreement (Abbott, 2000), or research that examines political alliances (Kupchan, 1988), but one is unlikely to find research that compares Asian country relationships to the South African Customs Union, or even research on non-formalized trading communities — where the involved nations do cooperate increasingly with each other without the benefits of an

[7] Each of these works use micro relationships to explore the causes and consequences of dyadic conflict.

official trade alliance. As a result, our understanding of inter-national interactions at the submacro level pales in comparison to our understanding of interactions at the micro and macro levels.[8] In this project, we seek to overcome this condition by observing submacro relationships embedded within dyadic relationships.[9]

To identify these several latent submacro groupings of countries, we shall take full advantages of recent developments in graph theory, especially utilizing advances in *community identification analysis*. Most networks typically have regions where the components are increasingly interconnected relative to the rest of the network, and these regions are known as *cliques*, or *clusters* (Palla, et al., 2005).[10] For our purposes, such *cliques* are nonformalized, submacro groupings of countries.[11]

Why consider latent cliques at all? In Figure 1, a friendship network of children in a US school is shown (Newman, 2003; picture courtesy of James Moody).[12] The light dots represent white children; the dark dots represent black children; the shaded dots represent children of other racial backgrounds.[13] Notice that while children do divide

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[8] The hyphen placed in the term "inter-national" is to draw attention to the fact that nations compete in an anarchic setting, with no all-powerful super-organization mediating actions. As a result, it is not fair to say that we are in a state of globalization, as we are in a state of inter-nationalization (Hirst and Thompson, 2002).

[9] In earlier drafts of this thesis, we described the latent cliques as "embedded." However, in *The Great Transformation*, Polanyi frequently refers to the economic system being embedded in the interactions of a larger international system, meaning that it is not autonomous. This concept of embeddedness has been adopted by many others, including Granovetter, Ruggie, and Evans (Block, 2001). To avoid confusion, from now on, we will use the term "latent" to describe non-formalized clusters in the international trade system.

[10] Cliques are also known as clusters, communities, and groupings (Derényi, et al., 2005).

[11] By a nonformalized grouping, we mean a grouping that is tied together by the fact that they trade with one another, not *necessarily* by geography, explicit trade bloc status, or culture.

[12] Newman's "Structure and Function of Complex Networks" represents the best compendium of network theory (2003). Citing 429 other references, Newman leaves few stones unturned.

[13] The hard copy of the thesis will be printed in black-and-white; the electronic version will include color. In the electronic version, white children are represented with yellow dots, black children with blue dots, and children of other racial backgrounds with green dots.

themselves along racial lines, what emerge are four distinct clusters – or communities of children – suggesting that some other divide beyond race exists as well.[14]

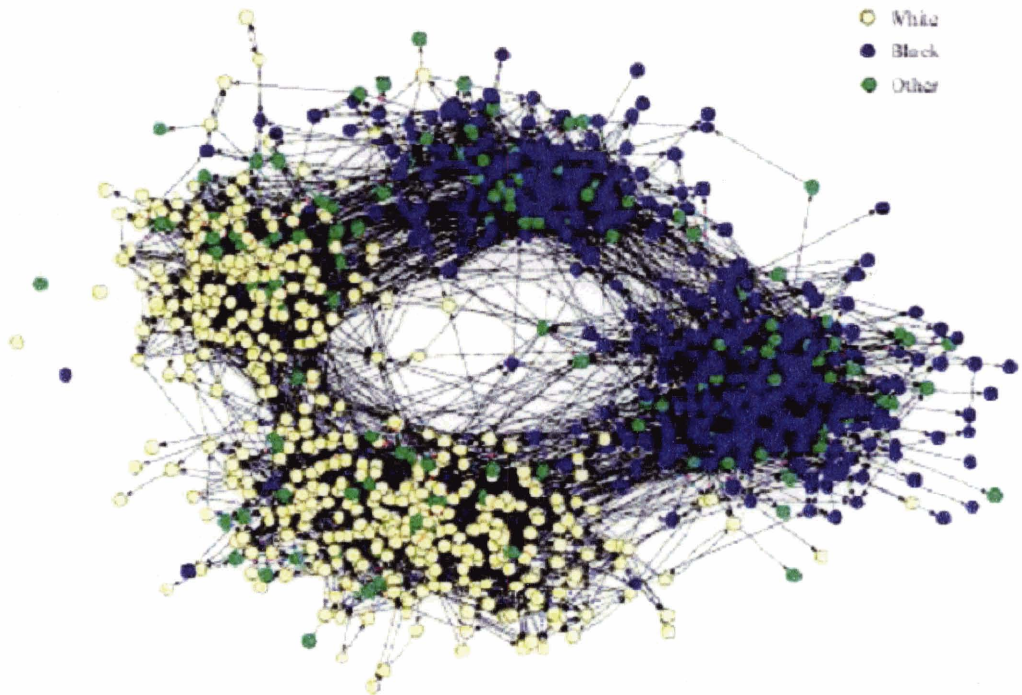

Figure 1: Friendship Relationships Between Children in a US School. From Newman, 2003, Courtesy of James Moody

As a thought exercise, let us consider these dots as countries instead of school children. Each color would then represent exclusive participation in a certain explicit trading bloc (such as NAFTA or the EU) as opposed to another trading bloc. However, the common divide within each of the trading groups would not be apparent if participation in a trading group were all that was being considered. Thus, the benefit of identifying each clique in the dataset is that it allows us to observe groupings that are not typically studied. For illustrative purposes, in Figure 2 we have provided one such latent

[14] One may suspect that this divide is perhaps one of gender or class, but in actuality, it is a product of an age divide.

submacro clique from 1984.[15] Notice that the seven countries included come from different trade groups, different cultures, different political alliances, and different continents.[16] To be clear, the value of considering latent trade cliques is that they are determined exclusively in terms of trade interactions, without relying upon any prior assumptions about identities or classifications.

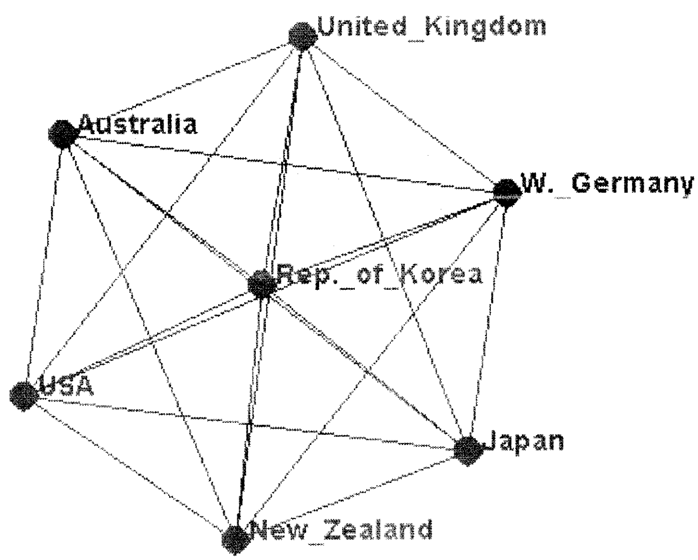

Figure 2: A Latent Submacro Clique in the International System

Finally, if our primary purpose in this project is to capture the structures and functions of the international system in terms of trade in order to understand the stability of trade, the latent purpose of this project is to demonstrate that graph theory should find a welcoming home in IR, and within political science at large.[17] To this end, we discuss

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[15] We shall discuss how this latent clique was identified and constructed in Chapters 3 and 4.

[16] A cynic might point out that these countries all belong to the Organization for Economic Co-operation and Development (OECD). However, in 1984, South Korea was not a member of this group and would not join for another twelve years. However, perhaps being so intertwined with these richer countries did help South Korea achieve OECD status, further demonstrating the benefits of examining latent submacro cliques.

[17] This is not to imply that graph theory has not been used before in political science. Indeed, as we shall show in the next chapter, its beginnings are rooted in political science.

the current state of graph theory in IR and political science, and we also speculate about future possibilities for graph theory across our field.[18]

Thesis Layout

The thesis is laid out as follows. In Chapter 2, we examine the history of graph theory, especially in the context of political science. Graph theory was born and first nurtured by sociologists and political scientists; however it has spent much of its adolescence in the company of scientists and engineers. As a result, applications of graph theory in the social sciences have predominantly been constrained to analyzing relationships between people, while incorporations of graph theory in the hard sciences have thoroughly pervaded physics (Albert and Barabási, 2002), computer science (Huberman, 2001), and especially biology (Anderson and May, 1991; Shen-Orr, Milo, Mangan, and Alon, 2002).[19]

In Chapter 2, we also explore the previous research pertaining to structures of the international system. Many structures of international systems have been presented in theoretical terms, but few have been tested. We shall examine and consider several of these propositions, as well as one of the leading empirical examinations which tests the propositions of systems theory. We shall also examine various literatures on international submacro systems. Several types of submacro systems abound, both in theory and in reality, and we shall briefly review several of these structures before calling

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[18] Throughout our speculations, we shall offer citations for the reader to follow up where graph theory are being employed.

[19] The selection of each of these citations is illustrative, but by no means random. Albert and Barabási have written one of the foremost reviews of network theory in physics; Huberman's book is entitled *The Laws of the Web*, and discusses network theory in context to one of the greatest contributions from computer science: the World Wide Web; Anderson and May's book discusses networks in the context of one of the most pressing issues in biology: the spread of infectious diseases; and Shen-Orr, et al.'s piece explores how various proteins interact to express genes. Examples are all described in Newman, 2003.

for the analysis that cuts across regional, political, cultural, and economic taxonomies of submacro systems.

In Chapter 3, we empirically examine the macro structure of the international trade system. Analyzing all of the major trade relationships between countries from 1962-2003, we find that a Scale-Free Network best captures and explains the dynamics of international trade.[20] A Scale-Free Network suggests that certain countries are tantamount to the stability of the system relative to other countries and that a hierarchy exists among actors. A Scale-Free Network also suggests that subsystems, or in our case, submacro systems, play an important role in the dynamics of the overall system.

In Chapter 4, we seek to empirically identify these submacro systems. Using one of the most recently developed algorithms in graph theory for latent community identification (and the one best-suited for our purposes of identifying cliques of countries), we present several of these cliques from the years 1962, 1982, and 2002.[21] We find that while the composition of cliques may change, several core properties are inherent to these groupings, which is the subject of Chapter 5.

In Chapter 5, we examine the differences of various submacro systems in the context of the hierarchical possibilities of the international system. A range of submacro systems exist, with different forms of interdependence uniting these multilateral groupings. We conclude from our submacro analysis that the international trade system follows a Multiscalar Hierarchy, one possible hierarchy of a Scale-Free Network. We

[20] A major trade relationship is defined as one in which a large portion of a country's overall trade comes from or goes to another country. While compiling the datasets, we found that several countries share minor and insignificant amounts of trade flows. In order to capture the true structure of trade, we established a cutoff to discern minor from major trade. For a further explanation of how the cutoff was designed and implemented, see Chapter 2 and Appendix A on data methodology.

[21] The algorithm we select comes from Palla, et al., 2005.

also discuss the ramifications of such an international system for economic stability and for economic coercion.

In Chapter 6, we introduce international institutions to the discussion of economic stability. We examine institutions both as a source of stability for the international system (through an analysis of macro institutions), and as a source for improving member country conditions (through an analysis of formalized trade blocs, which are submacro institutions).

We conclude in Chapter 7 with a summary of the major findings. Among the major findings is that we identify the presence of a Scale-Free macro system, with a whole myriad set of different latent submacro cliques, which suggest a Multiscalar Hierarchy of the international trade system. We also find that trade blocs are most effective at improving all member nations when they resemble Egalitarian Network as opposed to a Scale-Free Network. We conclude with some parting thoughts about possible future areas of IR research based upon systems theory, graph theory, and especially based upon international trade. This thesis represents only the tip of the iceberg in terms of the tools and datasets that have been brought together, and in this chapter we intend to lay out other possible directions for research.

CHAPTER 2: GRAPH THEORY AND INTERNATIONAL SYSTEMS THEORY: THEN AND NOW

Overview

Graph theory is also known as complex systems science, and there are several complex systems present in social structures (Newman, 2003; Marsden, 2002; Piepers, 2006).[22] We shall examine the history of graph theory in order to show that graph theory can also be usefully applied to several different areas of political science. We then turn to international systems theory literature to see whether graph theory may give us any leverage in testing these theories. We discuss theory and previous research of the submacro system, calling for analyses which consider latent country communities rather than pre-defined communities. We close by examining the shortcomings of De Mesquita and Lalman's empirical analysis of the systemic effects on conflict in the international system to identify how we may improve our own analysis (1988).

A Brief History of Graph Theory

One of the earliest forms of graph theory within the social sciences was the observance of the *small world phenomenon.* The *small world phenomenon* was first considered by political scientist Ithiel de Sola Pool and mathematician Manfred Kochen in the 1950s (Pool and Kochen, 1978).[23] Pool and Kochen argued that through familial

[22] These examples are illustrative: Newman explicitly states that complex systems exist in social structures, Marsden lists several possible sociological studies that could benefit from graph theoretic methodologies, and Piepers applies graph theory to international relationships.

[23] Pool and Kochen worked together for over twenty years, but did not co-author a published piece together until 1978. In "Contacts and Influence," the first ever article in the journal *Social Networks*, the abstract explains the story:

> "This essay raises more questions than it answers. In first draft, which we have only moderately revised, it was written about two decades ago and has been circulating in manuscript since then. (References to recent literature have, however, been added.) It was not published previously because we raised so many questions that we did not know how to answer; we hoped to eventually solve the problems and publish. The time has come to

ties, friendships, or acquaintances, any two people in the world are connected through a minimal number of links (Etheredge, 2006). In terms of political science, the applications of Pool's and Kochen's research were mainly contained to the comparativist literature – seeking to identify such conditions as the distance a message would have to travel from the average American to the president, or how an idea could spread among bureaucracies – but could eventually be applied across the various domains of political science. As time progressed, Pool's and Kochen's notion of a small world was accepted amazingly well by popular culture: their work gave rise to the hypothesis that all people were connected within six acquaintances, which in turn inspired a play entitled *Six Degrees of Separation* (Guare, 1990), and more recently, the title of the popular book *Six Degrees: The Science of A Connected Age* (Watts, 2003).[24] Barabási's *Linked: The New Science of Networks*, which explores degrees of separation across a whole range of disciplines, has also enjoyed large-scale popularity (2002).

Since the time of Pool and Kochen, the *small world phenomenon* has particularly manifested itself in comparative politics in the form of social capital. Robert Putnam defines social capital as the "features of social life – networks, norms, and trust – that enable participants to act together more effectively to pursue shared objectives" (Putnam,

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> cut bait. With the publication of a new journal of human network studies, we offer our initial soundings and unsolved questions to the community of researchers which is now forming in this field. While a great deal of work has been done on some of these questions during the past 20 years, we do not feel that the basic problems have been adequately resolved" (Pool and Kochen, 1978: Abstract).

Any true student of social capital would fully appreciate this piece.

[24] The history of six degrees is actually more nuanced. In his book, Watts recognizes Pool and Kochen were the first to attempt to academically investigate the *small world phenomenon*, doing so in the 1950s. Their work inspired Stanley Milgram to conjecture that the maximum number of degrees among any two randomly selected people in the population is six, technically making Milgram the father of the theory of six degrees of separation. However, without Pool and Kochen, "Milgram would have been off doing another experiment" (Watts, 2003: 160-161).

1995: 664-665).[25] And social capital may explain several important elements in the study of politics. In *Making Democracy Work: Civic Traditions in Northern Italy*, Putnam argues that social capital may stimulate the formation of democracy (1993). In its essence, Putnam's concept of social capital relies upon gauging the *small world phenomenon* across societies.

Recently, social scientists and business researchers have also tried to measure the frequency of interactions among individuals to measure the pervasiveness of various ideas (Choucri, et al., 2006; Shive, 2006).[26] In order to gauge the frequency and quality of interactions, researchers will estimate interactions using epidemic modeling (Sterman, 2000).[27] Knowing the approximate frequency of infectivity and the approximate number of affected individuals, they then can generate an approximation of the number and amount of interactions within a population. Such a methodology could be especially useful in testing Putnam's theory of social capital and democracy.

Research in systems is also nothing new to political science. Within our domain of IR, Morton A. Kaplan defines a system as "a set of variables so related, in contradistinction to its environment, that describable behavioral regularities characterize the internal relationships of the variables to each other and the external relationships of the set of individual variables to combinations of external variables" (Kaplan, 1960: 4).

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[25] Putnam has defined social capital many times and in many venues, always consistently. The choice of taking the definition from "Tuning In, Tuning Out: The Strange Disappearance of Capital in America" is not random, however. This talk was for prepared as the 1995 Ithiel de Sola Pool Lecture. Strangely, Putnam seems reticent to adopt tools of network theory, preferring instead to employ traditional empirical and qualitative methodologies.

[26] Shive shows that an epidemic model of investor behavior may explain price fluctuations of various stocks. She does not use diseases and infectivity rates, but another way of getting around the social capital methodology nightmare without using disease (particularly pertinent to developed countries), would be to inspect infectivity rates in terms of the stock market, or in terms of fashion.

[27] Sterman discusses the possibilities of epidemic modeling in the context of applications for business, but he gives much credit to network sociologists (2000).

A system can be defined more succinctly as "an interconnection of components, devices, or subsystems" (Oppenheim, Wilsky, and Nawab, 1997: 38).[28] Such a definition keeps the thrust of Kaplan's notion of *system* intact, while more concretely explaining the elements which might compose a system.

A *graph* is simply the representation of such a system.[29] Therefore, graph theory refers to the study of these systems. More specifically, graph theory "is a branch of mathematics concerned with how networks can be encoded and their properties measured," while network theory tends to refer to flows across these networks and among the various actors (Rodrigue, 2005: Chapter 2).[30] Since Pool and Kochen's speculations and musings more than fifty years ago, graph theory has rapidly developed, especially within the hard sciences. Over much of this time period, the methodology of graph theory was primarily visually-based, with scientists examining a network image to extract findings (Newman, 2003). And visualizations are still one of the key aspects of graph theory.[31] However, contemporary researchers in graph theory have added to this paradigm of visual-inspection by introducing various statistical techniques.[32]

This inclusion of statistical methods to graph theory has been partially driven by the advent of computational analysis – one cannot gainfully eye-ball a network composed of millions or billions of components – and partly by the emergence of domains devoted

[28] Defining terms is especially important in political science: this shall be exemplified further in the chapter with our discussion of previous usages of the term "system."

[29] Network theory involves actually identifying and mapping the links between various actors, and studying what these links mean in the context of the system.

[30] The definition of graph theory is provided by Rodrigue; the observation that network theory tends to focus on flows is our observation from the literature and is certainly not hard-and-fast as network theory and graph theory are often used synonymously with each other. As we mentioned in fn. 5, we expect this distinction to become more pronounced in proceeding years.

[31] Ortiz discusses the usefulness of analysis through visualizations throughout political science (2005).

[32] Visualization-as-method is also undergoing a similar catharsis as researchers are gainfully examining the ramifications of various spatial layouts in the context of viewer's perceptions. For a recent summary of this literature, see McGrath and Blythe, 2004.

to analyzing especially complex networks, and particularly the domain of computational biology (ibid). In computational biology, researchers have been trying to capture the structure of the system of genes and their relationships with proteins, a system of tremendous size and complexity (Palla, et al., 2005). While the international system clearly does not approach the complexity of protein-gene dynamics, statistical tools are nonetheless useful, and for our purposes both visual and statistical tools of graph theory are appropriate.

Systems Analysis in International Relations

In *Man, the State, and War*, Kenneth Waltz introduces three images for analyzing IR (1954). Each image includes an area of study that can affect world politics. The first image includes individuals, the second image includes the domestic institutions of the nation, and the third image involves the international structure, or system. Waltz's two chief goals are to justify realism in the context of international politics (that nations are driven by power-maximization rather than by simple desires for peace and harmony), and to stress the importance of research in the third image, and more broadly in understanding systemic patterns of IR.

What Waltz meant by "system," however, is not the only understanding of the term prevalent in our literature. Scholars in IR have employed the concept of "system" in three different usages in IR theory, oftentimes promoting ambiguity and confusion, summarized in Table 1 (Goodman, 1965). The first usage, *system-as-description*, is when the term is used to describe patterns of interactions between and among actors; typically nations are the identified actors. For example, nations go to war: the causes and consequences of these interactions give rise to a system. The second usage, *system-as-*

explanation, suggests that actions are determined by pre-existing systemic explanations, oftentimes not justifying the specific cause of a pattern of behavior. Kondratiev waves would be an example of system-as-explanation, where wars are expected to be more prevalent every twenty years without any specific cause (Goldstein, 1988). In a recent paper about war between the great powers, Peipers uses graph theory to explain how system regularity suggests that individual actors and forces are inconsequential pieces in the causes of great power war (2006).[33] *System-as-method* describes when the term is used to capture special methodologies to describe the international system in the context of interactions among actors. For instance, when game theory was first introduced to IR, the new methodology was described as one that would help capture the international system (Goodman, 1965: 260).

Usage	*Characterized By...*	*Examples*
System-as-Description	"an arrangement of the actors...in which interactions are patterned and identifiable"	James M. Rosenau: "a system is considered to exist in an environment and to be composed of parts, which, through interaction, are in relation to each other. Consequently, a system has a structure and encompassed processes through which it is either sustained or changed."
System-as-Explanation	"a particular arrangemeent in which the nature of the arrangement makes *it* the *major* variable"	Charles McClelland: "Since both principal actors occup similar positions and experience similar difficulties, they might drift gradually toward collaboration, except that such a movement is blocked *by the essential conflict structure of the international system*."
System-as-Method	"application of special types of approaches, methodologies, or analytical concepts to the data of international politics"	"[t]he particular 'systems' utilized in Sysetm-as-Method are often drawn from other disciplines and applied to international politics. McClelland's homeostatic equilibrium 'system' concept derives from biology, George Lipska derives his concept of equilibrium 'systems' from economics; and R. N. Rosencrance finds 'systems' in mechanics analogous to those of politics."

Table 2: Usages of *System* in IR Theory. Adapted from Goodman, 1965: italics added by Goodman

[33] Unfortunately, Peipers uses statistical tools of network theory that are most useful for large numbers of observations. Even if one looks over a period of 450 years, as Peipers does, there have only been 97 great power wars. Also, Peipers argues that there is some sort of system that causes these great power wars, and that this system does not include individual.

To be clear, Kaplan's definition of *system* that we chose at the beginning of this section is one of system-as-description. For the purposes of this project, such a definition is the most appropriate. While we do use methodologies extracted from graph theory that are new to political science and IR, the system we are concerned with is not primarily the method. We are chiefly concerned with identifying the structures and substructures of the international trade system. If our work is so fortunate as to see future developments, it may give rise to system-as-explanation work, where the structures can be used to explain relations and interactions.

Not surprisingly, with such a heavy focus on systemic analysis, methods in system dynamics have also become more common across our field (Choucri, et al., 2006; Lofdahl, 2002; Robbins, 2005).[34] In Figure 3, we include a theoretical system dynamics model of insurgency activity and recruitment.

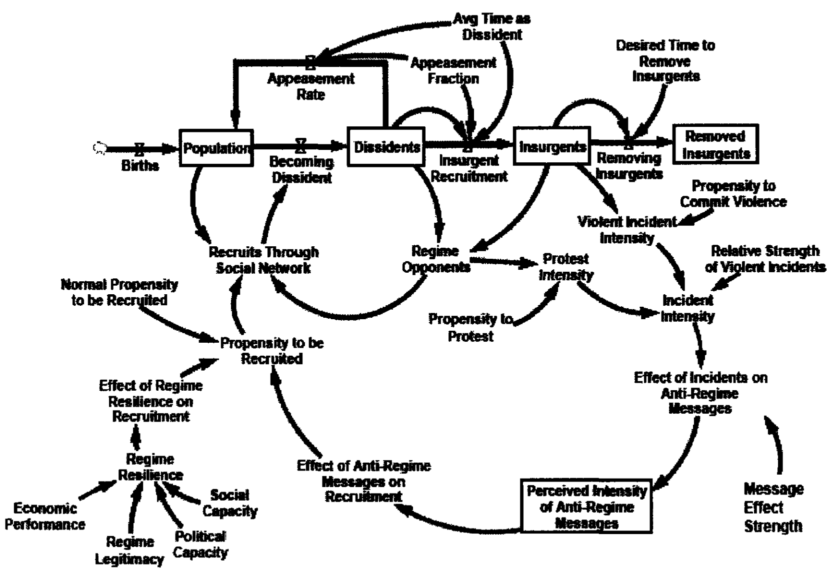

Figure 3: A Conceptual System-Dynamics Model of Insurgent Activity and Recruitment (from Choucri, et al., 2006)

[34] Again, the examples are illustrative rather than exhaustive. Of these, the book by Lofdahl is probably most closely related to the topic at hand: in *Environmental Impacts of Globalization and Trade: A Systems Study*, Lofdahl highlights the negatives of increased trade (2002).

Notice that most of the components of the system are not specifically actors, but instead include a variety of concepts. While the purposes of system dynamics and graph theory are similar – both seek to capture and understand the nature of systems – graph theory tends to be contained to understanding relationships between actors rather than relationships between concepts. Graph theory and system dynamics are separate methodological approaches.

It should also be noted that neural network analysis and graph theory are qualitatively distinct. In neural network analysis, the goal is to predict a set of results, typically by bypassing the causal pattern. In graph theory, the goal is to identify the structure of relationships between the actors to understand the system structure. As we have discussed, graph theory is a method of system-as-description. Oppositely, causality-based prediction remains the primary goal of neural network analysis.

Despite their differences, approaches to integrating IR with neural network analysis do yield an important lesson for those who wish to introduce a new methodology to IR: introducing new methodologies to IR occasionally draws skepticism and criticism. For instance, to better understand the nature of international conflict, Beck, King, and Zeng designed a neural network model for predicting the frequency of conflict among nations (2000). Working at a time when neural networks were still in a primitive stage, Beck, King, and Zeng demonstrated the promise of neural network analysis by comparing their findings to findings derived from traditional empirical tools, most notably including regression models.[35] Their proposal of utilizing neural network analysis to predict

[35] Neural network analysis is rapidly developing, but we fully expect that in several years neural network analysis circa 2006 will also be described as "primitive." Beck, King, and Zeng explain the development

conflict generated significant backlash from traditional, regression-focused, empirical researchers for implying that a new statistical methodology may offer better insight (De Marchi, Gelpi, and Grynaviski, 2004). In response, Beck, King, and Zeng convincingly demonstrate that neural networking does have value by re-creating a successful neural network model, in turn proving that the implementation of new methodologies to consider old questions is a worthwhile activity (2004). We agree with Beck, King, and Zeng that IR can benefit from the investigation of novel methods.

As we discussed earlier, it is not fair to say that graph theory is an entirely new approach to political science, but graph theory today is so very different from what it was in Pool and Kochen's time. Modern-day graph theory has been used in limited fashion in IR, but for the most part, it has not been used to examine the international system as a whole. Peipers' article on great power wars shaping the international system is the obvious exception, where Peipers searches for tipping points for war among the great powers (2006). However, Peipers only considers the great power countries rather than all the countries of the world when framing his international system. Within international trade analysis, Krempel and Plümper have utilized graph theory and gravity modeling, but have only included forty-five countries in their models.[36] Furthermore, Krempel and Plümper use graph theory primarily to conduct micro system analysis, re-confirming the Gravity Theory model, whereby trade is more likely to occur between two countries when the two countries are geographically closer together or the economies are large

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of neural network analysis in the context of their project when they redo their experiments in subsequent work, finding that their methods used in 2000 need to be updated when employed in 2004 (2004).

[36] Gravity modeling is the practice of taking into account geographic distances when examining the causes of international trade, usually at the dyadic, or micro-level; Krempel and Plümper offer several visualizations of their forty-five country network with geographic weighting: http://www.cmu.edu/joss/content/articles/volume4/KrempelPlumper_files/m5country.html (Accessed May, 2006).

(2002). To be clear, they do not claim to be examining the structure of the international system, but do implement tools which could help us understand relationships that are more complex than simply dyadic relationships. Their work offers little traction in examining the submacro and macro levels of international systems. Fortunately, IR theory does have a set of propositions that could guide this work.

Scoping the Topology of International Systems

In our conception, the international system includes several submacro systems interacting with a larger, macro system.[37] However, the concept of the international system is distinct from the concept of a world system. The typical definition of a world system in the context of political science is "the social organization of the human species" (Modelski, 2000: 25). World system theorists are concerned with identifying patterns of group behavior that hold over long-term time periods and across different organizational hierarchies. In contrast, to understand the international system is to understand the contemporary version of one part of the world system: one in which nations and their actions and interactions drive international politics.

There are several overlapping concepts between the world system and the international system, and understanding the international system can shape our understanding of the world system. Denemark, Friedman, Gills, and Modelski wonder whether center-periphery hierarchies have always dictated social organizations and whether they differ in various subsystems of the world system (2000: xvi). In the next chapter, we shall examine the center-periphery hierarchies of the international trade

[37] These subsystems include relationships at the macro level where all countries are involved, relationships between two countries, which are micro level relationships in IR, and relationships between more than two, but less than all countries, which are relationships at the submacro level (Berton, 1969). These relationships include both cooperation and conflict.

system and how it has changed (or not changed) over recent time. Two other world systems theorists, Chase-Dunn and Hall, note that all world hierarchical networks exhibit cyclical "pulsations in the spatial extent of interaction networks" (2000: 100). This would suggest that in the context of the international system, nations undulate in their relations with others and in their participation in an international order.

In order to fully understand the international system, we also need to understand various other subsystems within it. One especially important misconception about analyzing international systems is perhaps best exemplified by J. David Singer in "The Level-of-Analysis Problem in International Relations" (Singer, 1961). Representing the backlash to the domain's call for more research in the third image, Singer explains that "[t]hus, we tend to move, in a system-oriented model, away from notions implying much national autonomy and independence of choice and toward a more deterministic orientation" (ibid: 81). While Singer is simply voicing the concern that analyzing IR in an international systems perspective may be fundamentally flawed (he does not necessarily adhere to this position), understanding the world as a system is not a bad approach. Such an approach does not mean we ignore domestic and internal variations among separate nations: indeed if anything, we must especially focus on such components, devices, and subsystems if we are to understand how the larger international system works.[38] Individual decision-makers and other exogenous elements do exist and interact with the world system, and understanding the consequences of such elements is crucial to understanding the international system. In this project we strive to maintain a

[38] Another weakness of Peipers' finding is that he refuses to recognize the importance of such components in his international system. He explains that the pattern of his international system is such that regardless of the leaders or of the institutions involved, great powers will go to war. In fact, one of the weaknesses of his conclusions is that he does not consider that the pattern of change is unfolding at the leadership-level or at the institutional level and is simply manifesting itself with great power wars (2006).

balance between the international system and the international submacro systems, but we recognize the limitations of simply examining international trade without considering individuals, non-governmental organizations, or multinational corporations.

Macro International Systems Theory

For our purposes, we analyze the international trade system in terms of one large, macro meta-system and in terms of various international submacro systems. Such macro meta-systems can be considered as variants of the international order. Kaplan offers six such states of equilibrium of the international order; note that only one macro system can exist at any given time (1957: Ch. 2):

1. **The Balance of Power System:** Exists in a null political subsystem (anarchy). There are at least five "essential" actors / nations in a Balance of Power System that implement the "essential" rules which govern the characteristic behavior of the population of actors.
2. **The Loose Bipolar System:** Formalized, supranational actors as well as national actors both participate in such a system. Two subclasses of supranational actors must exist to form the bipolar system. During the time of the Cold War, NATO and the Communist blocs formed a Loose Bipolar System.
3. **The Tight Bipolar System:** Similar to the Loose Bipolar System except all national actors belong to one of the subclass supranational organizations. Such a system would resemble the international system during the Cold War if all of the members of the Third World had allied with NATO or the Communists.

4. **The Universal System:** The previous three systems include an anarchic political order; the universal system assumes that national actors are governed by a universal actor. If the United Nations and the World Trade Organization had greater power in the contemporary international system, we would call our modern-day international system a Universal System.
5. **The Hierarchical System in Directive and Non-Directive Forms:** The Hierarchical System is one in which a universal power rules directly over the people, with no independent national political systems. In its Non-Directive Form, the Hierarchical System is a world-wide democracy; in its Directive Form, the system is authoritarian.
6. **The Unit Veto System:** The Unit Veto System can occur when either national actors or bloc actors control the system. The Unit Veto System stipulates that all members have the capability of destroying each other, suggesting that all members are equally powerful.

While Kaplan was writing in the 1950s and 1960s, understanding the macro international system again became popular following the end of the Cold War.[39] Richard Ned Lebow observes that due to the collapse of the USSR, "prominent realists maintain that a shift is under way in the international system from bi- to multipolarity" (1994: 249). For Lebow, a Multipolar System is most similar to a Balance of Power System, except that in a Multipolar System, anarchy could be supplanted by a universal actor. Contending that the paradigm of realism requires the condition of international anarchy,

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[39] Between Kaplan and Lebow, several prominent scholars have considered the meta-structure of the international system, coming up with a whole slew of various orders. One system that deserves mentioning is that of Hegemonic System, where one national actor maintains stability across the international system. However, the Hegemonic System is really a derivative of the Universal System. The key readings on the Hegemonic System are Gilpin, 1981 and Keohane, 1984.

Lebow calls for theorists to explicitly state which system paradigm their theories exist within, and to search for theories that would hold across multiple systems. Lebow explains that theories with carry-over capacity across the various types of international orders form the backbone of neorealism (ibid).

Kaufman further examines the nature of international orders in the context of neorealism (1997). Kaufman explains that simply because the twentieth century has been dominated by bipolar and multipolar systems does not mean that these are the only two such systems in existence. History is replete with examples where the international order is best described on a complete gradient, from Hegemony (Universal) to fragmented and wholly separate smaller units (ibid). More importantly, Kaufman explains that "the causes of system variance include not only power-balancing dynamics, which work only imperfectly, but also principles of unit identity [and] economic interdependence..." (ibid: 200).[40] As a result, Kaufman calls for analyzing both submacro systems and economic interdependence within the international order.

Submacro International Systems Theory

One might imagine a whole range of international submacro systems affecting the world order. Kaplan suggests supranational groupings may make the international order bipolar, or otherwise politically divided (1957); Huntington suggests that the international order is divided by cultures (Huntington, 1996); regionalists have explored cooperation among neighboring states (Schirm, 2002); international political economists frequently investigate trade blocs. In each of these cases, submacro systems are defined (1) along political or military boundaries, (2) along social boundaries, (3) along

[40] Kaufman also calls for investigating technologies for governance and how they affect the international order. This topic encompassed the thrust of a class the author co-taught with several other GSSD affiliates in January, 2006.

geographic boundaries, or (4) along explicitly-defined trade boundaries. This taxonomy of submacro systems explains all of the types of submacro systems which form, but no individual gradient of this taxonomy explains the participants of all submacro systems. For instance, if one seeks to capture submacro systems by only considering geographic boundaries, the cases of Cuba during the Cold War or Israel today show that such a methodology will have shortcomings (Berton, 1969: 333). If one only considers the cultural submacro systems in Inglehart and Carballo's displayed in the diagram in Figure 4, one does not capture the economic-political submacro system of the EU or the divides of the Cold War.

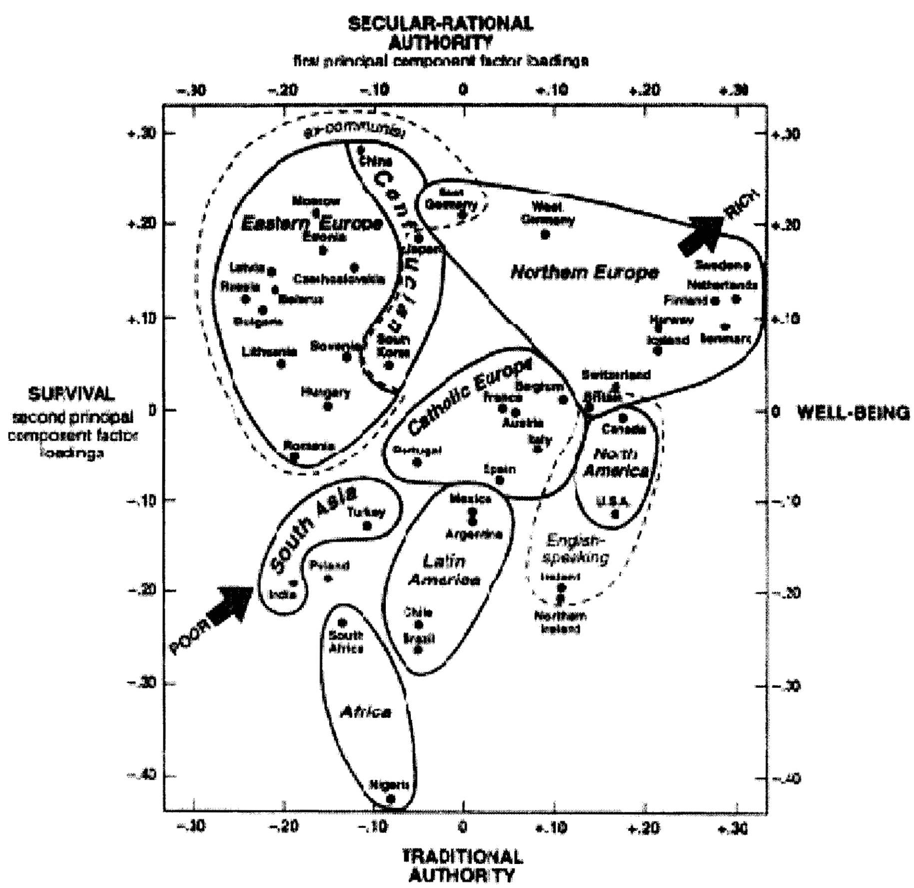

Figure 4: Where Given Societies Fall Along Two Cultural Dimensions. From Inglehart and Carballo, 1997: pg. 41.

Surprisingly, few scholars take a holistic perspective of these taxonomies into account, instead calling for the further examination within each of the gradients, not across the entire range of possibilities (Berton, 1969). After brilliantly discussing how the world order may experience a reversion to fragmented groupings, Kaufman himself falls into the regionalist camp, explaining that "rather than hegemony, the current system is more likely to devolve into regionalization as regional subsystems become increasingly autonomous from global forces" (1997: 201-202). Despite the fact that much of the IR domain compares specific types of submacro groupings, by not limiting ourselves to any specific taxonomy of submacro systems, we may be able to better capture the international system. We shall keep this in mind when we conduct our submacro analysis.

Previous Empirical Research of International Systems Theory: An Example

Some nations are stronger than others, leading to hierarchies in the international system. As different alliance structures exist, some nations are more closely connected with one another. This homophily, or level of interconnections among groups of counties, varies across the international system.[41] Moreover, the hierarchies of the macro system and the levels of homophily of the various subsystems vary over time. These systemic variations may have consequences for the likelihood of peace, leading to a host of questions. Does a system with a Balance of Power hierarchy tend to be peaceful compared to an imbalanced hierarchy? Are systems with bipolar hierarchies more peaceful than systems with multipolar hierarchies? Do systems with tight poles (with

[41] The terms "hierarchy" and "homophily" have been adopted from Dodds, Watts, and Sabel 2003. De Mesquita and Lalman did not use them.

high homophilies) tend to be more peaceful than systems with loose poles (with low homophilies)?

Bruce Bueno De Mesquita and David Lalman seek to answer these questions in "Empirical Support for Systemic and Dyadic Explanations of International Conflict" (1988). Using both systemic and dyadic statistical techniques, De Mesquita and Lalman's research suggests that systemic differences do not seem to affect international conflict. In contrast, individual country calculations of expected utilities of war are far better predictors for the breakout of international conflict. Before simply accepting that there is no relationship between system-types and international conflict however, we should formally scrutinize De Mesquita and Lalman's methodology.

De Mesquita and Lalman's Methodological Strategy

De Mesquita and Lalman examine whether systematic conditions are causes of higher levels of breakouts of international conflict between 1816 and 1965. The dependent variable is the breakouts of international conflict. The independent variables include various elements of macro structure of the international system (including bipolarity, multipolarity, Balance of Power, etc.), as well as a calculation of national incentives to go to war.

In order to investigate the relationship between system and conflict, De Mesquita and Lalman conduct large-N empirical research, cleverly utilizing both systemic and dyadic strategies in their analysis. By considering the empirical problem in terms of both of these statistical approaches, De Mesquita and Lalman are also able to examine whether individual-country war calculating is a better gauge of conflict than a systemically-oriented variable. De Mesquita and Lalman recognize that a nation's interests may occasionally differ from the interests of the greater international community: the benefit of a split methodological approach is that they can test to see whether systemic variables affect international conflict, and then they can compare whether systemic variables are better determinants than individual country variables.

De Mesquita and Lalman's Dependent Variable

The dependent variable is defined clearly and concisely. The dependent variable in this project is outbreaks of conflict involving major powers. De Mesquita and Lalman utilize two datasets for identifying this outbreak of international conflict. The first dataset is provided by Singer and Small and each observation includes the onset of international conflict. As they are interested solely in outbreaks of war where major powers are involved, Singer and Small's dataset is ideal, as it also includes a classification for major powers. In the second dataset, De Mesquita and Lalman gather 125 observations of international disputes. 97 of these disputes did not become wars, while 28 escalated to interstate wars, in accordance with the definition of war provided by Singer and Small. It is worth noting that we do not know how many of these international disputes involved major powers, a key component of the independent variable, but there is reason to suspect that there are not very many observations. De Mesquita and Lalman mention that for one of the three models presented which demonstrated that systemic influences have marginal effects on conflict, there were only six observations of major power war: a large problem for a model which had seven variables.[42]

[42] De Mesquita and Lalman 1988: fn. 19.

De Mesquita and Lalman rely upon classifications of power and major power countries by Singer and Small, but they do not mention Singer and Small's definition of power, nor do they include examples of major powers beyond the United States following 1939. Offering either of these pieces of information would have helped the reader understand major power war. Also, rather than including all major power countries, De Mesquita and Lalman constrict the major powers to countries in Europe, and include the United States following 1939. They justify doing so because it turns out that they are only concerned with international conflict involving Europe. Apparently, for De Mesquita and Lalman, the *international system* is really just a continental system. Of a more minor note, while Singer and Small analyze major powers from 1816-1970, De Mesquita and Lalman drop the last four years (1966-1970) from their analysis for seemingly no good reason.

De Mesquita and Lalman's Independent Variables

When we turn to the independent variable, De Mesquita and Lalman's methodology is not robust. For starters, the authors do not define several key terms critical to the independent variables. The authors never explain what they mean by "international system." De Mesquita and Lalman implicitly consider *system* to include a range of both hierarchical and homophilic properties in terms of three structural dimensions – Balanced-Preponderant, Bipolar-Multipolar, and Tight-Loose (in the context of the polar relationships) – but they do not explain why these are the only dimensions of the international system that they are considering. Furthermore, while De Mesquita and Lalman do consider the homophily of the polar relationships in terms of Tight and Loose, they do not consider the homophily of the entire macro system. From

1816-1965, the levels of isolation versus interconnection in the macro system have undoubtedly fluctuated: economic globalization researchers have demonstrated that the level of macro homophily decreased following the Depression and increased following World War II (Hirst and Thompson, 2002). Not surprisingly, De Mesquita and Lalman do not control for fluctuations in macro level homophily. The challenges of operationalizing the components of the international system present a clear problem in their analysis. De Mesquita and Lalman acknowledge as much in their conclusion by passing the blame to systems theorists: "[w]e hope that such theorists will help to inform future empirical investigations by specifying clearly and precisely what tests of their propositions are most appropriate" (1988: 20).

De Mesquita and Lalman juxtapose systemic-oriented independent variables with individual country incentives for war. To calculate these country incentives, the authors calculate the expected utility of war by using De Mesquita's equations for expected utility from "The War Trap Revisited: A Revised Expected-Utility Model" (1985). De Mesquita's paper updated his original expected utility equations to include the risk perspectives of a nation. Some nations are risk-takers, others are risk-neutral, while others are risk-averse, and each category has a different expected utility associated. De Mesquita and Lalman do not mention which category captures major powers, leaving us to guess which expected utility approximations they used.

Improving De Mesquita and Lalman's Methodology for the Purposes of Identifying the Structure of the International System

While De Mesquita and Lalman should be applauded for undertaking such an ambitious project, there are several ways in which their research methodology can be improved. First, an analysis of the international system needs to include the nations of the world, not just the nations of one continent. Second, an analysis of the international system needs to consider the fact that during certain times, we see different levels of isolationism across the entire system, meaning that the macro component of the international system itself may exhibit fluctuations in homophily. Third, the expected utility equations for a nation's desire to go to war are not explained in sufficient depth as variances in risk patterns are not explained.[43] As we are not concerned with replicating De Mesquita and Lalman's project of comparing the effects of systems versus individuals, we shall not further concern ourselves with this part of De Mesquita and Lalman's project.

How can we address the other shortcomings? In *National Power and the Structure of Foreign Trade,* Hirschman argues that trade and trade relationships can serve as good indicators for international power (1980). By applying graph theory to international trade data, we can rectify the first shortcoming by identifying the positions of countries relative to one another in the international system of trade, a useful proxy for the international system at large.[44] We can then use a large-N database of war such as the Correlates of War to measure international conflict beyond Europe and the great powers.

Using graph theory, we can also measure levels of homophily, both at the macro level, and within subsystems and clusters of countries.[45] We can measure the level of isolationism (versus interconnections) of the international system, adding another systemic dimension to De Mesquita and Lalman's analysis.

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[43] Or even touched upon.

[44] As we shall explain later, one could identify major powers by selecting those countries with the highest numbers of degrees every year, where a degree is the number of major trade relationships a country enjoys.

[45] As we shall explain later, one could either use a clustering coefficient or the average degrees of separation as measures for homophily.

Chapter Summary

In this chapter, we have alluded to how we intend to capture and analyze the international system of trade. We plan to use graph theory to investigate the macro network and the submacro networks in the international trade system. Rather than assuming the memberships of the submacro groupings, however, we shall instead search for latent cliques of countries in the trade system and analyze those in the context of identifying an international hierarchy.

In the next chapter, we shall implement techniques borrowed from graph theory in examining the macro structure of international trade relationships. What emerges is an alternative structure of the international order, with cliques and submacro systems playing a crucial role in the overall international system. We also present a basic set of terms and phrases common to graph theory, with clear explanations for the lay graph theorist.

CHAPTER 3: MACRO PATTERNS IN THE INTERNATIONAL SYSTEM

Overview

In the previous chapter, we discussed the international system of trade, suggesting that there are many possible macro level possibilities for the international system. In this chapter, we present the basic concepts of graph theory, in conjunction with our analysis of the macro level of the international trade system. To be specific, we shall empirically examine the macro system of world trade from 1962-2003. We find that the macro system most closely resembles a Scale-Free Network. This type of network suggests that other, non-dyadic relationships must be examined to best comprehend the hierarchy of the international trade system.

Network Analysis of the Macro System[46]

In the previous chapters, the reader has been exposed to several different ideas pertaining to the international system, including the international order and the various types of submacro systems as they relate to the international system. The usefulness of identifying such systems can help us understand how best to preserve equilibrium balances (Kaplan, 1957). In other words, identifying the structure and function of this international trade network should help us understand system stability and contagion effects. Contagion is defined by the World Bank as "the transmission of shocks to other countries or the cross-country correlation, beyond any fundamental link among the countries and beyond common shocks" (World Bank, 2006). The causes of these shocks

[46] Much of the computational work that is presented in this chapter was originally produced by Behram Mistree, a co-author of a forthcoming book chapter on this research.

are variable and unique, but they have the effect of introducing instability to the international system, and therefore it is desirable to understand how contagion spreads.

Understanding the structure and the evolution of the international trade network may have implications beyond understanding contagion as well. Considering economic globalization, there are two differing opinions about the way in which nations are becoming more interconnected.[47] Hirst and Thompson argue that the term "globalization" is a misnomer (2002). For them, what is really happening is increasing inter-nationalization, whereby separate and distinct national economies play the major role in the international system. On the other hand, Mansfield and Milner suggest that we are seeing a rise in regionalism, where nations band together to compete in the global economy (1999). Understanding the nature of the international system and how it has changed over time can help us observe whether we are approaching an inter-regional system or whether we are destined to remain in the same-old inter-national system.

Identifying these systems may also help us comprehend the nature of economic coercion and, as a result, the nature of power relationships between countries. Barnett and Duvall offer a value-neutral concept of power: "[p]ower is the production, in and through social relations, of effects that shape the capacities of actors to determine their circumstances and fate" (2005: 42).[48] Power is not just an absolute: the overall wealth of a nation or its military strength are both useful metrics of power to the extent that they can be compared to other nations. Therefore, the true power of a nation can only be

[47] Several works in international political economy simply seem to take the fact that international economic interconnection as an assumption, rather than empirically demonstrating it (Hirst and Thompson, 2002). We shall give these works evidence for their assumptions in Chapter 4.
[48] Barnett and Duvall are particularly concerned with avoiding definitions of power that force the scientist to automatically adopt the realist framework (2005).

identified by considering that nation's placement in the international system *relative* to other nations.

To understand the international system and power between nations, we need to identify the structures of the macro system. For better or worse, there are many to choose from, as we found in the last chapter. One may accept Walt's contention that "balancing is the dominant tendency in international politics" (1985: 39). But is the international order best described as one of a Balance of Power? Or is the order better conceptualized as Universal-Hegemonic? Maybe the international order has shifted from one type of structure to another over time?

Such statements are queries relating to the system structure, and applying techniques of graph theory to international trade data may yield revealing findings. However, the reader must be familiar with at least a basic level of graph theory, so in this section, we will fully explain the terms and methods we are using. Just in case readers find themselves lost, or if the readers simply want a compendium of basic terms for future work, we have provided a Glossary at the end of this thesis.

To begin, as we identified earlier, a *graph,* or a *network,* is simply a representation of a system.[49] In our case, the network includes all countries and their relationships in a given time period. A *node*, also known as a *vertex,* represents an individual component of the system.[50] For our purposes, a node represents a country within the international system. Interactions among the nodes can be considered as the

[49] Most of the terms and descriptions have been identified and adapted from Newman, 2003, but they are all among the standard lexicon in network theory. Some of these terms are presented in this chapter, but are not used until later chapters. We group the terms together because it is helpful to make one repository of all the terms for ease of reading.
[50] Network theory is plagued by multiple labeling of similar concepts. In physics, a vertex is known as a *site*; in sociology a node is often referred to as an *actor* (Newman, 2003).

unit of analysis. These interactions are usually expressed as an *edge*, which represents a relationship between two nodes.[51] An edge may be *directed* or *undirected.* A directed edge represents a flow, while an undirected edge simply depicts the existence of a relationship between two nodes. A directed edge is usually displayed with an arrowhead showing the direction of the relationship; an undirected edge is simply a line connecting the two nodes.[52] For examples from international politics, a directed edge could represent the flow of migrants from one country to another, while an undirected edge could represent the existence of diplomatic relations between two nations. In Figure 5, a network with its basic components is presented; note that the edges are undirected.[53]

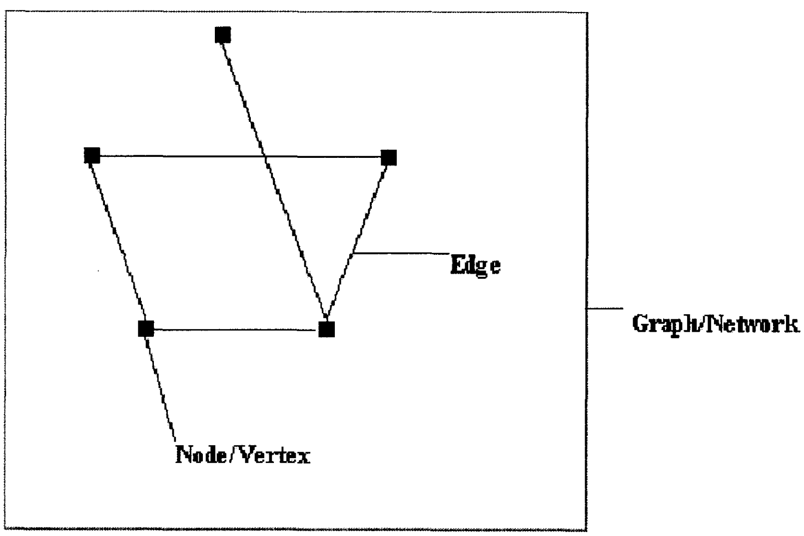

Figure 5: A Labeled Network

Graph theorists frequently discuss the number of *degrees* of a certain node. Degrees correspond to the number of relationships that a certain node enjoys. The

---

[51] Some individual edges can connect more than two nodes, but these are rare and are typically contained to very complex network theory. In physics, edges are also known as *bonds;* computer scientists call edges *links;* sociology labels these connections as *ties.* For an excellent summary of the concepts of graph theory that both a novice graph theorist and a network veteran would appreciate, read Newman's "The Structure and Function of Complex Networks" (2003).

[52] Any existing relationship between two nodes is either directed or undirected.

[53] Directed edges are oftentimes known as arcs, and they are represented as arrows (rather than lines) to show directionality.

number of degrees can be counted by counting the number of edges of a node. In Figure 6, Nodes A, C, and E all have only one degree (A-F, C-B, and E-D, respectively). Node B has two degrees (B-C and B-F), Node D has two degrees (D-E and D-F), and Node F has three degrees (F-A, F-B, and F-D). Sometimes one node may be included in the system, but may not connect to the larger grouping. Node G is one such example, with zero degrees. In practice, one would be hard-pressed to identify a country entirely isolated from the rest of the modern-day network, but it is nevertheless theoretically possible.

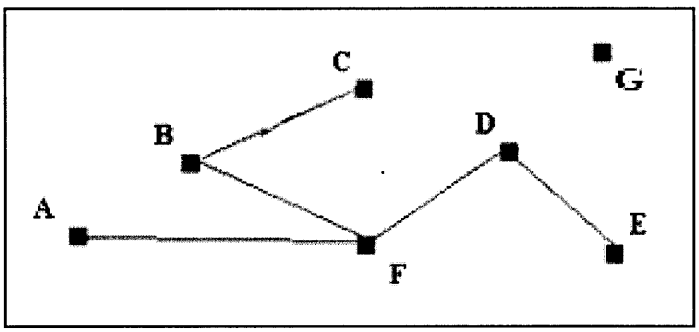

Figure 6: A Network with Nodes A-G

The *degree of separation* is the minimum number of edges between two nodes.[54] In Figure 6, the degree of separation from A to E is three (A-F, F-D, and D-E).[55] In the international system, imagine the United States and Cuba, which for all intents and purposes do not trade directly with each other. However, both the US and Cuba trade with Mexico, meaning that the US and Cuba are only separated by two degrees. Each node also has an *average degree of separation*. The average degree of separation represents the mean distance from a given node to the other nodes in the network.

[54] The degree of separation is also known as a *geodesic path*.

[55] The concept of degrees of separation has been popularized by the theory of six degrees of separation, whereby any two randomly selected individuals are suspected to be connected by six or fewer acquaintance relationships. Duncan Watts has written *Six Degrees: The Science of a Connected Age* which considers the history and the future of network theory in understanding social systems (2003).

Excluding G from Figure 6, the average degree of separation for Node A is 11/5, while the average degree of separation for Node F is 7/5. Notice that Node A is less central to the network than Node F. The average degree of separation reflects this centrality.

While nodes have average degrees of separation, a network also has an average degree of separation. The average degree of separation for an undirected network is simply the mean of the average degrees of separation for all nodes contained in the network. In Figure 6, if one once again excludes G, the average degree of separation in the network is 62/25.[56]

Finally, we have the *clustering coefficient*.[57] The clustering coefficient for a node is the likelihood that its partner nodes interact with one another. In terms of trade, imagine three countries: A, B, and C. If Countries A and B trade, and Countries B and C trade, the clustering coefficient shows the likelihood of a trade relationship existing between Countries A and C. In Figure 7, the clustering coefficient of A in the top-left quadrant is one (B, C, and D all trade with each other); the clustering coefficient of A in the top-right quadrant is zero; in the bottom-left A is again zero; and in the bottom-right, A's clustering coefficient is 2/3. The clustering coefficient may also be averaged over the entire network. In the top-left network in Figure 7, the average clustering coefficient of the network is one; in the top-right and the bottom-left quadrants, the average clustering coefficients of the networks are both zero; and in the bottom-right quadrant, the average clustering coefficient of the network is 1/12.

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[56] The average degree of separation for A= 11/5; B= 9/5; C= 13/5; D= 9/5; E= 13/5; F= 7/5. Combining the average degrees of separation, we have 62/5, which then needs to be divided by 5, as there are five nodes in the network. This gives us an average degree of separation in the network of 62/25.

[57] Clustering is also known as *transitivity*.

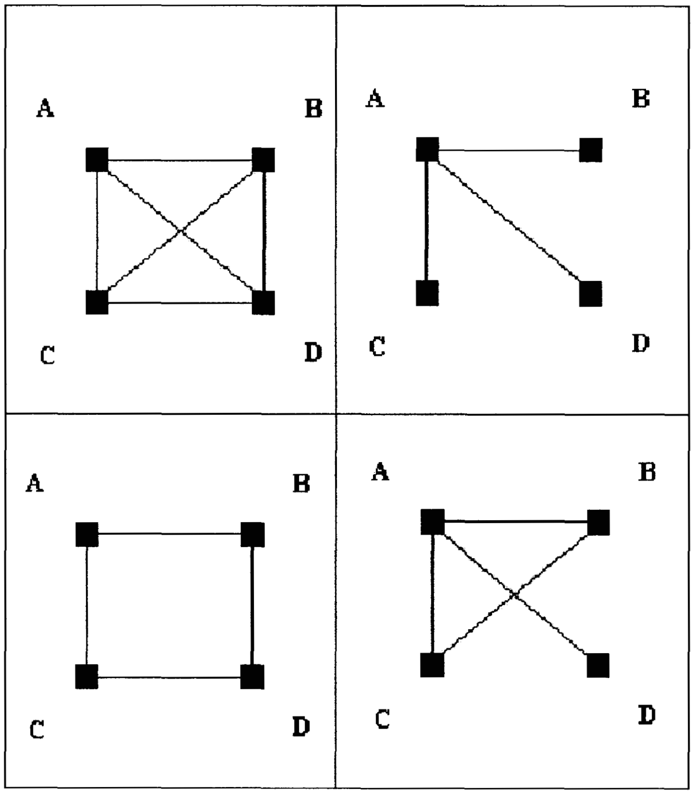

Figure 7: Four Different Networks

The clustering coefficient is useful for explaining the insularity of various networks, but it can also show when a country serves as a connector between other nations. Consider Node A in the top right-hand quadrant versus Node A in the top left-hand quadrant in Figure 7. In the top right-hand quadrant, Node A has monopolized the relationships, meaning that B, C, and D are all dependent upon A. On the left, nodes are connected directly, and therefore if they are trading, they may go through their own channels rather than having to go through A.

Albert Hirschman convincingly argues that countries strive to be Node A in the top right-hand quadrant (1980). Keohane observes that "Hirschman defined the 'influence effect of foreign trade' as resulting from dependence of one nation on another and argued that 'the classical concept, gain from trade, and the power concept, dependence on trade, are seen merely as two aspects of the same phenomenon" (Keohane, 1997: 158). Dependencies caused by trade are sources of power: Nodes B, C, and D, all depend upon Node A for trade, making Node A relatively powerful.

Three Possible Network Structures

In Chapter 2, we discussed several possibilities of the international order (also known as the macro system) derived from the IR literature, and one can imagine a list of possibilities even beyond those presented. In graph theory, there is a corresponding set of possibilities, each of which may capture the structure of the macro system in the context of the international system.[58] There are at least three broad categories of network types, with a whole range of network types in between. The first category is the *Egalitarian Network*. In an *Egalitarian Network*, all nodes are equal in terms of their relationships with one another. All nodes have the same number of degrees and no form of hierarchy exists between the nodes. An Egalitarian Network in the context of the macro trade system would occur if all countries were equal in terms of both the number of bilateral trade relationships they enjoyed and the size of the bilateral trade relationships. In Figure 8, such a network is displayed. Notice how each node is equally connected.

[58] Actually these are the two most commonly-discussed types of networks in network theory; other networks are simply derivations of these networks.

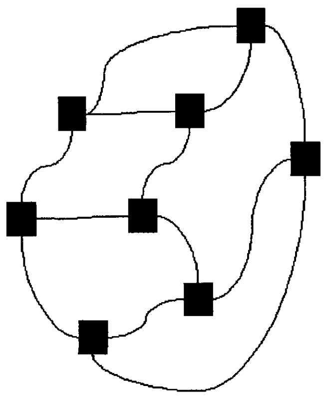

Figure 8: An Egalitarian Network Structure

Another type of network frequently discussed in the graph theory literature is the *Random Network* (Newman, 2003; Barabási and Albert, 1999). A Random Network is one in which the degree distribution is Gaussian, or evenly distributed. In a Random Network, a hierarchy could exist with certain nodes playing more important roles than others, but the bulk of the nodes have a similar set of degrees. Hence, Random Networks have interactions taking place across a global arena: there are few submacro groupings, if any. Figure 9(a) presents such a network structure.

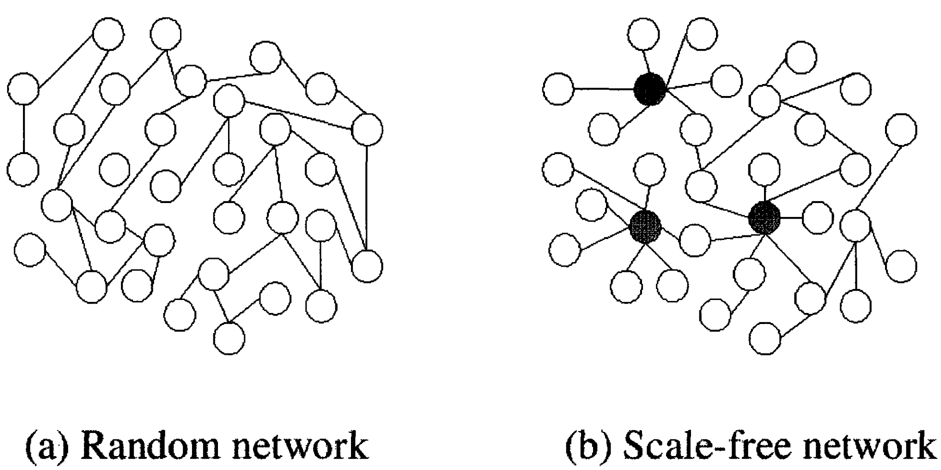

Figure 9: A Random Network (a) versus a Scale-Free Network (b), from Wikipedia[59]

[59] We realize that using Wikipedia should be done with caution, but they present one of the clearest images of a random versus a scale-free network. The image is located in *Scale-Free Networks* at http://wikipedia.org/ (Accessed 2006).

In contrast, a *Scale-Free Network* is one in which the degree distribution follows a Power-Law, where most nodes have few degrees while just a few nodes have high numbers of degrees. A Scale-Free Network tends to be dominated by submacro interactions. It must also have a hierarchical structure as certain nodes are more central to the network than others. These types of networks have recently received special attention by theorists as "citation networks, the World Wide Web, the Internet, metabolic networks, telephone call graphs and the network of human sexual contacts" all appear to be scale-free networks (Newman, 2003: 188). Figure 9(b) presents a Scale-Free Network. Notice the colored nodes, which indicate nodes that are more central to the system structure than the peripheral nodes surrounding them.[60] All networks that have hierarchies involve such Hubs and Spokes, where certain nodes are central to the system structure (Hubs), while others are at the fringes of the system structure, both literally and figuratively (Spokes).

Macro Level Methodology

To test which type of network best represents the macro system, we gathered export data from 1962-2003 from the UN Comtrade Database.[61] We selected trade data for this experiment for three reasons. First, trade relationships are easy to measure.[62] Data is easily accessible, and unlike war or conflict, trade relationships are generally

[60] Discussions of core- and peripheral- countries are common in IR literature (Wallerstein, 1976; Denemark, et al., 2000). However, such terms have developed a pejorative connotation as they are frequently associated with colonization and imperialism. In order to jump this semantic hurdle, we shall utilize their graph theoretic terms: Hubs and Spokes.

[61] Behram Mistree extracted the data from the database by constructing a computer program that interfaced with the United Nation's website using standard http protocols. The program requested, parsed, and stored information from the site.

[62] We are analyzing relationships over time, but we want measures that are time-appropriate. Imagine receiving a measure that Country A received six million dollars in capital from Country B in a given year. Due to the tremendous fluidity of capital, this number might become inflated as over the course of the year, some of the capital given to Country A is returned to Country B, only to be again returned to Country A. Therefore, measuring relationships in terms of capital flows does not work.

agreed upon. Second, trade is one of the most important relationships in IR: all countries engage in some level of international trade. At the same time, with economic globalization, the World Trade Organization, and the unification of currencies in Europe, patterns of trade have undergone profound changes over the last forty years. Understanding how these changes have affected the international system is worthwhile. Third, trade is a strong proximate indicator for power relationships between countries and power relationships are the fundamental building blocks of the international system at large (Hirschman, 1980). In other words, we may be analyzing the international system of trade, but such analysis helps us better understand the international economic system, as well as the international system in general.

In our analysis of the macro system, all relationships are undirected. This means that we are studying interactions not in terms of flows between countries, but instead we are looking at the aggregate numbers and sizes of the interactions themselves. The database itself provides dollar value relationships between all countries. The level of detail of the UN Comtrade data is actually quite impressive. For instance, Comtrade lists that Egypt exported $575 worth of goods to Bermuda in 2003. However, Egypt's exports to Bermuda account for a negligible fraction of its overall exports. Afraid that the inclusion of such superfluous relationships may obfuscate the fundamental dynamics we are attempting to uncover, we only include "major" export flows.

For the purposes of this paper, we define "major" in such a way that an export flow will only be included when Country A receives a quantity of exports from Country B that is in the top 70% of total exports for Country B.[63] In as much as quantitative

[63] We believe that using 70% as the cutoff adequately strikes a balance between reducing the relatively minor data that would shroud the depiction of the macro network while preserving the general and major

analysis is an art, we recognize that such a cutoff introduces a level of subjectivity, but this subjectivity is minimal. More important, this cutoff is rendered consistently throughout the analysis. For more about the data-organizing methodology, please see Appendix A.

To discern results, we shall use two tools: visualization and statistical analysis. Visualizations are one of the key aspects of graph theory. Newman explains that "[t]he human eye is an analytic tool of remarkable power, and eyeballing pictures of networks is an excellent way to gain an understanding of their structure" (Newman, 2003: 170-171). Beyond graph theory, Ortiz discusses the potentials of visualization as a methodology in political science, as visualizations may reveal patterns and relationships which would have gone undetected using traditional analysis (2005). When implementing visualizations as a methodology, however, the researcher must be wary. McGrath and Blythe discuss the dangers of visualizations as methodologies as visualizations may appear different to different people, conveying different meanings and relationships to different researchers (2004). Therefore, we will complement our analysis by investigating degrees of separation and clustering coefficients in an empirically-oriented manner. Fortunately, graph theory has recently begun to adapt to such empirical techniques as complex networks with millions and billions of relationships are now common in other areas of study (particularly biology) and simply visualizing these networks with millions and billions of interconnections is relatively ineffectual (Newman, 2003). As a result, statistics are also being introduced to graph theory to better explain how components in complex systems affect one another.

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international trade trends. In the future, we shall conduct sensitivity analysis to see how greatly our results change with various cutoff rates.

To return to the methodology for visualization, there are several different ways of portraying networks. After reviewing several of these different ways, we decided to employ a *spring embedding function* when our graphs get too complicated, a special type of energy minimization technique.[64] An energy minimization function plots the nodes with higher degrees in the center of the image as the algorithm tries to minimize the distance of each edge while allowing a minimum set space between each node. As a result, Hub countries are centered in the image, while outer Spoke countries are placed at the fringe of the image.

In Figures 10 and 11, export relationships among the nations of the world are presented for 1965. Throughout this thesis, we have chosen to show one network image without labels and one with labels so that the reader can first get a general feel for the system structure without being impeded by the country labels, and in the following graph the reader can then identify the locations of the countries themselves. The reader should notice the large number of degrees shared between the nodes in the center of the network relative to the rest of the network. Not surprisingly, these countries are among the world's richest: the United Kingdom, the United States, and West Germany are the three countries with the most degrees in 1965.

In Figures 12 and 13, the state of the macro trade network in 2000 is presented. Again, in the first graph, we do not include country labels so that the reader can visually inspect the network. Looking at Figure 12 versus Figure 10, the central part of the graph

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[64] These figures were drawn using Netdraw with 100 iterations of the spring embedding function with distance between components equaling 5. Due to the nature of these graphing programs, images are never completely replicable, although the significant relationships should still stand out. After experimenting with another widely-available program known as Pajek, we found Netdraw to be more user-friendly.

contains more nodes. Furthermore, those central countries are increasingly linked with one another.

Before drawing any more conclusions about the changes between 1965 and 2000, two caveats are worth noting. First, since the Comtrade data only offers data for selected countries (typically only for countries that are members of the UN), some countries are not captured in these images, particularly the countries that are not somehow attached to the main network. Second, more countries are included in the dataset in 2000 than in 1965. There could be two reasons for such a condition: more countries may have joined the UN database and/or more countries have entered the macro trade system. Despite these caveats, we can observe that the overall structure of the network has remained the same, with the center countries maintaining their importance to the overall network stability (if not assuming more importance). The center region has also become denser as the Hub countries seem to be trading more with one another and there appears to be more Hubs in 2000.

(This area has intentionally been left blank.)

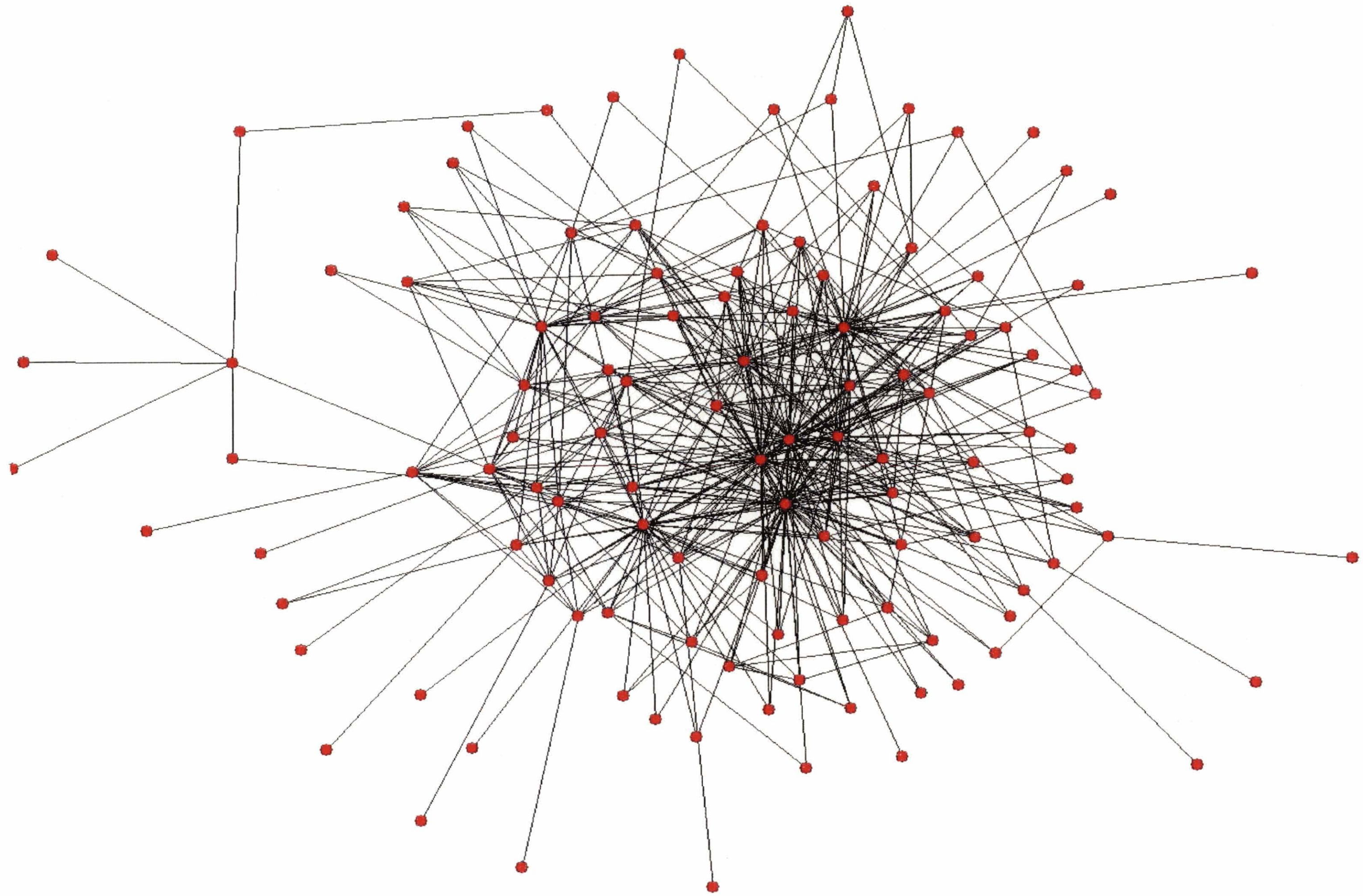


Figure 10: Visual Depiction of Export Network in 1965

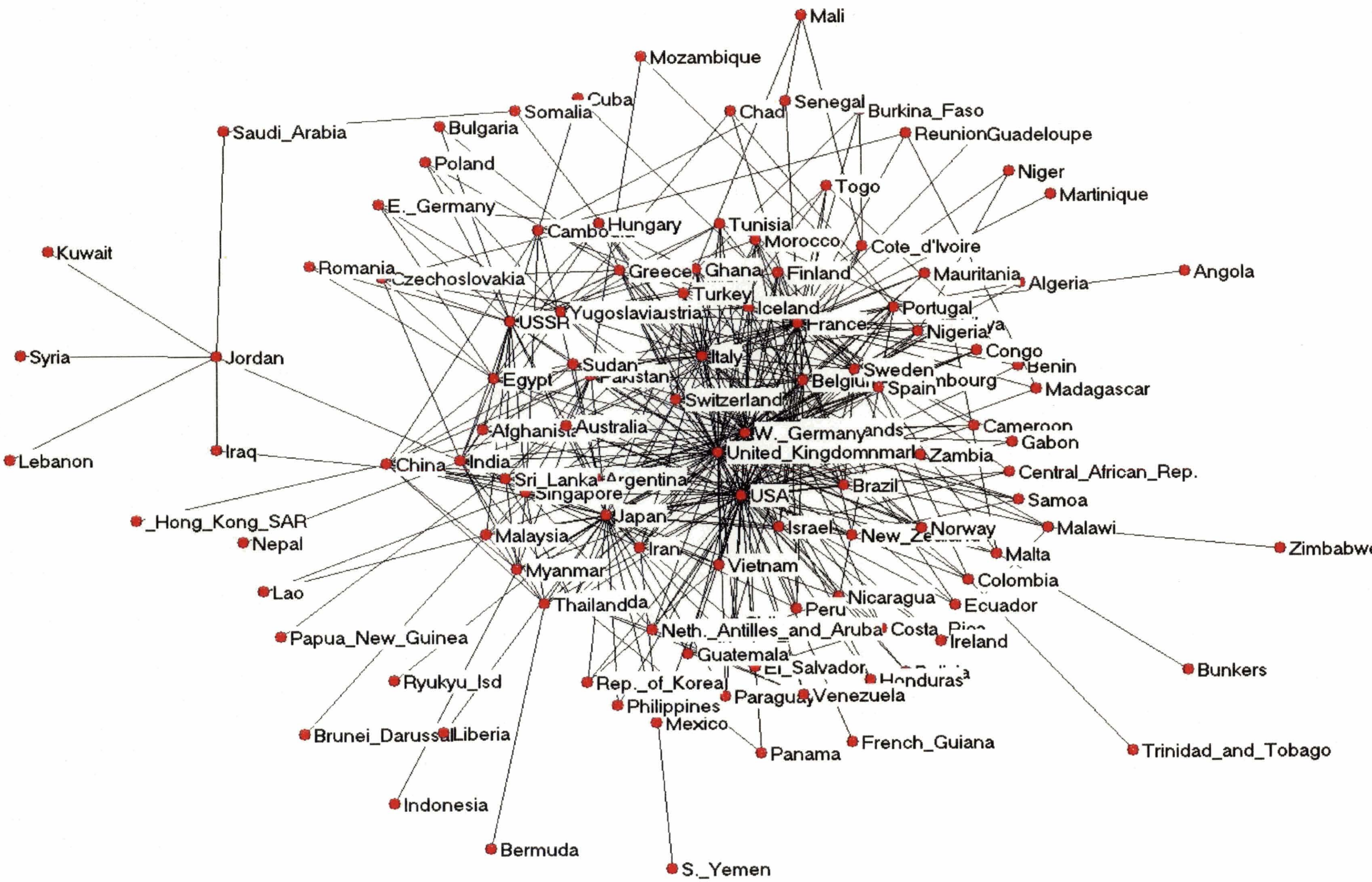
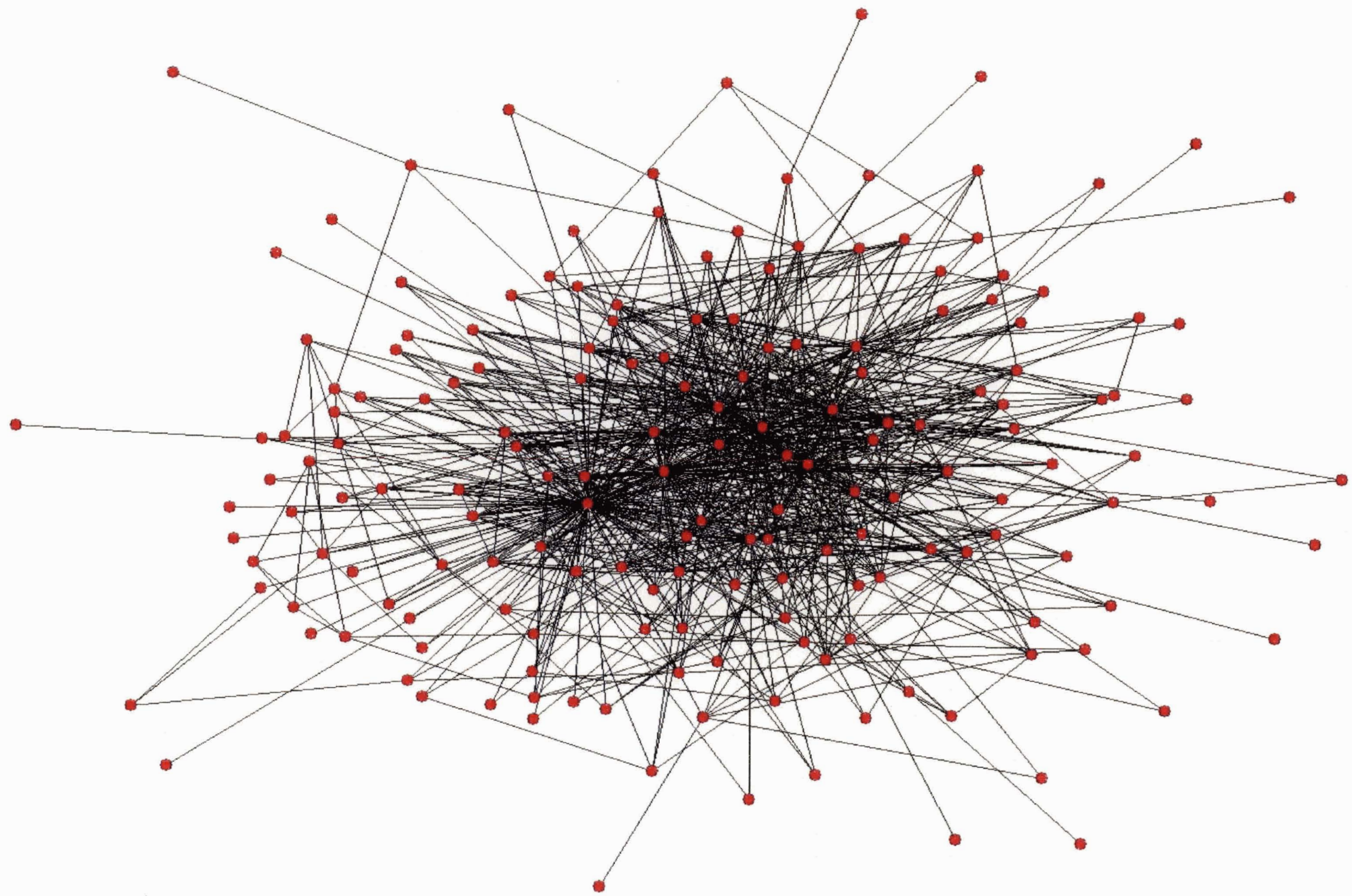


Figure 11: Visual Depiction of Export Network in 1965 (Nodes Labeled)



igure 12: Visual Depiction of Export Network in 2000

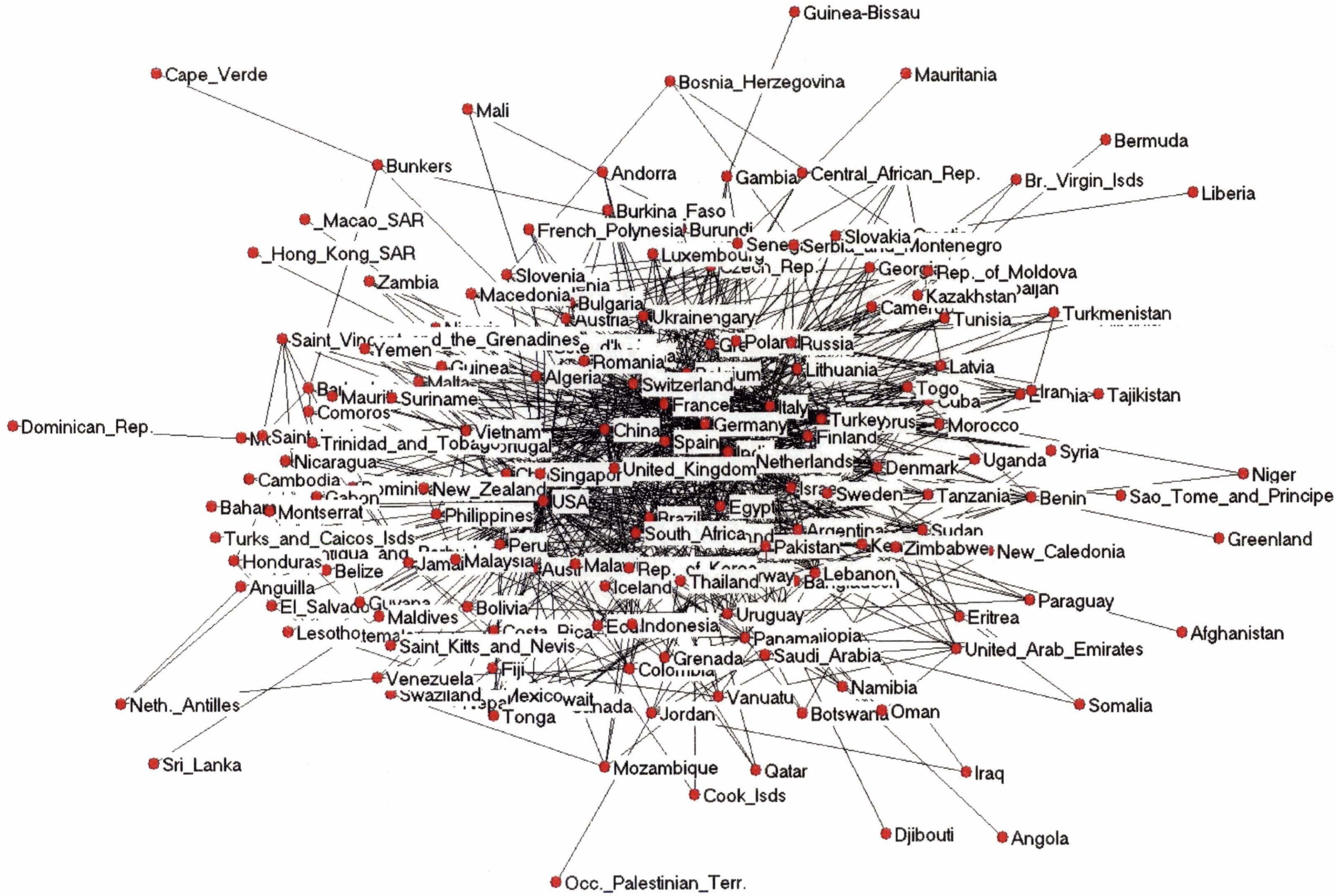


Figure 13: Visual Depiction of Export Network in 2000 (Nodes Labeled)

These images alone do not confirm the existence of a Scale-Free Network, but they do show variations among countries that may suggest differences in trade-power as expressed by their macro positioning.[65] Notice that the countries in the center – countries like the United Kingdom and the United States – are the ones which most trade relationships are dependent upon. Notice how the outer countries tend to have few relationships with other countries and are typically dependent upon only one or two countries. Notice how China moves from an outer ring of trade in 1965 to the inner echelons of the network in 2000. In contrast, notice how Afghanistan's position in the international trade system declines as it moves from a semi-Hub location even more central than China to a remote corner of the graph by 2000.

In order to determine whether the trade system conforms to a Scale-Free Network, we must inspect the distribution of degrees. In Figures 14 and 15, we display the distribution of degrees in 1965 and 2000, respectively.[66] The x-axis represents the number of degrees of a nation and the y-axis represents the probability of a given country having that number of degrees. So in 2000, 2 out of 161 countries had forty degrees exactly. Therefore, there is a 2/161 chance that if a country were selected at random, it would have forty degrees. If we were to observe a Dirac distribution (whereby all countries would have the same number of degrees), an Egalitarian Network would be in effect; if we were to observe a Gaussian distribution, a Random Network would be in effect; if we were to observe a Power-Law distribution, a Scale-Free Network would be in place, with a definite hierarchy among nodes. We find that in both 1965 and 2000, the

[65] Power is used here in terms of Hirschman's conception of power.

[66] These charts were generated using Matlab. We also used Stata and Microsoft Excel for statistical work.

power-law distribution confirms that the macro trade system conforms to a Scale-Free Network.

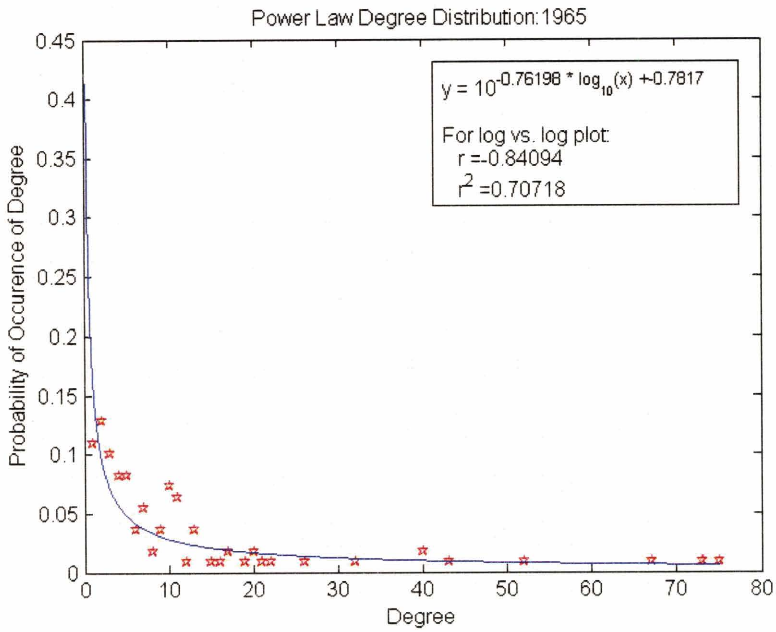


Figure 14: Distribution of Degrees in 1965

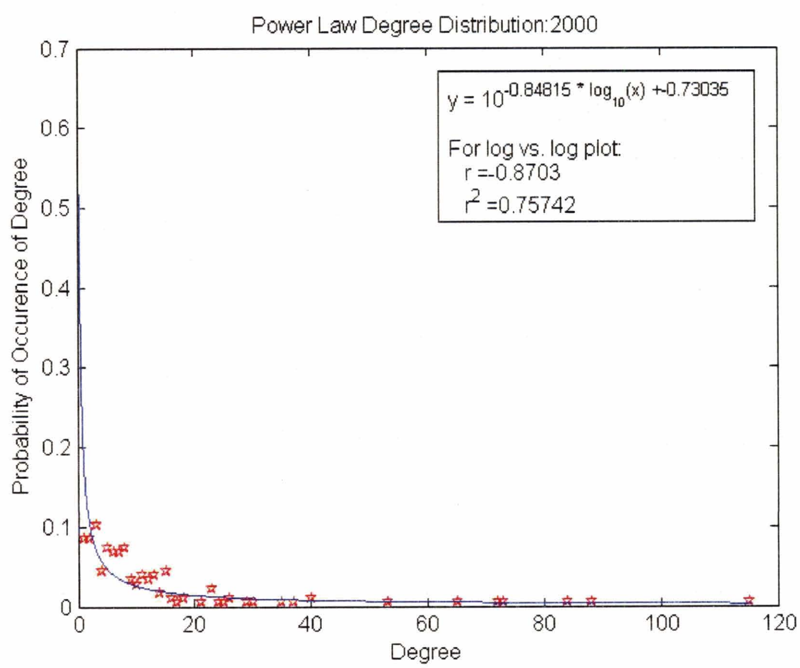


Figure 15: Distribution of Degrees in 2000

A Scale-Free Network suggests that the overall system is dependent upon some sort of hierarchy. There are several possible hierarchies outlined in the graph theory literature. Beyond Hubs and Spokes, Dodds, Watts, and Sabel have categorized five such possibilities for hierarchical network structures: *Random, Random Interdivisional, Core-Periphery, Local Team, and Multiscalar* (2004).[67] The first two hierarchies are restricted to Random Networks. In a *Random Hierarchy*, links are distributed across a system so that flows and relationships need not necessarily follow a top-down structure. In a *Random Interdivisional Hierarchy*, there are apparent top-down relationships, but interactions take place across these cliques in a macro manner more so than a submacro manner. The second two hierarchies occur within Scale-Free Networks. In a *Core-Periphery Hierarchy*, links occur exclusively within clear-cut cliques in a very rigid and top-down structure. In such a hierarchy, a subservient node may only interact with the node above it. In a *Local Team Hierarchy*, the distributions are further mottled, as nodes of the same team can interact with one another, but must interact with a Hub node. Between the Random Network (typified solely by global interactions) and the Scale-Free Network (typified solely by clique interactions) lies the *Multiscalar Hierarchy.*[68] In the Multiscalar Hierarchy, both global *and* clique interactions are equally implicit to the network structure. In a Multiscalar Hierarchy, link density (the frequency of links) decreases monotonically with depth. In the top grouping, such hierarchies share a

[67] Since Pool's days, MIT's Department of Political Science has played a relatively small role in social network analysis, but former department members are playing active roles in the domain nonetheless. For example, Charles Sabel was a professor at MIT from 1977-1995; according to his publications, however, he did not become involved in graph theory until joining the faculty at Columbia University. This lack of researchers within our department is particularly surprising given the fact that graph theory has emerged in departments across the Institute, and that the Department of Political Science has a strong history of multi-disciplinary collaboration.
[68] The term "Scale-Free" refers to the fact that there are no scales in the degree distribution; there may be scales in other elements of a Scale-Free Network, however (Newman, 2003), giving rise to the possibility of a Mulitscalar hierarchy.

multitude of relationships with one another, with nodes involved in both horizontal and vertical relationships, but by the bottom grouping, relationships are almost entirely vertical. In Figure 16, several possible hierarchies are displayed, courtesy of Dodds, et al. In the image, the darker area implies thicker link density, or *homophily,* between the component nodes.

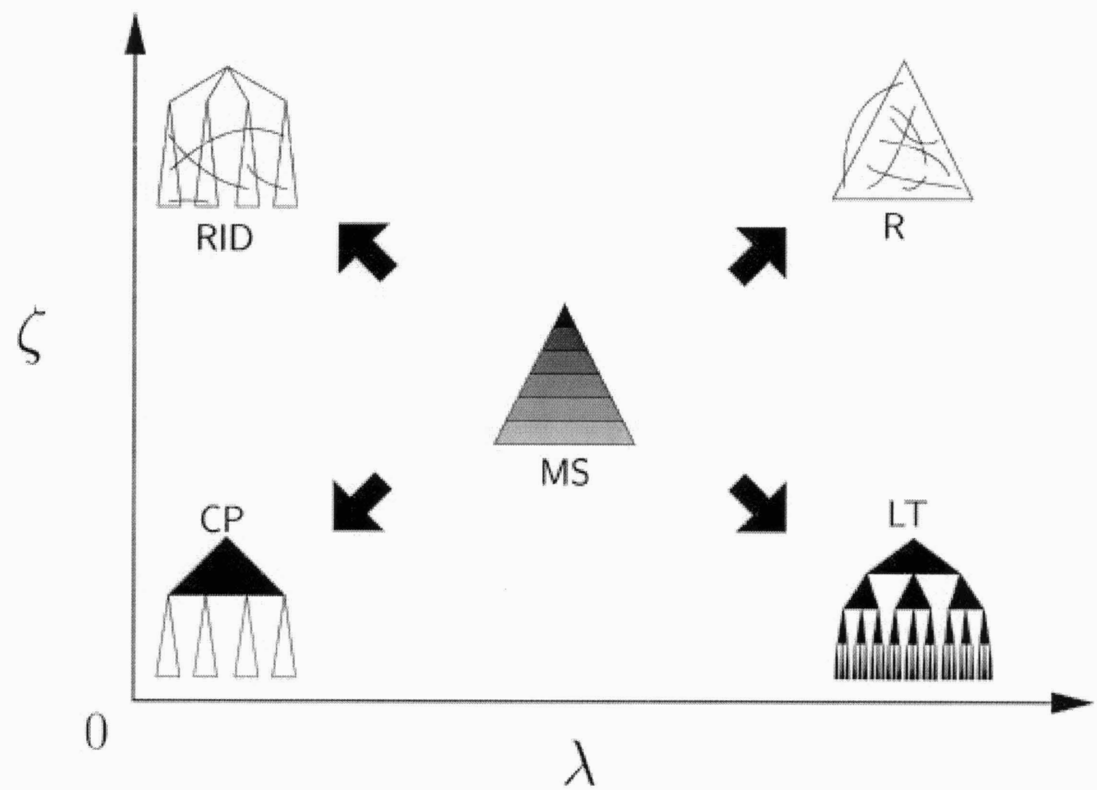


Figure 16: Possible Hierarchical Structures. Courtesy of Dodds, et al., 2004

In each of these last three hierarchies, the key players – the Hubs – are critical within their own clique of countries (their own submacro systems), but they can also render huge effects upon the overall international order. But how well do these structures map onto traditional IR theory? The most striking similarity rests in terms of the Core-Periphery distinction. As we mentioned earlier, in the literature, one often encounters discussions of core and peripheral countries (Wallerstein, 1976; Denemark, et al., 2000). Core countries are countries which effectively run and determine the international system due to their economic and military strength, while peripheral countries are dependent upon other actors and play a distanced role in the world system (ibid). However in our IR literature, the existence of core and periphery countries could – and frequently should – take on the structure of these hierarchies and therefore the core-periphery distinction is more similar to Hubs versus Spokes. So as not to confuse the reader, we shall continue to label what is usually described as core countries as Hub countries, while we shall classify peripheral countries as Spokes.

Scale-Free Networks contain important subsystem groupings that have profound implications for the overall network structure and stability. A Scale-Free Network has several subsystem groupings and it is the structure and function of these submacro system groupings that have huge ramifications for the international system. If the subsystems are becoming separated and more distinct, as we would expect if regionalism or some other submacro form were on the rise (as Mansfield and Milner, 1999 suggests), we would observe cliques in which the distributions of relationships and the distribution of power increasingly centered on the Hub of the clique. Alternatively, if we were observing the increasing cohesiveness of nations relative to each other and the emergence of a flat world, as Thomas Friedman suggests (2005), we would expect to see a transition to a Random Network where cliques and inter-national economies do not matter as much.[69]

[69] Hirst and Thompson discuss the difference between globalization and inter-nationalization, explaining that globalization occurs when a single unified global market is more prevalent than any national markets. Hirst and Thompson explain that the international system is actually one in which inter-national markets dominate the international arena (2002).

However, we clearly cannot understand the international system or its macro system without understanding the submacro system.[70]

Chapter Summary

In this chapter, we have offered a primer of the basic concepts of graph theory by analyzing international trade in the macro system. We find that rather than resembling an Egalitarian Network or a Random Network, patterns of international trade most closely resemble a Scale-Free Network, with localized relationships playing a significant role in the international trade system. Hub countries exert tremendous influence in their own cliques, and can exercise limited influence among the clique of Hubs that, for all intents and purposes, runs the macro system. Furthermore, this structure of a macro system has been in place for at least 35 years, and according to the macro system analysis, it should continue to be the case. However, submacro analysis will better help us understand how the macro system is changing, as we shall see in the upcoming chapters. Submacro analysis will also help us further understand the hierarchy of the system.

Graph theory is useful for understanding a system's overall structure, but it is also useful for understanding relative positions of elements within a system. Therefore in the following chapters, we aim to further understand the relative positions of nations within the international system by identifying the submacro components of the international trade system and the hierarchies inherent to the system, but we also aim to identify where countries lie in terms of their submacro systems and the macro system as a whole.

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[70] The existence of submacro clusters may confirm Huntington's position that sub-international groupings of countries are the best way of conceiving of the macro system (Huntington, 1996). Alternatively, the existence of clusters in the international system may confirm those who believe the macro system is actually just a set of several regional systems, with the regions primarily dictated by geography (Schirm, 2002). Certainly, there are formal regional structures which countries join, forming explicit clusters. However, in order to determine the true conditions of the system and whether Huntington and the Regionalists are correct, we must identify the latent subsystems.

CHAPTER 4: SUBMACRO PATTERNS IN THE INTERNATIONAL SYSTEM

Overview

In Chapter 2, we reviewed a host of literature which suggested that we need to understand the substructures of the international system in order to understand the international system as a whole. In Chapter 3, we empirically demonstrated the importance of such submacro systems in the context of the international order as we found the presence of a Scale-Free Network. In this chapter, we design and implement a graph theory-derived methodology for inspecting these international submacro systems in order to determine which sort of system hierarchy best describes the structure of international trade. In this chapter and in Chapter 5, we find that a Multiscalar Hierarchy best captures the international system of trade.

Formulating a Rigorous Submacro Approach

In order to construct the international system, we need an approach that will help us identify latent cliques in the international community. From these latent cliques, we hope to be able to identify the hierarchy that best captures the international system. Once we recognize the hierarchy, we can discuss economic stability, contagion, the utility (or futility) of economic sanctions, integration, and neo-functionalism with a better understanding of the true state of the international system.

As we mentioned in Chapters 1 and 2, much research has been restricted to analyzing parallel submacro systems that belong to similar taxonomies (such as culture, formalized trade, etc.), while few approaches, if any, explore parallels between these taxonomies. In other words, when investigating submacro conditions, researchers tend to make implicit assumptions about the inter-country group they are examining. In order to avoid introducing our own biases into the study, we need to craft a way in which to transcend these taxonomies and capture the true formation of international interactions at the submacro level, especially across time.

Techniques of graph theory once again offer us a solution. Scholars in graph theory have increasingly focused on uncovering latent clique structures within complex networks (Newman, 2004). There are several algorithms that have emerged for identifying these cliques.[71] Among them are *spectral-bisection*, the *Kernighan-Lin Algorithm* (both championed by computer scientists), and the *Bron-Kerbosch Algorithm* (especially useful for finding and defining sociological cliques) (Newman, 2004). In each of these algorithms, the number of latent cliques must be predetermined, and each component must belong to one – and only one – of the cliques. The *Girvan-Newman Algorithm* represents an improvement as it finds "natural" grouping among the components, whereby the user does not have to define how many cliques actually exist at the outset (Newman, 2004).

For studying the international trade system, there are many drawbacks to even the *Girvan-Newman Algorithm*. Firstly, by requiring all countries to be classified in a clique, inaccurate groupings of loosely-related nations will be endemic in our analysis. Secondly, our grouping algorithm should reflect the conditions of the submacro system that we have already identified. Most importantly, an algorithm which recognizes that a country may belong to more than one clique would be tremendously advantageous. Consider the United States, for example, which is heavily involved in trade across the

[71] Rather than engage in a lengthy discourse about the mathematics behind each of these algorithms, we shall contain our discussion to the pros and the cons of each algorithm only with regard to our purposes. We recognize that the Palla, et al. algorithm which we end up utilizing is the best for our purposes and not necessarily best for other purposes. For a brief introduction to community analysis, consult Newman, 2003 and Newman, 2004.

world. If we were to use the *Girvan-Newman Algorithm*, the United States could only be included in one submacro system. However, the United States plays an important role in several submacro systems, interacting in otherwise secluded trading communities in Africa, as well as trading communities in South America, for example.

Palla, Derényi, Farkas, and Vicsek offer a solution in the form of an algorithm which recognizes that components in a network may belong to several different communities (2005).[72] Such an algorithm offers us a way of identifying latent submacro systems without limiting the participation of a country to a singular submacro system.[73] In Figure 17, from Palla, et al., the image on the left shows how typical community identification analysis does not recognize overlaps. Such an image is the product of a divisive grouping algorithm, like the four previously identified. The image on the right shows overlapping cliques, with nodes that belong to more than one clique, as produced by Palla, et al. Considering the manifest divides in the international system alone, such a structure may be more appropriate: France belongs to NATO *and* the EU while the United States is a member of both NAFTA and the OECD. The *Palla, et al. Algorithm* offers us the best leverage for considering the submacro systems of the international trade system.

[72] Palla, et al., are all biologists. It is comforting to note that other methodological techniques employed in IR and biology are also shared. McClelland's concept of equilibrium comes from biology (identified by Goodman, 1965). More recently, evolutionary biologists have adopted methodologies in game theory for their purposes (Hauert and Doebeli, 2004).

[73] The algorithm was originally constructed to observe protein cliques in yeast to make predictions for the unknown functions of some proteins (Derényi, et al., 2005).

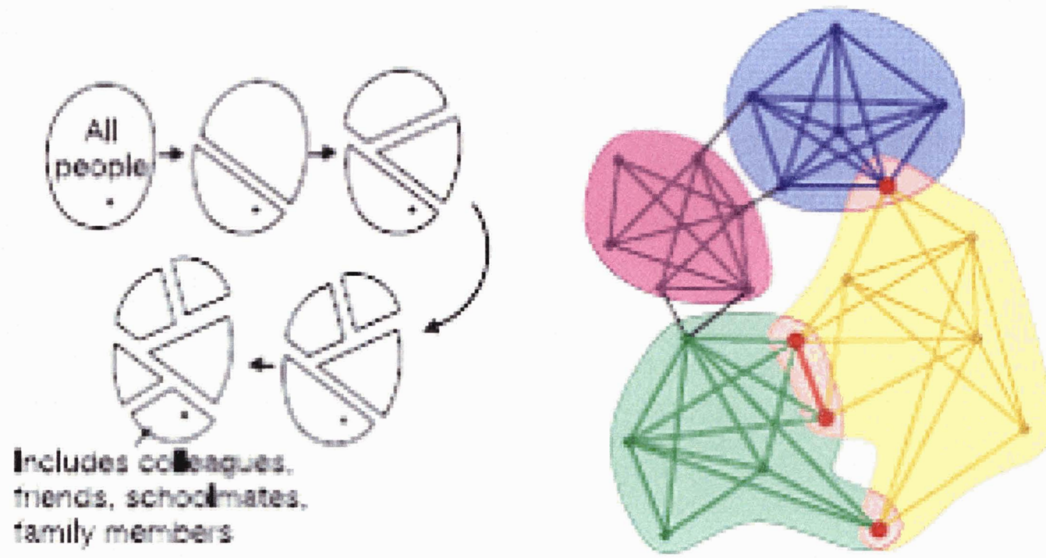

Figure 17: Divisive Cliques vs. Overlapping Cliques

Recognizing that there are overlaps among latent trading communities, the *Palla, et al. Algorithm* allows us to entirely reconsider the submacro concept. Such community identification analysis should not be confused with typical clustering analysis found in traditional statistics. When one uses methods of clustering analysis found in traditional statistics, one is grouping observations based upon similar characteristics.[74] Such clustering analysis would be useful for creating a cluster of the richest countries in the world, for example. In contrast, community identification analysis groups countries based upon their relationships with one another rather than basing the groupings upon their similar attributes. In order not to further confuse the reader, we shall not use the term "cluster" to describe our submacro groupings, but instead we shall call them either *cliques* or *communities*, both acceptable substitutes in the graph theory literature (Newman, 2004; Palla, et al., 2005).

[74] Newman observes that the algorithms used for clustering analysis and community identification analysis can be adapted for one another with some effort (2003).

The *Palla, et al. Algorithm* is based upon an adaptation of an existing method for identifying latent cliques.[75] The existing method is known as the Clique Percolation Method (CPM). The CPM identifies cliques by scanning for *k*-cliques. A *k*-clique is one in which all nodes within the clique share a specified minimum number of edges minus one. More formally, *k*-cliques are "complete (fully connected) subgraphs of *k* vertices" (Derényi, Palla, and Vicsek, 2005: 160202-2). In Figure 18, a *k*-clique is presented where *k*=2. Because it is the minimum number of edges, notice that despite the fact that two of the nodes in this figure actually have four edges, the rest of the nodes have three edges, making *k*=2. Essentially, a CPM algorithm scans the data for each of these *k*-cliques starting at *k*=3, then proceeding to *k*=4, and so on. As a result, any clique requires at least 3 nodes. As the algorithm reaches the maximum *k*-clique, the percolation method instructs the algorithm to terminate.

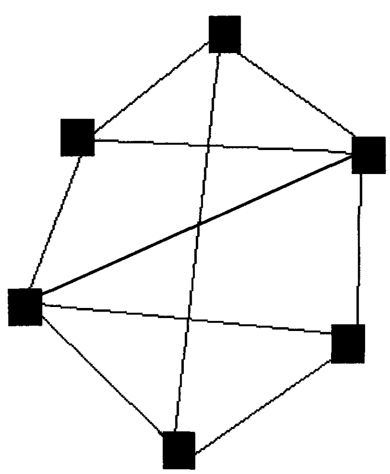

Figure 18: A k-Clique Where *k*=2

Ordinarily, once a typical algorithm identifies a node at one *k*-clique level, it does not group that node with any other clique at that level. The *Palla, et al. Algorithm* does

[75] For those further interested in the mathematics behind the algorithms, first consult the Derényi, et al. article in *Physical Review Letters*, 2005, before Palla, et al., 2005, in *Nature*.

the opposite. Nodes are included across several cliques, even at a common *k*-clique level (Derényi, et al., 2005; Palla, et al., 2005).

Palla, et al. have graciously made their clique-identifying algorithm publicly available and free of charge, even providing a graphical user interface for convenience (2005).[76] The program which they create, known as CFinder, visually displays the latent cliques.

To locate and identify the submacro structures, we again use export data from the UN Comtrade Database from 1962-2003.[77] From this data we again identify dyadic relationships between countries, again only including major trade relationships.[78] Once the data is organized in terms of dyads, stored in a text file, and selected, CFinder runs the calculations and computes the latent clusters.

CFinder not only identifies relationships and shows latent clusters, but also graphs the clusters. However, CFinder does not incorporate spring embedding or any energy minimization function into its graphs, making some of the visualizations very difficult to analyze. We therefore will use another visualization program (known as Netdraw) to visually depict some of the more complex submacro systems, utilizing spring embedding functions and energy minimizations, which we discussed in Chapter 3.

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[76] For Palla, et al.'s algorithm and clustering program, visit http://angel.elte.hu/clustering/ (Accessed April, 2006).
[77] For a more rigorous discussion about the methods of data collection, please see Chapter 2 and Appendix A. Again, Behram Mistree did the initial data work by gathering the data from UN Comtrade. His help and guidance throughout the project has been greatly appreciated. Hanyin Lin's assistance in organizing the data and polishing the graphs is much appreciated.
[78] Major trade relationships are already defined and explained in Chapter 2.

Findings

Palla, et al.'s CFinder program returns ten to twenty latent submacro systems for each year of analysis.[79] Recall that a latent submacro system is one in which the relationships need not be formalized or established beforehand. The findings in and of themselves show many temporal patterns and international developments, but we are interested in extracting intertemporal patterns that can help us understand the overall international trade system. For this reason, we only present selected latent submacro systems and we contain our analysis to three years: 1962, 1982, and 2002.

Latent Submacro Systems in 1962

1962 was an exciting year for scholars of international politics. Colonialism was in a downturn, as France ceded independence to Algeria, and the United Kingdom was unable to halt the new constitution in Southern Rhodesia (now known as Zimbabwe), while also losing Jamaica. Malaysia would become independent from the United Kingdom the next year. Also in 1962, the Cuban Missile Crisis would grip the international community.

In terms of trade, several major events took place. Cuba and the Soviet Union formally signed a trade pact on January 9, provoking the United States to begin a trade embargo on Cuba three weeks later. The 1962 United States Trade Expansion Act authorized the United States government to negotiate tariff cuts of up to 50%, a move largely celebrated by those involved in the General Agreement on Tariffs and Trade (GATT).[80] The European Economic Community (EEC), the precursor of the EU, was a

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[79] A latent clique, a latent cluster, a latent community, a latent grouping, and a latent submacro system are all equivalent. We avoid "cluster" because we do not want to confuse the reader with clustering analysis typical in traditional statistics.

[80] The historical information presented comes from a shining beacon of graph theory: the World Wide Web, and more specifically, from Wikipedia. One should always confirm facts found on Wikipedia,

fledgling organization, in its fourth year of its existence. The Central American Common Market (CACM) had been formed the year before between El Salvador, Guatemala, and Honduras; in 1962 the CACM would accept Nicaragua.

CFinder identifies twelve cliques in 1962: one k=9 clique, one k=8 clique, two k=7 cliques, two k=6 cliques, two k=5 cliques, one k=4 clique, and three k=3 cliques.[81] As is the case across all of the years, among the largest cliques is a Western / Euro-centric clique that includes the United States. In Figure 19, we present this grouping of traders.[82]

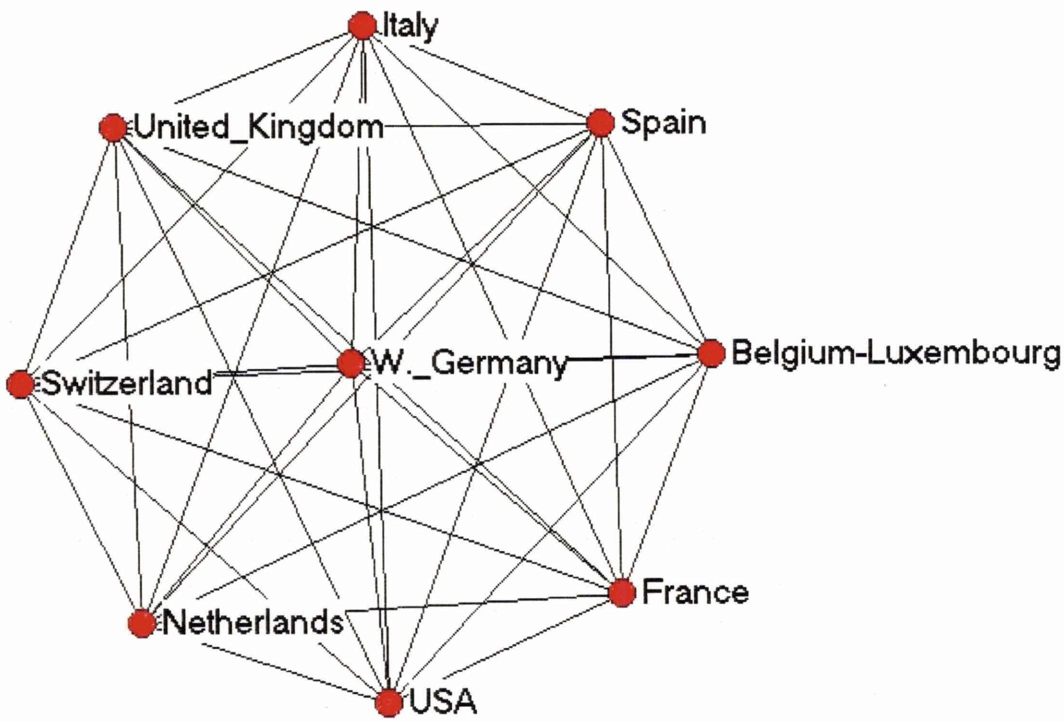

Figure 19: A k=9 Latent Clique from 1962, with Country Labels

however, and we have done so using other websites not linked through Wikipedia. Plus, most of the historical facts are common knowledge.

[81] CFinder's algorithm is consistent and efficient, showing the same number of cliques on repeated iterations of the algorithm, while taking a short amount of time to compute.

[82] Following our pattern established earlier, when the image of the network may not be apparent with country labels, we first present the image of the network, and then the image of the network with country labels. We do so in order to best visualize the structure of the system and to best visualize the locations of components of the system.

Of the nine countries included in this clique, four of them – France, Belgium-Luxembourg, West Germany, the Netherlands, and Italy – were all founding members of the EU, and they were the EU's only members in 1962.[83] Of the countries in the clique, all except the United States and Switzerland would eventually join the EU. In Chapter 3, we discussed the concept of the *clustering coefficient.* Recalling the example, if Countries A and B trade, and Countries B and C trade, the clustering coefficient shows the likelihood of a trade relationship existing between Countries A and C. Each node has a clustering coefficient, which represents the likelihood that its trading partners also trade with one another. In 1962, the average clustering coefficient of the 86 countries included in the database was 0.6363. In contrast, the nine countries in the k=9 latent clique had an average clustering coefficient of 0.3466.

To understand why this number is so low, consider the United States, Venezuela, and Afghanistan in 1962. Both Venezuela and Afghanistan exported to the United States, but they did not trade with each other, and therefore this lowered the United States' clustering coefficient. Countries with low clustering coefficients tend to serve as connectors across the several Spokes in the system. In 1962, the five countries with the lowest clustering coefficients were France (0.1220), the United States (0.1396), the United Kingdom (0.1582), the Soviet Union (0.1621), and China (0.2000). Interestingly, countries at the higher end of the spectrum are not necessarily economically deprived, but they are not as critical to the international trade system. Heavily dependent upon their

[83] According to the UNCTAD Handbook of Statistics, the EU actually included five countries: France, Italy, the Netherlands, Belgium, and Luxembourg (2005). However, Comtrade data only recognizes the country of Belgium-Luxembourg in 1962.

local partners, Norway (0.9524) and Denmark (0.9286) are among the countries with the highest clustering coefficients.[84]

It is also sometimes helpful to visualize the actual amount of trade taking place between nations in a submacro system. In Figure 20, we display the trade relationships of the same k=9 clique, only in this case, the edges are thickened according to the natural logarithm of the dollar amount of the trade relationship along a pre-determined gradient. We do not see one country where all trade must flow through. Notice that among this clique, countries are for the most part equals.[85] They are mutually reliant upon one another, but they are all also strong enough to rely on other parts of the international system.

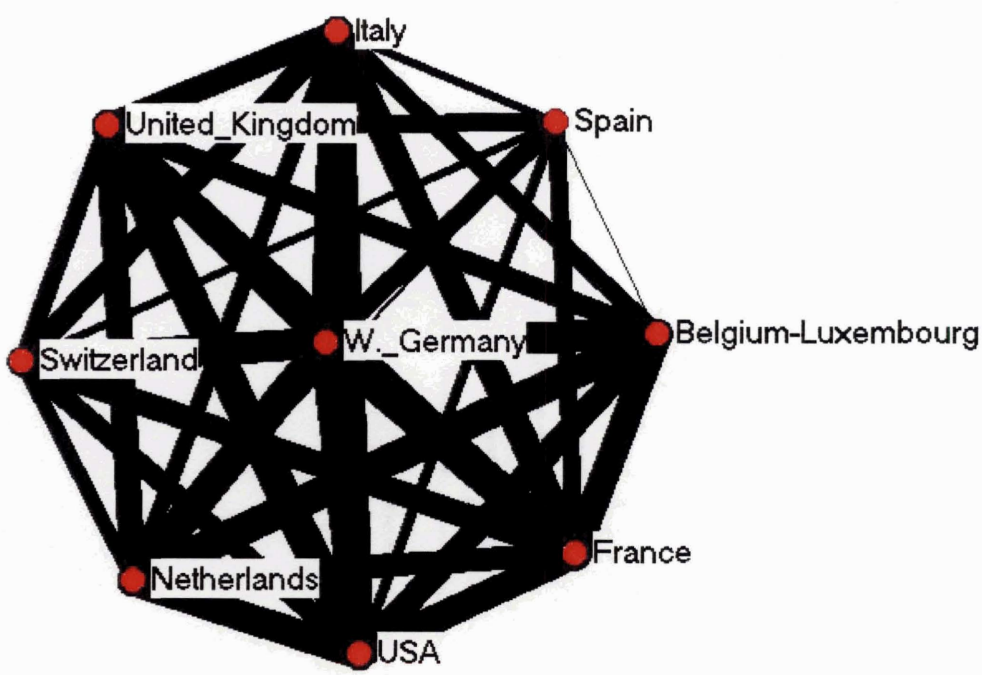

Figure 20: A k=9 Latent Clique from 1962, with Weighted Relationships and Country Labels

[84] Norway and Denmark have the highest clustering coefficients of all countries that had clustering coefficients below 1.000. Typically the countries that have a perfect clustering coefficient are less developed, although Norway scores a 1.000 in 1963, proving that there are exceptions to the rule.
[85] With Spain appearing to be a somewhat more marginal player in the community.

Figures 21 and 22 display images of two different latent cliques at the *k*=6 level. The first clique involves several Asian-Oceanic nations. The second clique shows trade relationships among a primarily European clique. In Figures 23 and 24, we combine the two cliques to show their interconnections, using the spring embedding function in Netdraw.[86] Again, the first figure simply displays the pattern; the following figure gives the country labels as well. These figures are very hard to interpret, so in Figures 25 and 26, the graph has been manipulated to highlight the role of intermediaries between the cliques. Figure 26 is weighted so that the reader may see the strength of relationships with intermediaries. Again, the intermediaries' vital role as connectors is visually clear: the majority of trade flowing between these cliques goes through the intermediaries. As one can see from the images, five countries serve as Gatekeepers, or trade intermediaries, between these two large trading cliques: the United States, Japan, West Germany, the United Kingdom, and Pakistan.[87] Except for a few stray connections, almost all cross-clique trade relationships must go through these five countries. Notice that not all of these countries would be considered Hubs, especially Pakistan. In Chapter 5 we shall engage in a more rigorous discussion of Gatekeepers, but for now the reader should be thinking about the ramifications of a country being involved in both cliques.

[86] Following our pattern established earlier, when the image of the network may not be apparent with country labels, we first present the image of the network, and then the image of the network with country labels. We do so in order to best visualize the structure of the system and to best visualize the locations of components of the system.
[87] While it may be hard to tell visually, much less trade goes through Pakistan than through the other connectors.

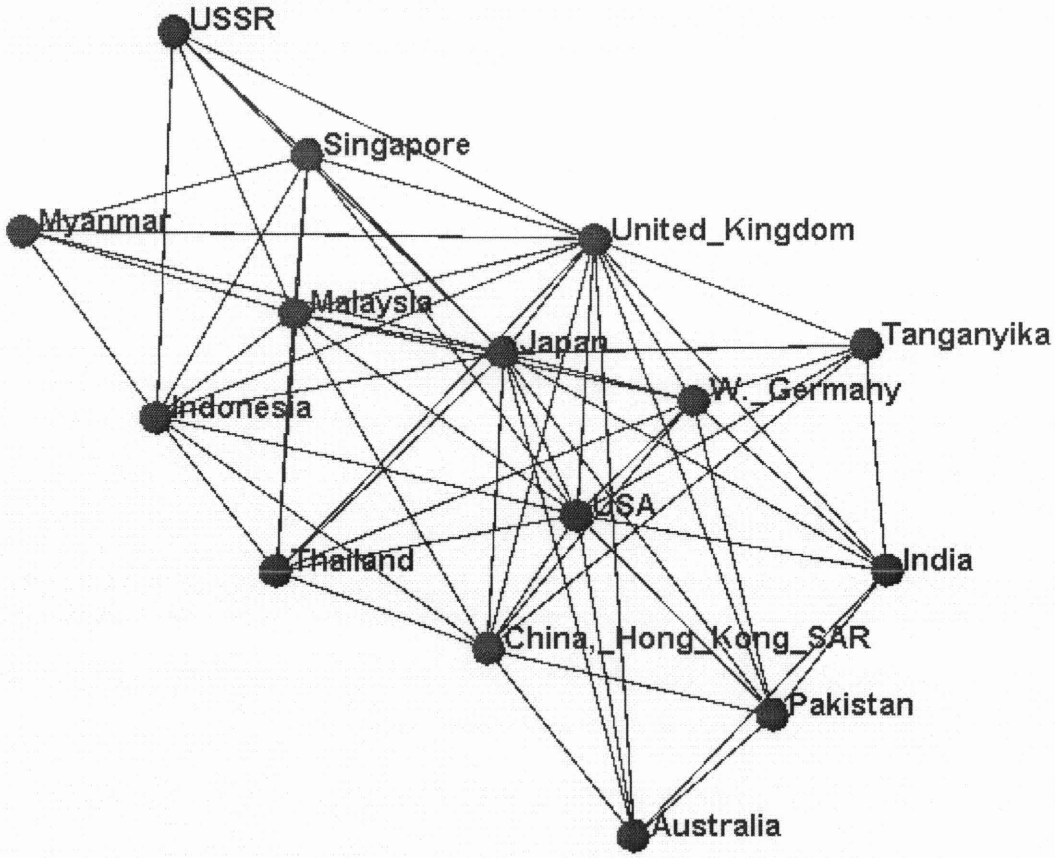

Figure 21: The First of Two *k*=6 Latent Cliques in 1962, with Country Labels

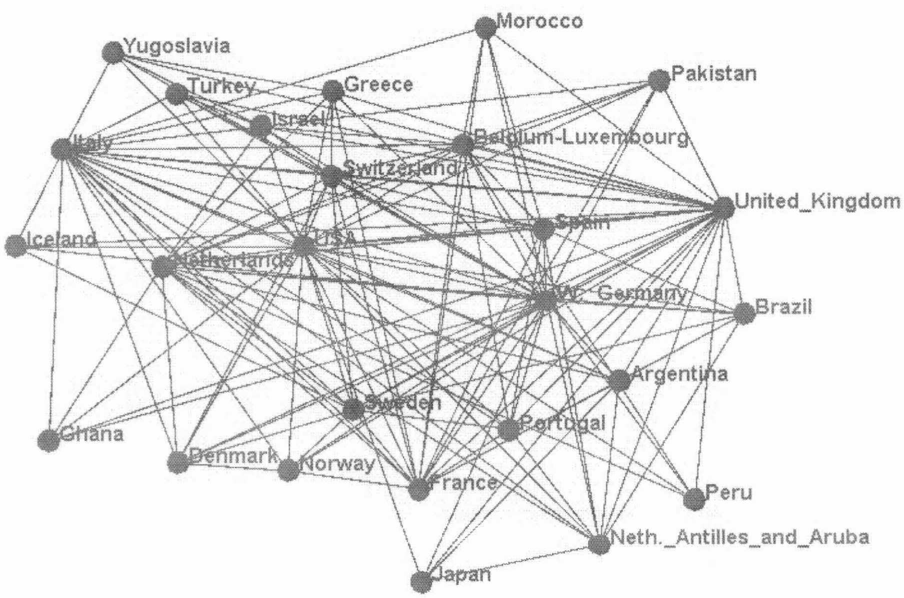

Figure 22: The Second of Two *k*=6 Latent Cliques in 1962, with Country Labels

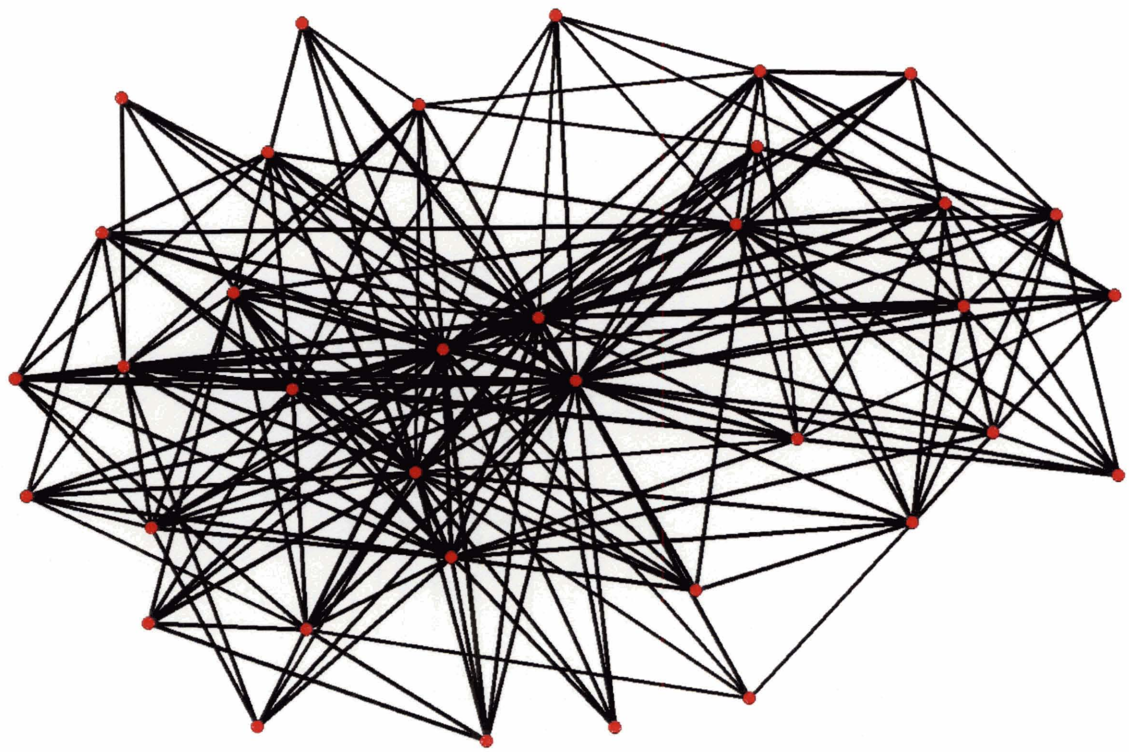

Figure 23: Two *k*=6 Latent Cliques in 1962

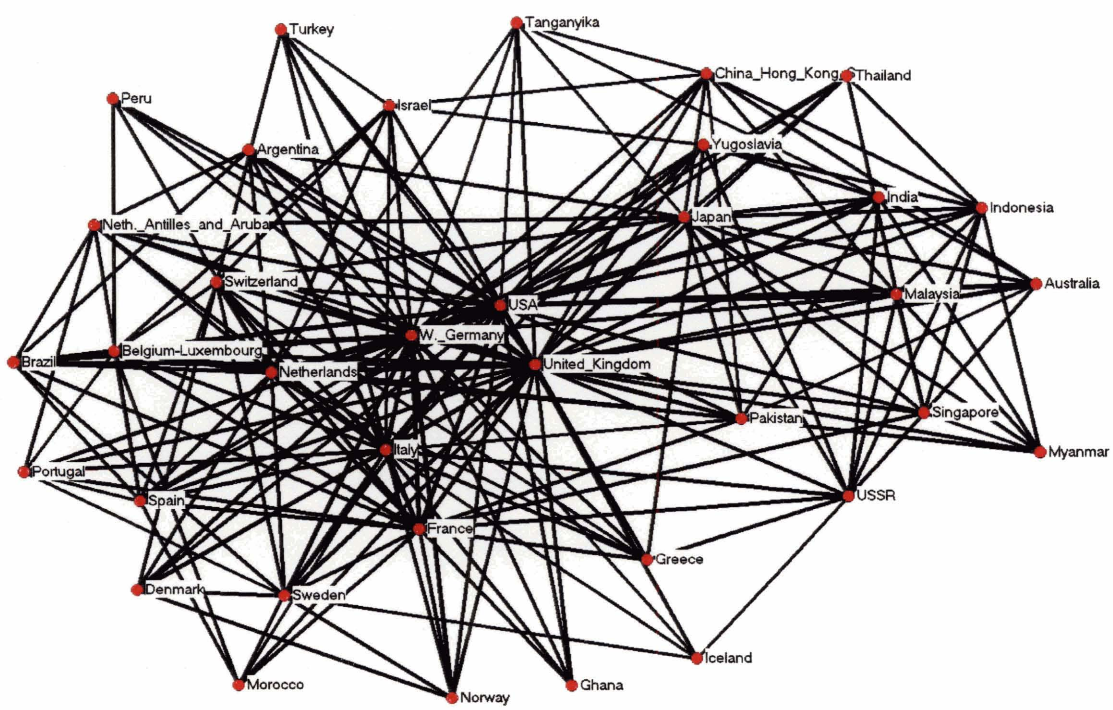

Figure 24: Two *k*=6 Latent Clique in 1962, with Countries Labeled

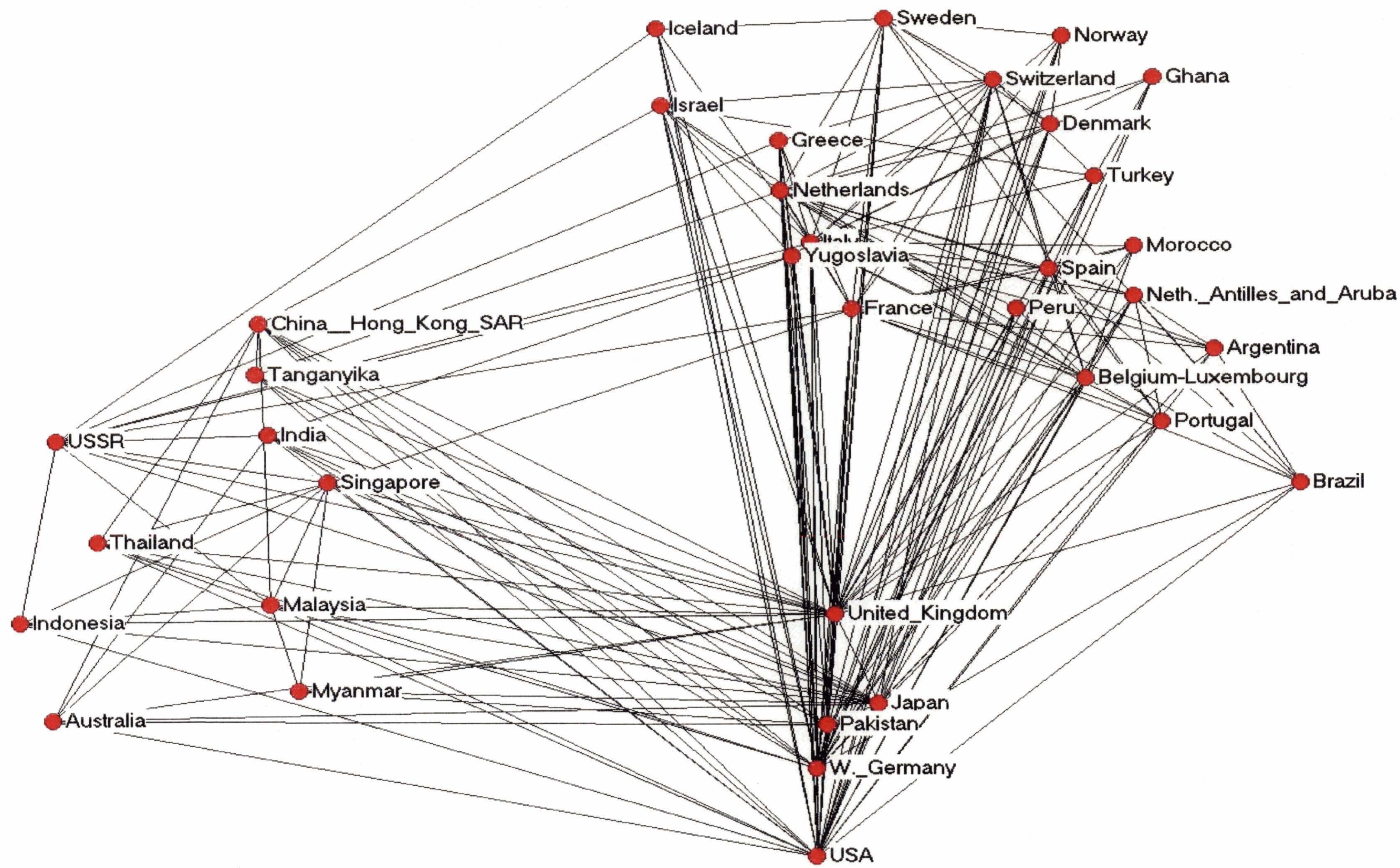

Figure 25: Two k=6 Cliques and their Connecting Nodes, with Country Labels

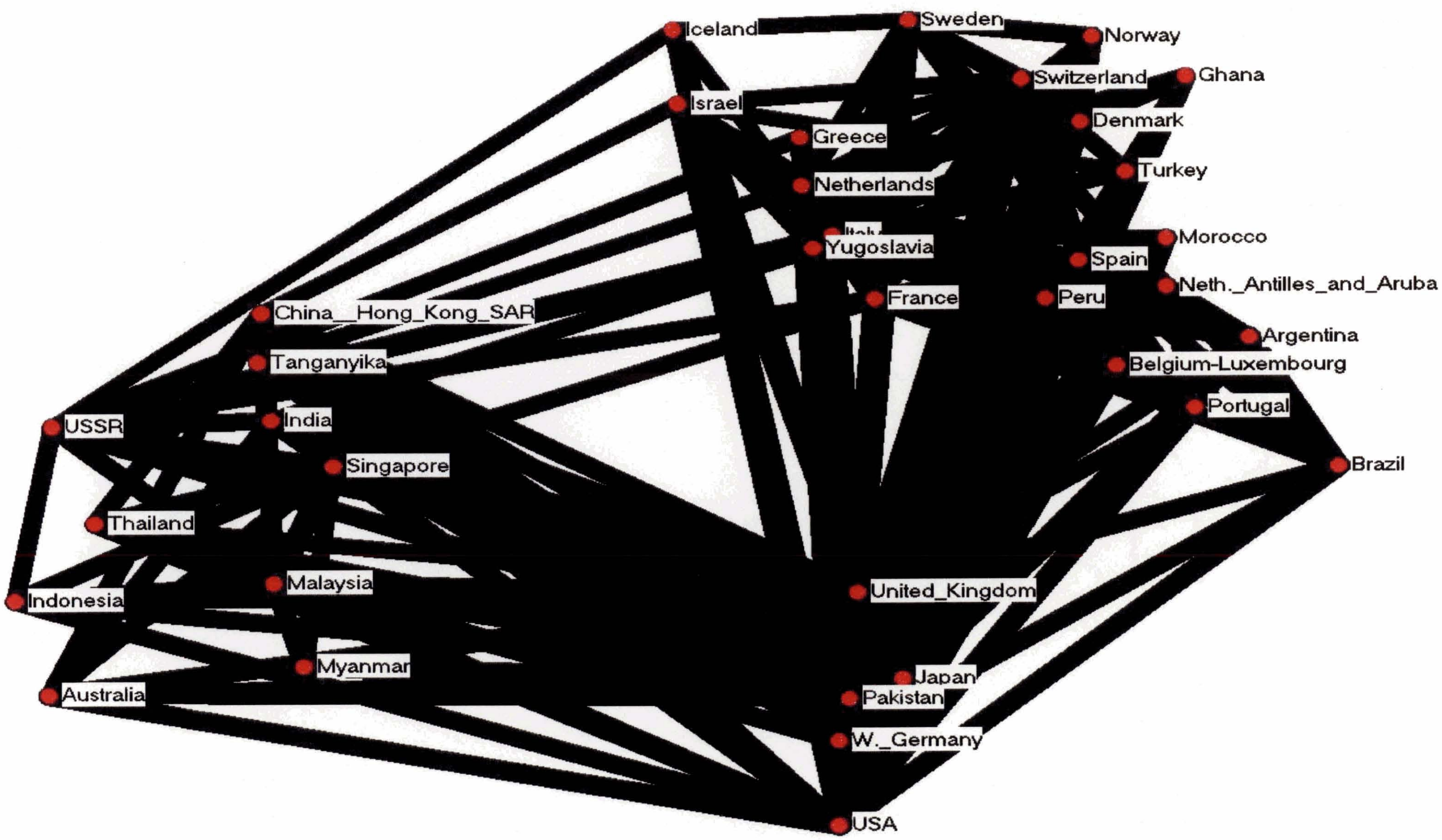

Fig re 26: Two k=6 Cliques and their Connecting Nodes, with Weighted Relationships and Co ntry Labels

As we approach the lowest *k*-cliques, the cliques increasingly approach the macro system structure, with Hub-Spoke Systems emerging. In Figures 27, 28, 29, and 30, we show the same *k*=4 clique from 1962. Figures 27 and 28 are unweighted; Figures 27 and 29 do not have country labels. Notice that in each of the figures, the Hub countries are concentrated in the middle of each diagram, with Spoke countries increasingly distant from the center. In Figures 29 and 30 in particular, notice the heavy, black relationships emerging from the Hub countries; one can see how removing the United States or the United Kingdom and their many substantial trade relationships would destabilize the network, while removing Poland or Czechoslovakia would only impact a few countries, and only very lightly.

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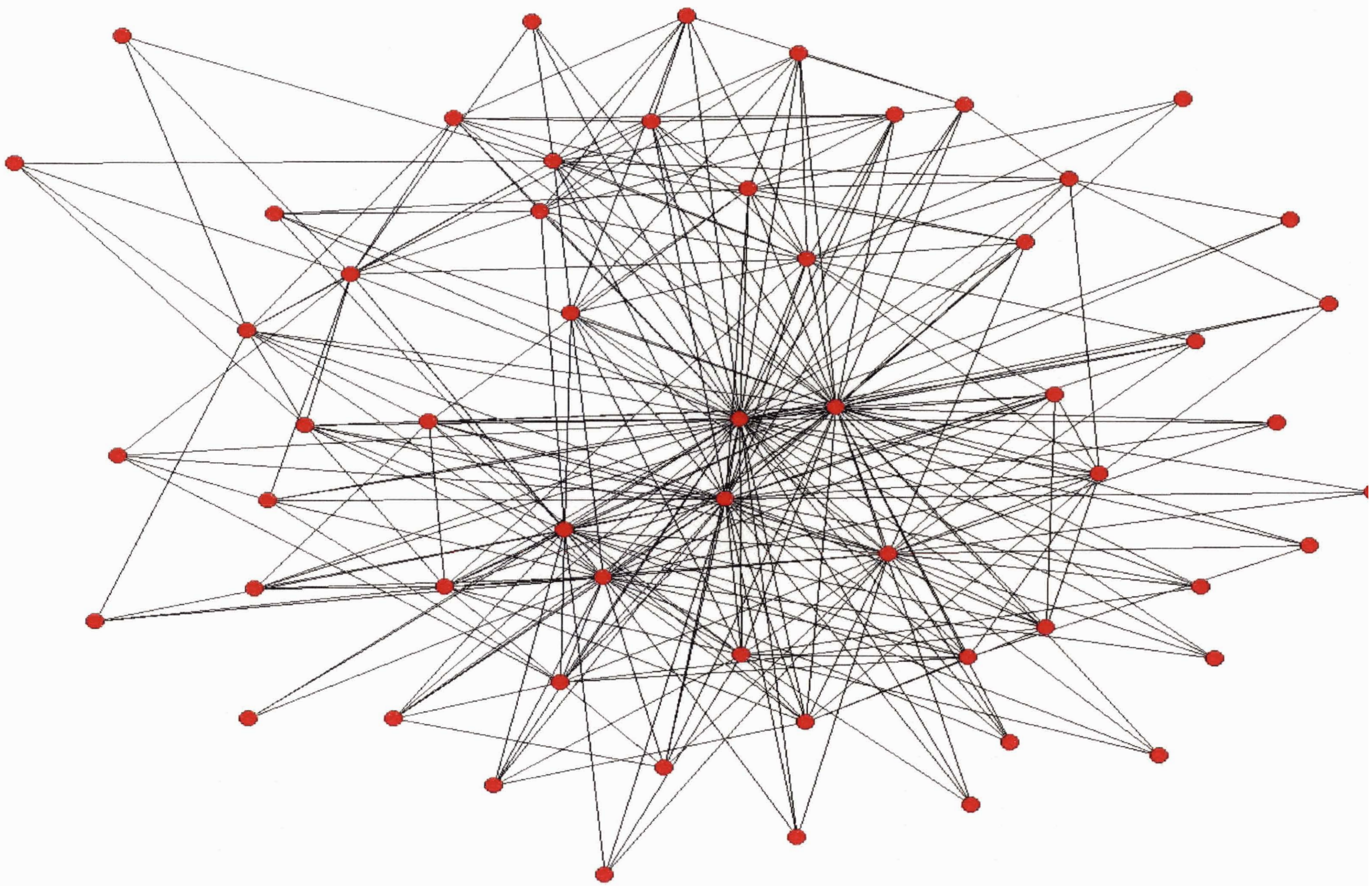
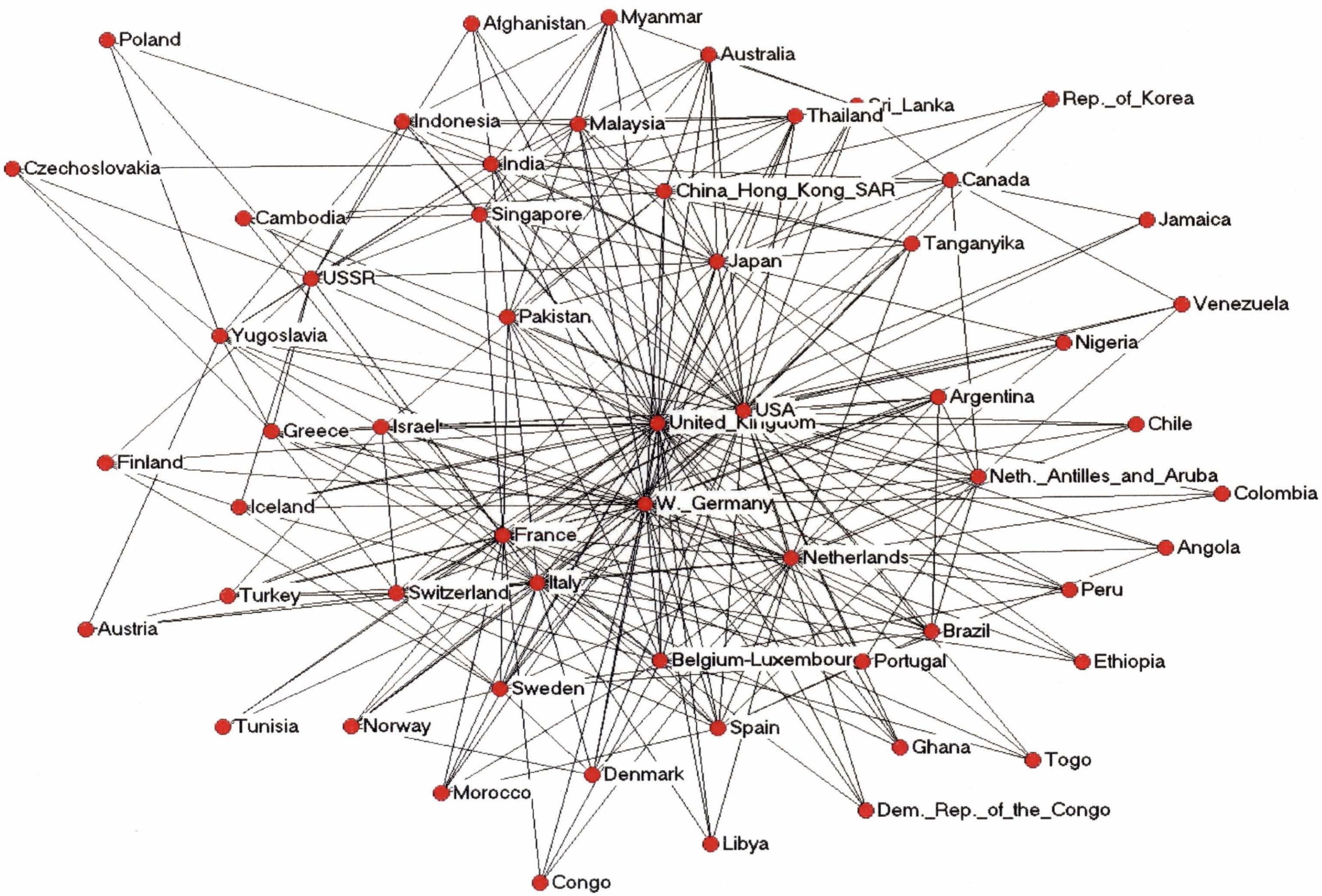


'igure 27: A k=4 Latent Clique in 1962



Fi ıre 28: A *k*=4 Latent Clique in 1962, with Country Labels

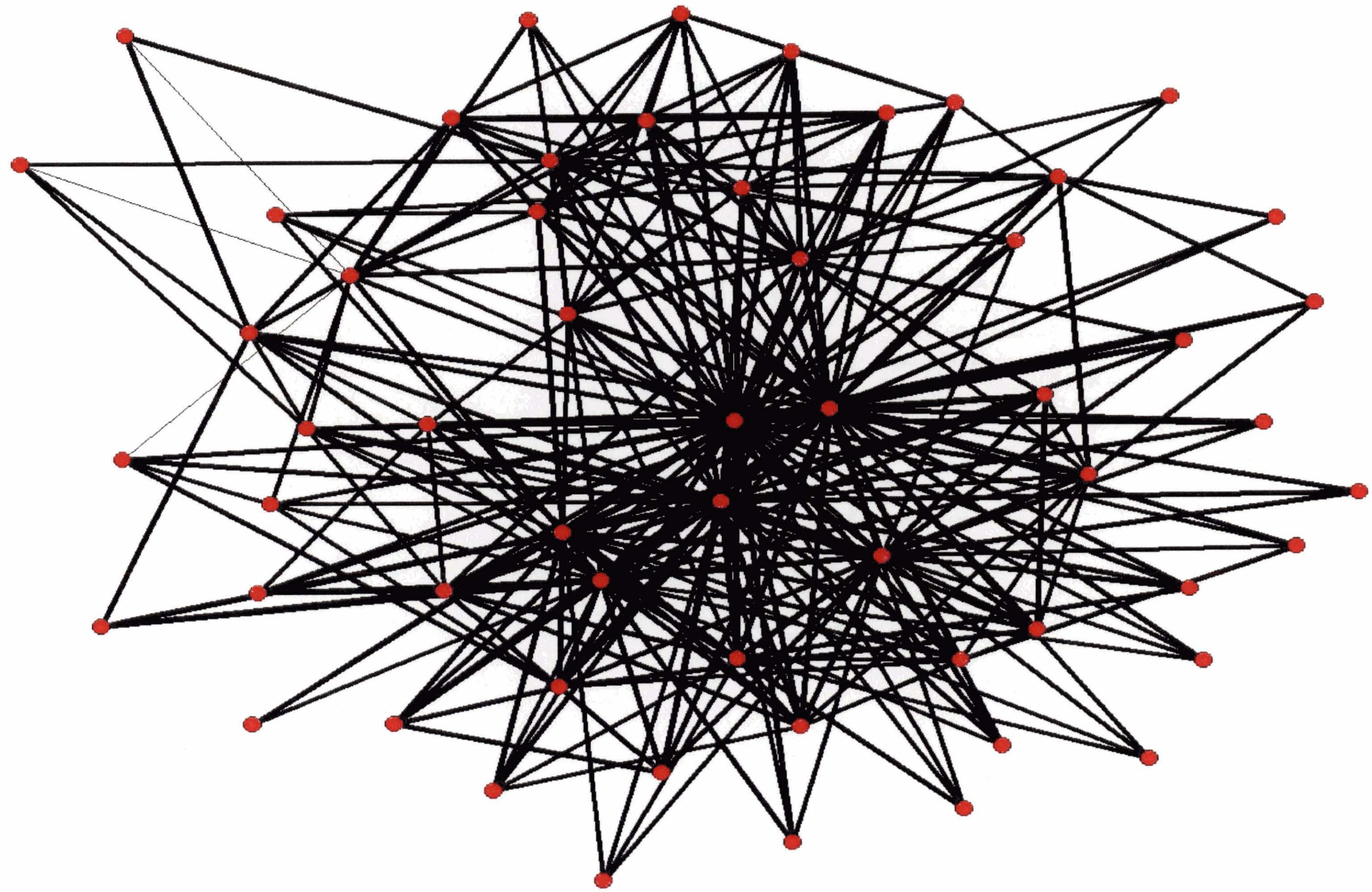


Figure 29: A k=4 Latent Clique in 1962, with Weighted Relationships

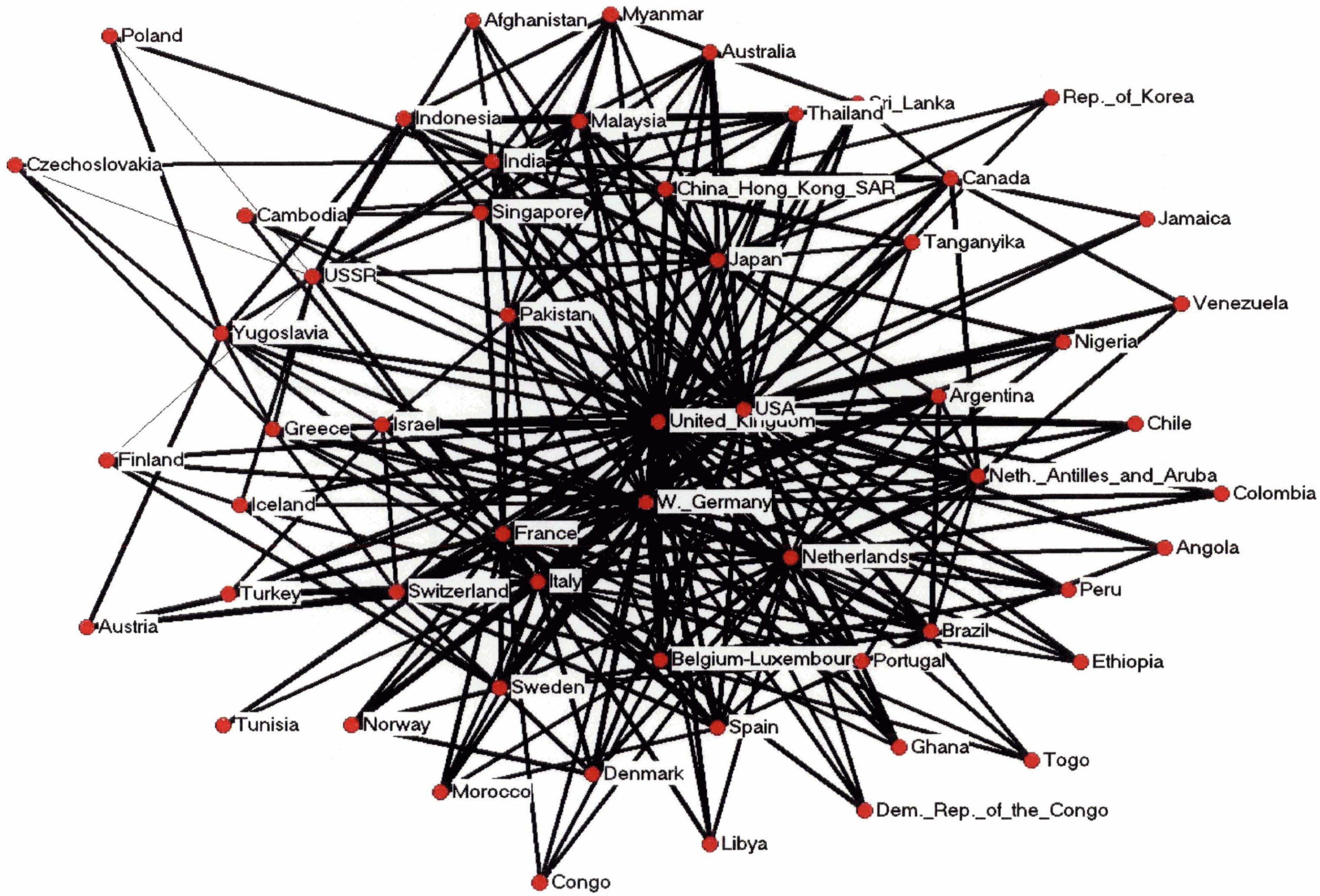


Figure 30: A *k*=4 Latent Clique in 1962, Weighted and Country Labels

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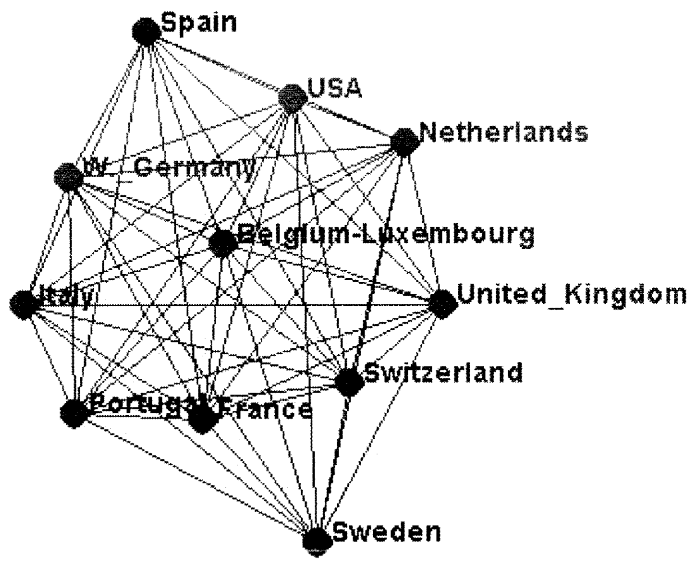

Figure 31: A *k*=10 Latent Clique in 1982, with Country Labels

The international system is composed of many different types of formalized cliques and latent cliques. These represent some cliques that we would be able to recognize using traditional means of analysis and those that we would not be able to recognize. In Figures 32-35, a *k*=6 latent clique is presented. Following precedent established in other parts of the thesis, in Figures 32 and 33 we show the clique with unweighted relationships while in Figures 32 and 34 we have removed country labels so the reader can better observe the network structure. Notice how the nations in the clique all come from several different geographic areas, how the nations also come from both the Communist and NATO blocs, as well as the Third World bloc, and how the nations represent a whole range of different cultures. Such a grouping would not be analyzed had we chosen to only investigate geographically regional country groupings or formalized trade blocs.

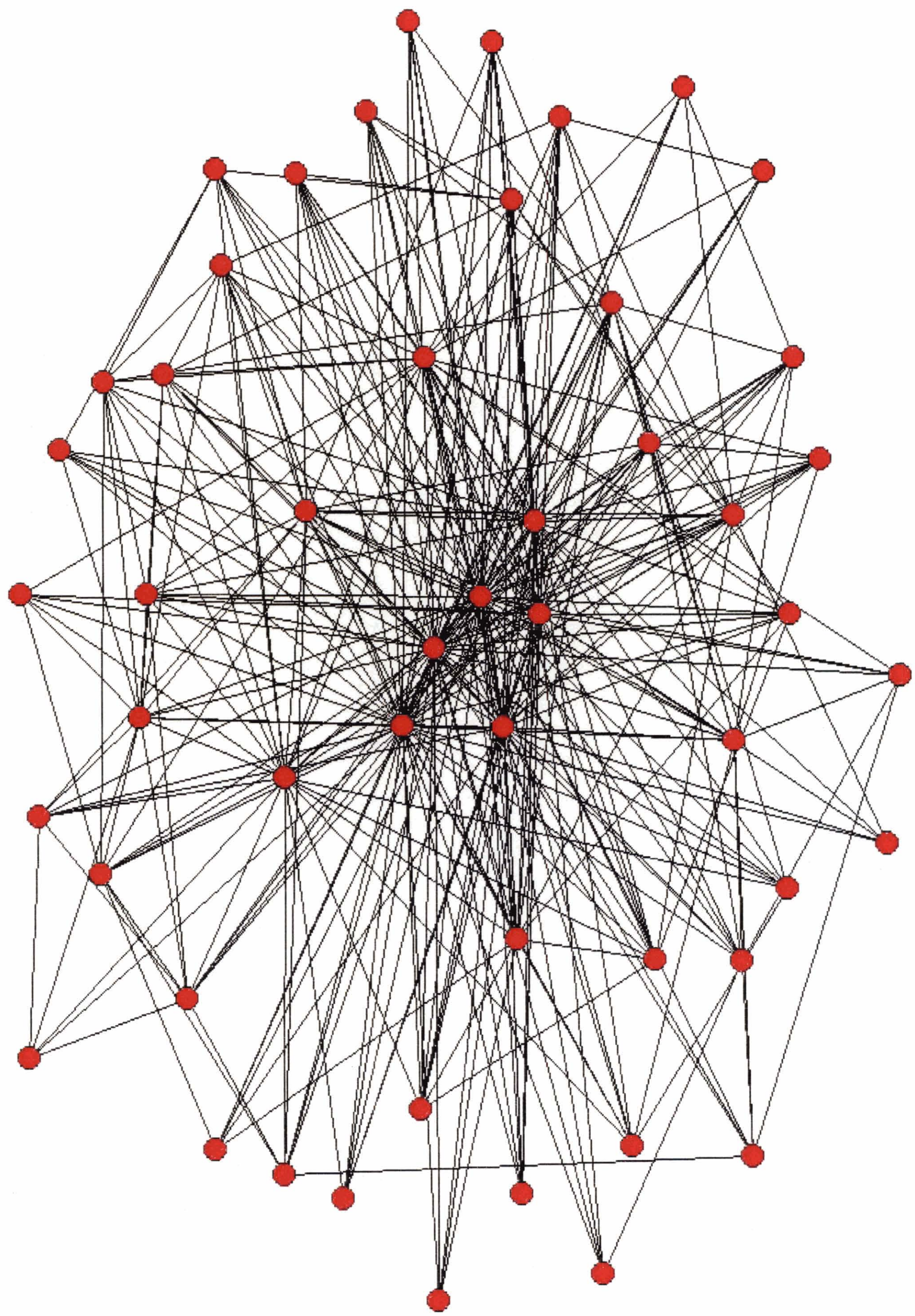

Figure 32: A *k*=6 Latent Clique in 1982

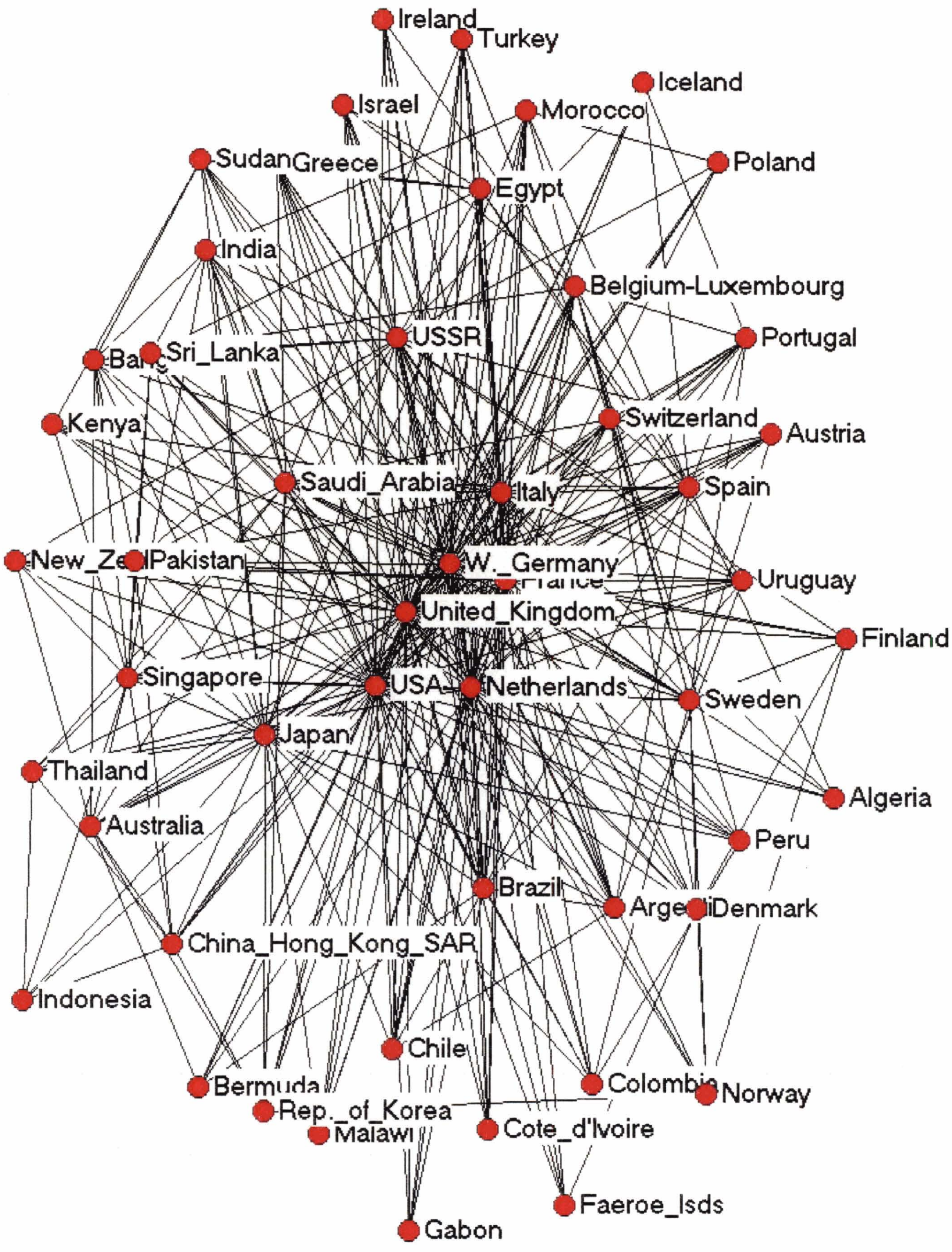

Figure 33: A *k=6* Latent Clique in 1982, with Country Labels

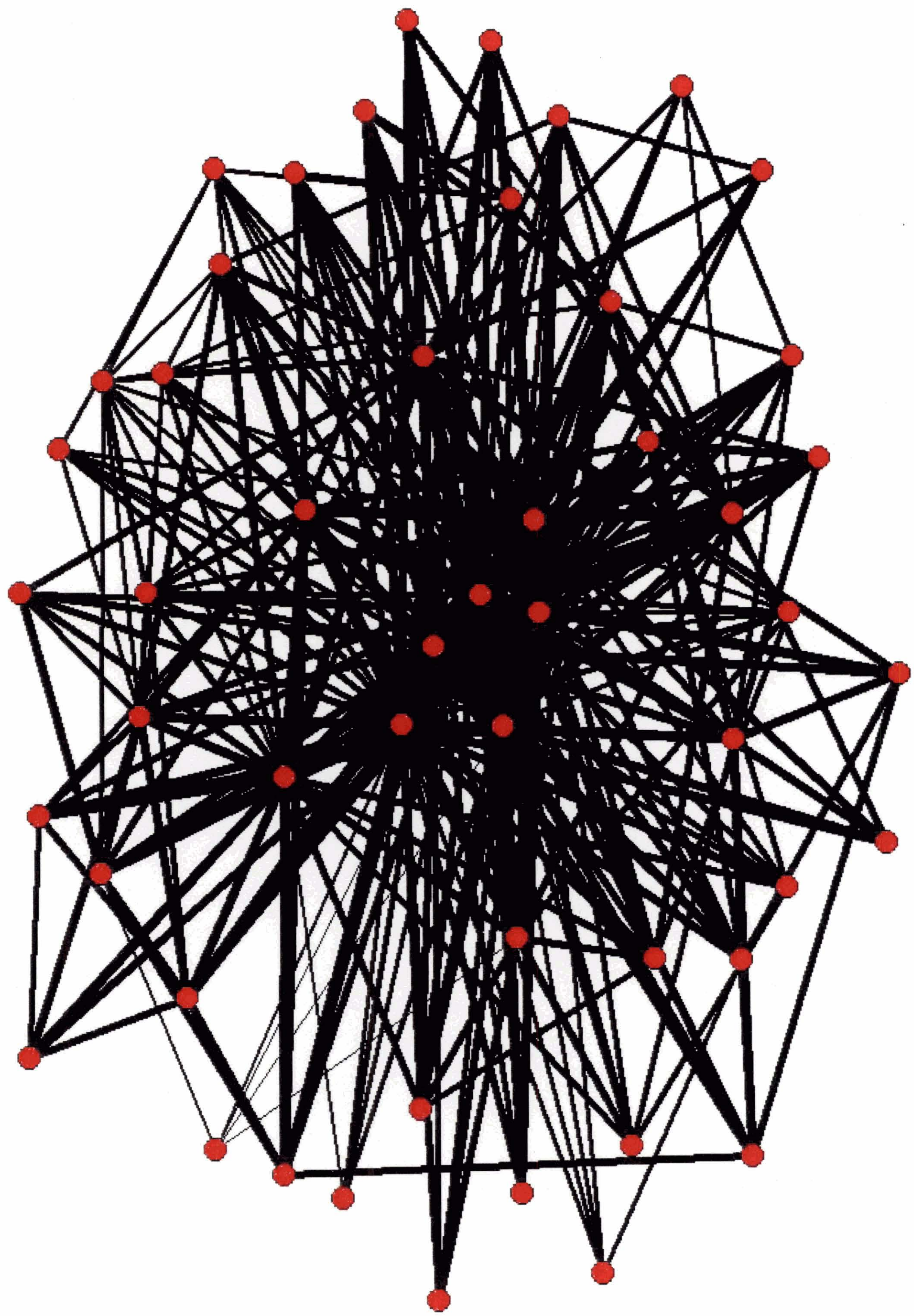

Figure 34: A k=6 Latent Clique, with Weighted Relationships

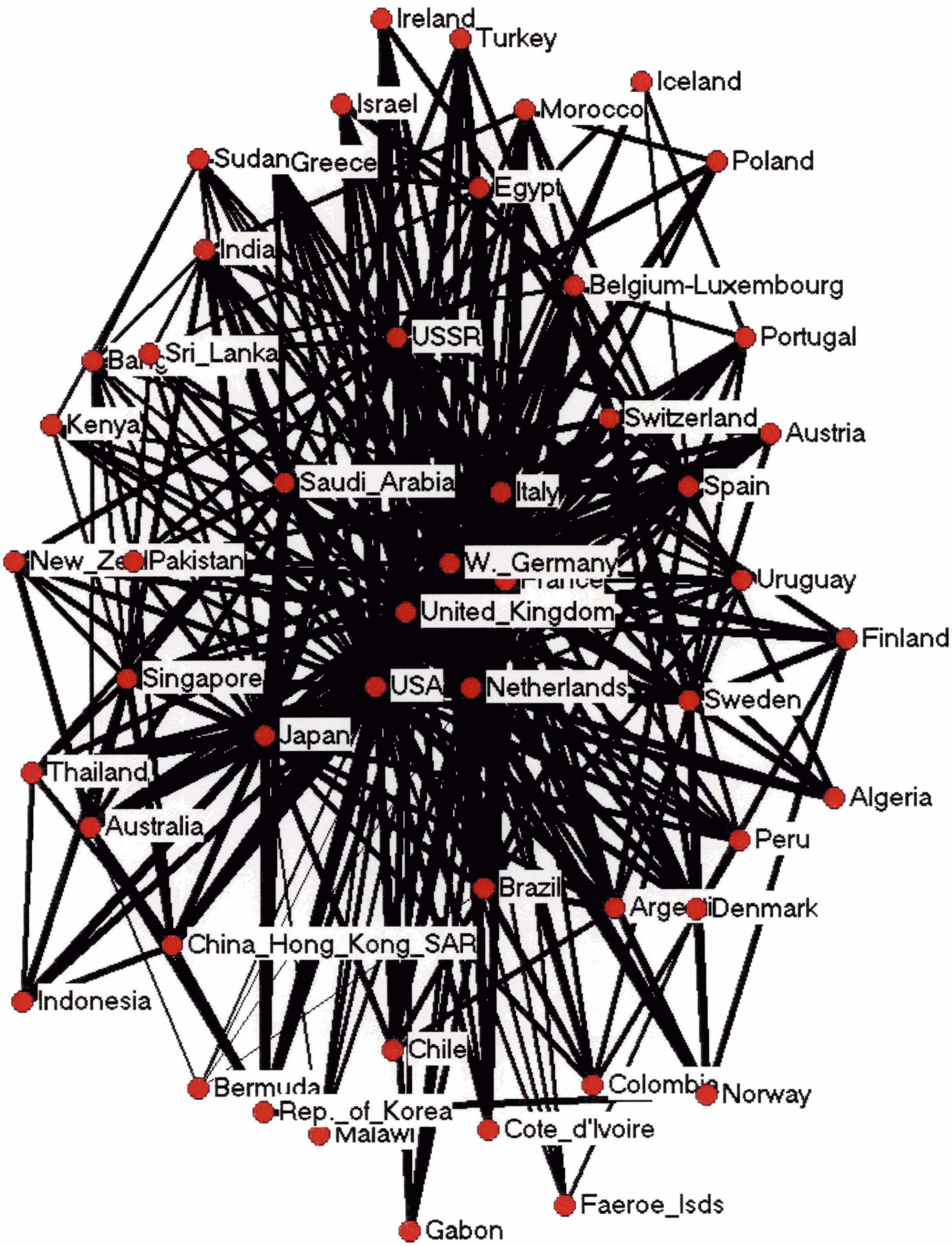

Figure 35: A *k*=6 Latent Clique, with Weighted Relationships and Country Labels

Latent cliques need not always bring together different and unique countries. In another k=6 latent clique from 1982, its membership is dominated by members of the Communist bloc. The relationship is displayed in Figures 36. One interesting note is that West Germany and East Germany do not seem to trade with each other, but they are only separated by two degrees: Yugoslavia, Poland, Czechoslovakia, Hungary, and the Soviet Union all serve as intermediaries for trade flows between the two nations.

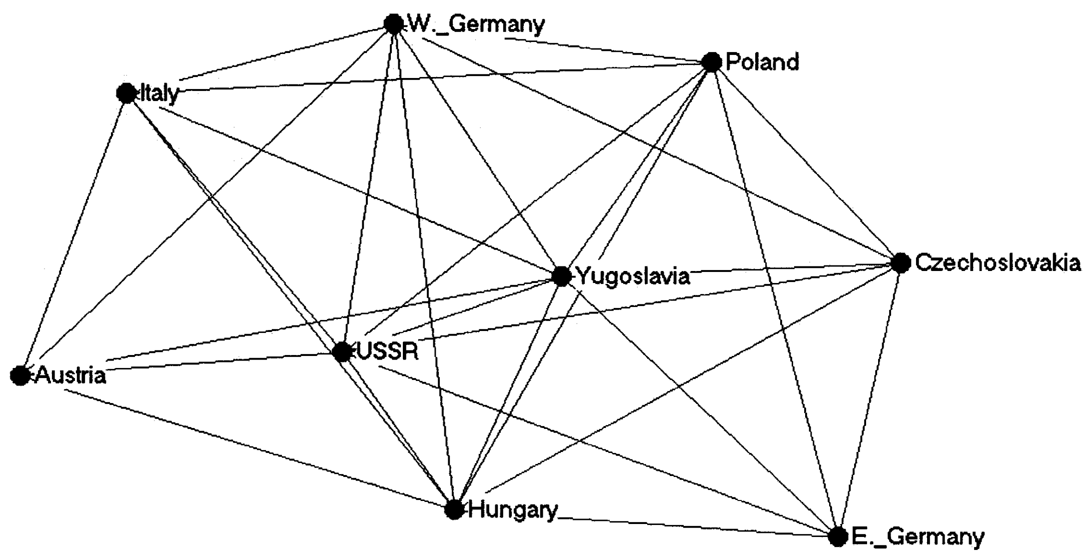

Figure 36: A Second *k*=6 Latent Clique in 1982, with Country Labels

In Figures 37-40, we show the interactions of the two latent cliques. From the country-labeled networks in Figures 38 and 40, one can observe that the Communist bloc is concentrated in the bottom section of the graph. Interestingly, the NATO countries have positioned themselves to be the intermediaries between the Communist bloc and the rest of the nations of the world. These diagrams show economic containment. Perhaps because of their centrality to the international system, the NATO bloc survived, while the Communist bloc is no longer with us. In other words, for Marx's revolution to succeed, either (1) some of these central countries had to be successfully overthrown; or (2) the

Communist countries had to be better occupy the central sections of the overlap; or (3) the notion of the national economy gave rise to a unified economic system.[88]

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[88] On this third possibility, Hirst and Thompson convincingly show that the international economic system is one of inter-nationalization rather than one of globalization, as the national markets are the main component of the economic system (2002). Marx, however, expected globalization to supplant national markets with the unification of workers across the world. This movement was the basis of the Marxist revolution.

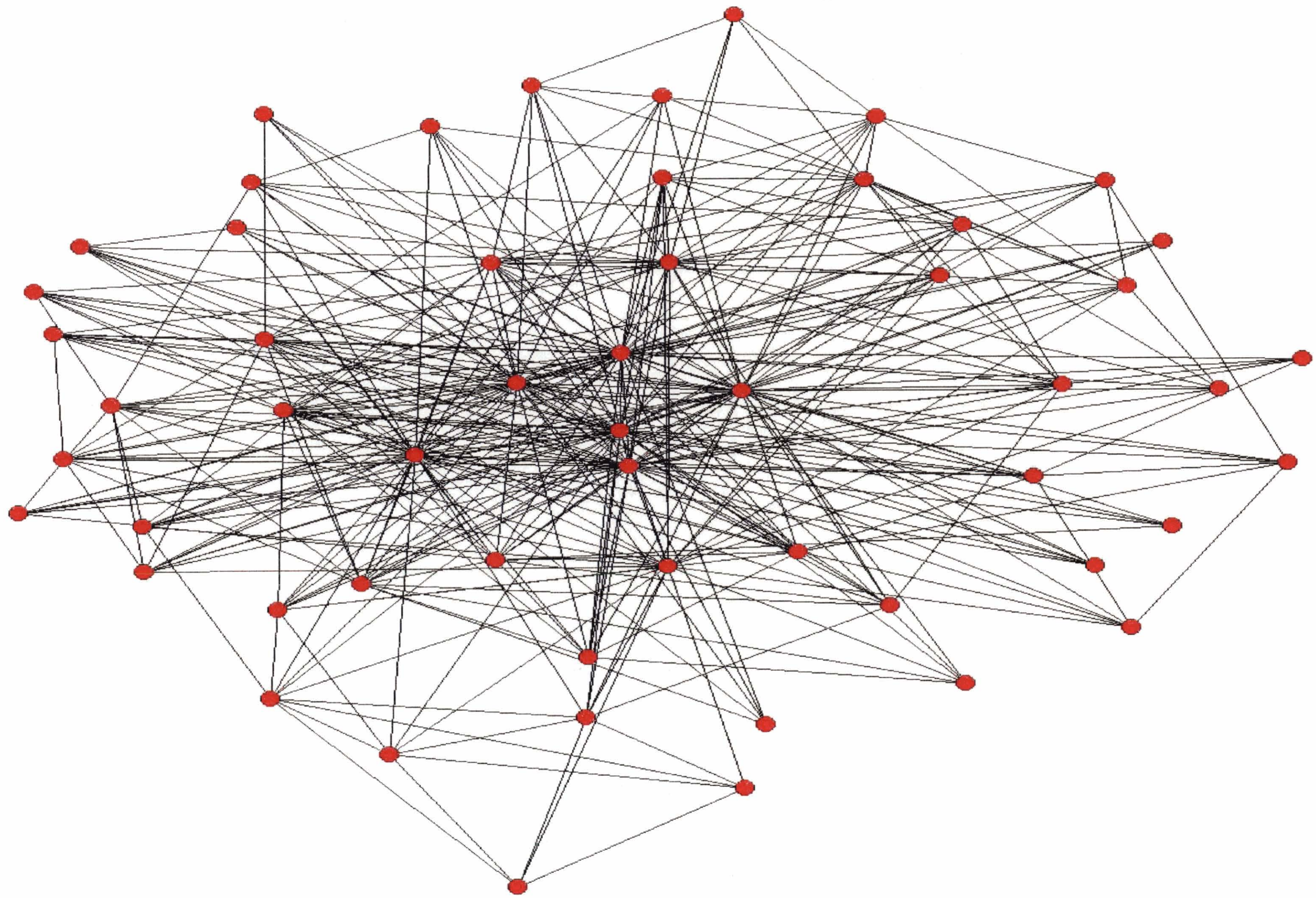
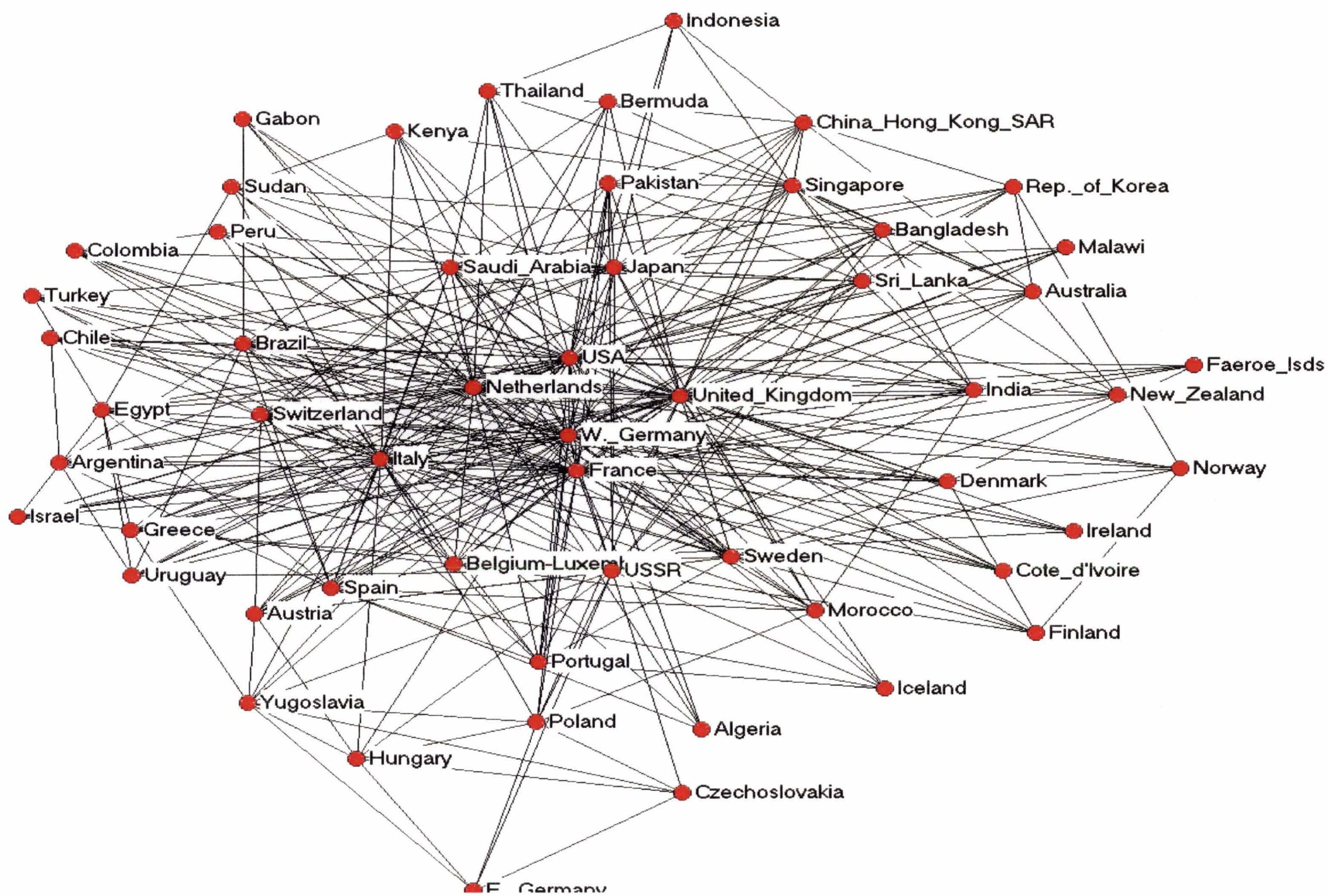


Figure 37: The Interactions Between Two k=6 Cliques in 1982



] gure 38: The Interactions Between Two k=6 Cliques in 1982, with Country Labels

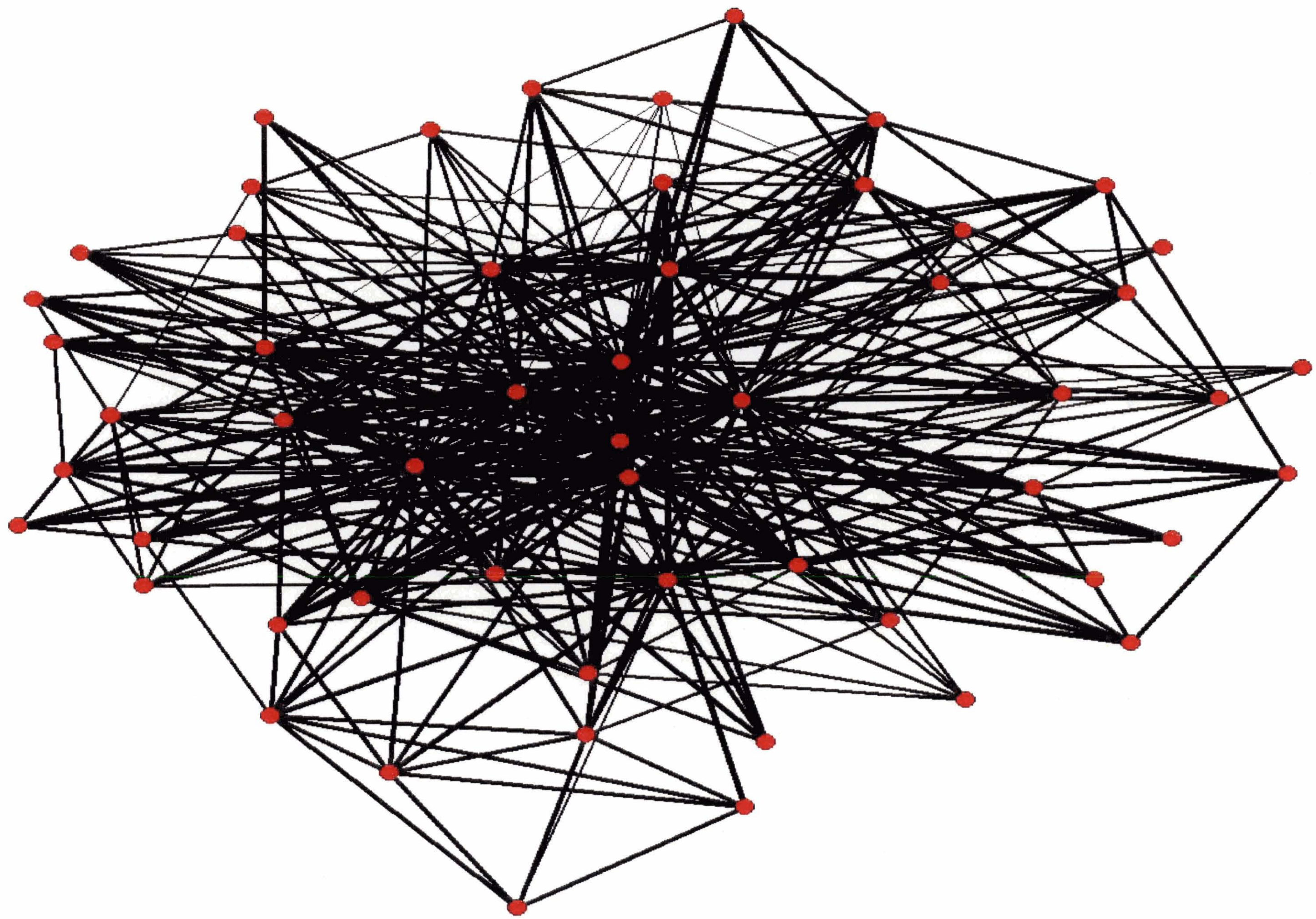
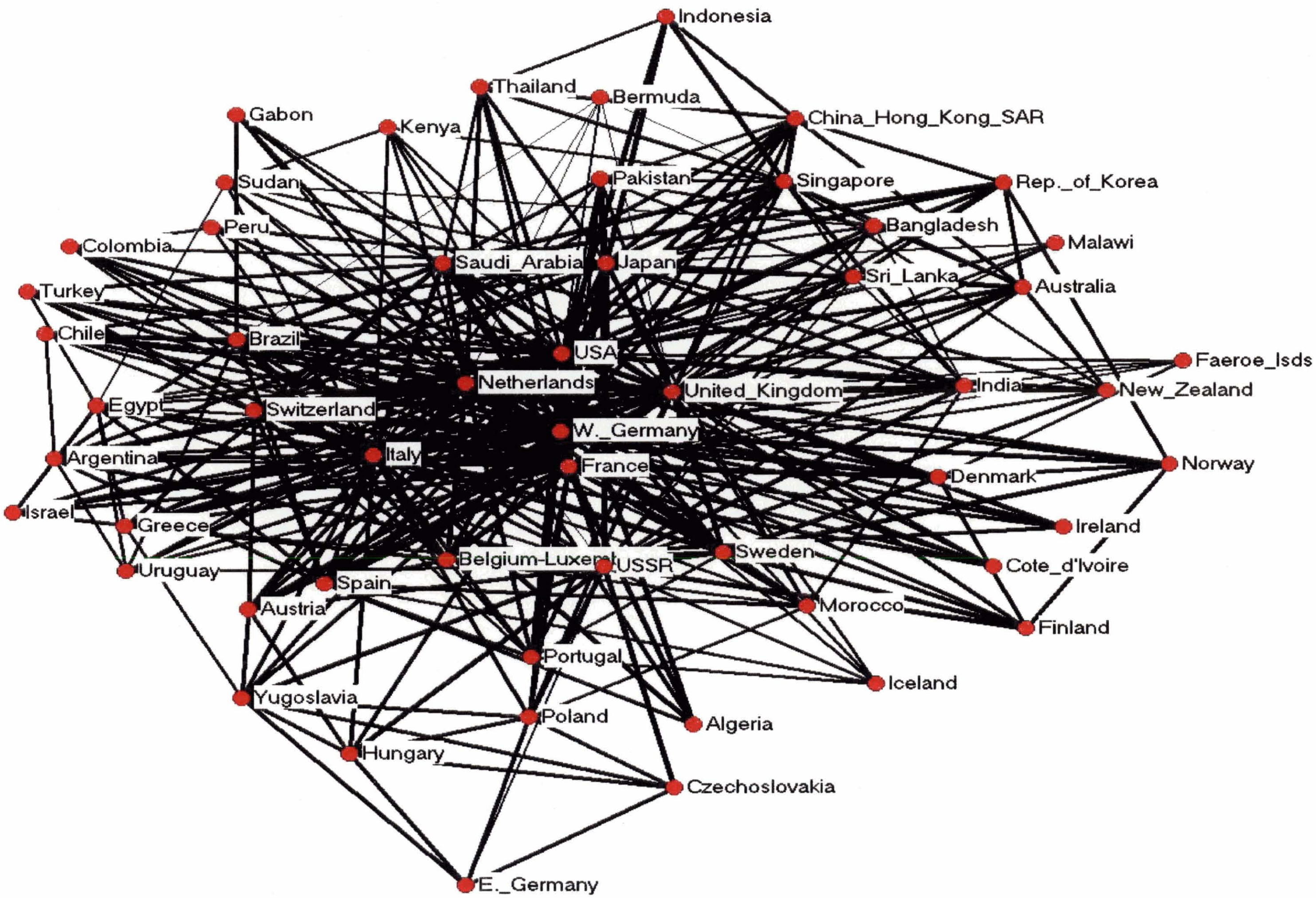


Figure 39: The Interactions Between Two k=6 Cliques in 1982, with Weighted Relationships



Fi ure 40: The Interactions Between Two k=6 Cliques in 1982, with Weighted Relationships and Country Labels

Latent Submacro Systems in 2002

The period between 1982 and 2002 saw dramatic shifts that changed long-standing conditions of world politics. There are two conditions that are especially notable. First, the collapse of the Berlin Wall and the fall of the Soviet Union symbolized the conclusion of the Cold War. Following the Cold War, the next decade would be one where integration of the international economic system was celebrated and championed. The second condition affecting international politics was the spread of free trade. Attempts were made to integrate the formerly-Communist countries into the larger economic system; the GATT – reborn in 1995 as the World Trade Organization (WTO) – encouraged cooperation and free trade amongst the nations of the world, while governmental- and non-governmental-organizations alike helped to speed the economic development of several less-developed countries. In addition, technological advances changed our interactions at the individual level by bringing us closer together, in no doubt affecting the proximity among nations as well. The chart in Figure 41 shows just how much more interconnected the nations of the world have become over time. Taking the normalized average degree of separation from 1962-2003, we see a gradual drop in the amount of separation, with a recent increase following 2001.[89] This graph shows that the *small world phenomenon* is not contained to individuals, and that the world is on track to become even smaller.

[89] We explain how the Normalized Average Degree of Separation Across Time is produced in Appendix A. We especially had to control for the number of countries in the international system, which has increased considerably over the past forty years. Despite the fact that we control for the existence of more countries, we still see a trend towards increasing interconnection. We speculate that this increase is the result of the 9-11 terrorist attacks in Chapter 5.

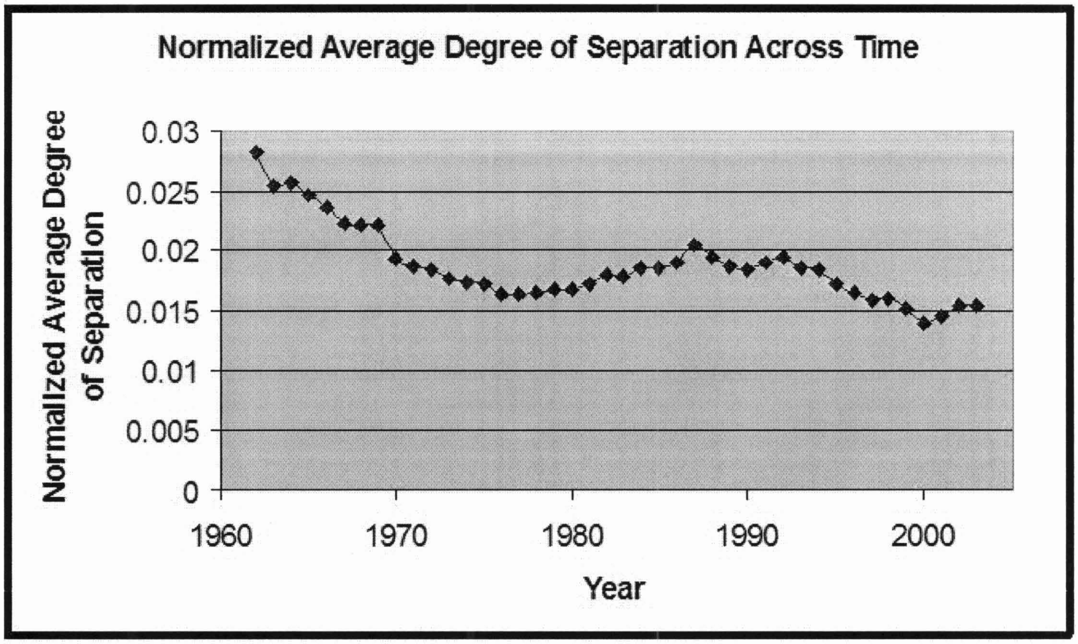


Figure 41: Normalized Average Degrees of Separation Across Time

Between 1982 and 2002, to say that several changes happened in the context of the international system is an understatement. But we again see that for the most part, membership in our high-*k* clique remains unchanged. How is the international system changing? Recall in Figure 20, we presented the highest *k*-clique from 1962, a *k*=9 clique. The countries displayed remarkable equality in their submacro system, forming an Egalitarian Subsystem. In Figure 42, the *k*=10 clique is presented in unweighted form. From the *k*=9 latent clique from 1962, only Switzerland dropped out, and it was replaced by two other European countries, Sweden and Finland. In Figure 43, we include relationship weights for the same *k*=10 clique. Something very interesting is happening here. Of the ten countries that make up the top echelon of trade, the quality of the trade relationships no longer takes the form of an Egalitarian Subsystem. At least four of the countries – Sweden, Finland, the Netherlands and Spain – have much lighter lines compared to their rich counterparts. These countries in particular should be concerned with their tenuous foothold in the upper echelons of the trade system hierarchy.

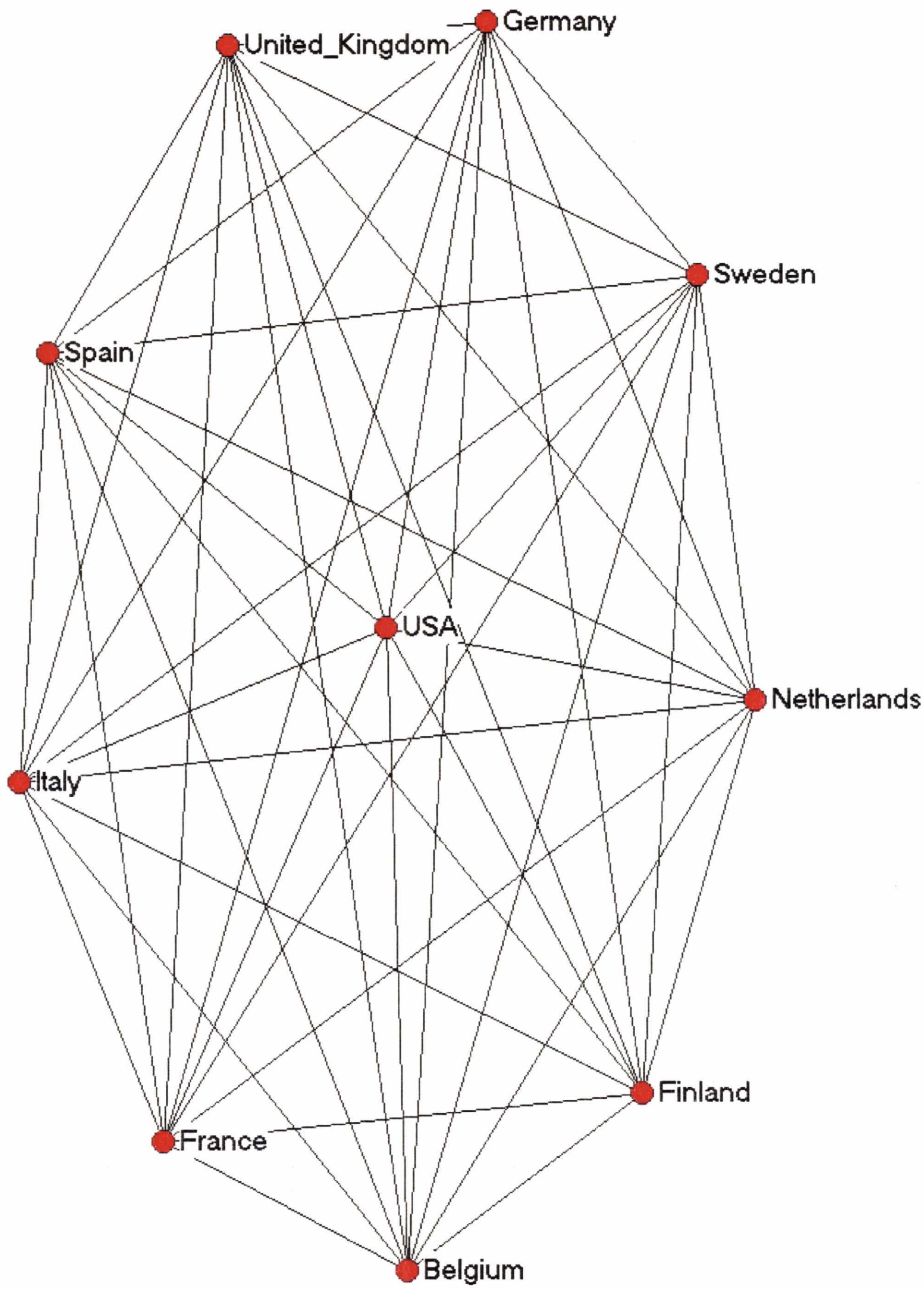


Figure 42: A *k*=10 Latent Clique in 2002, with Country Labels

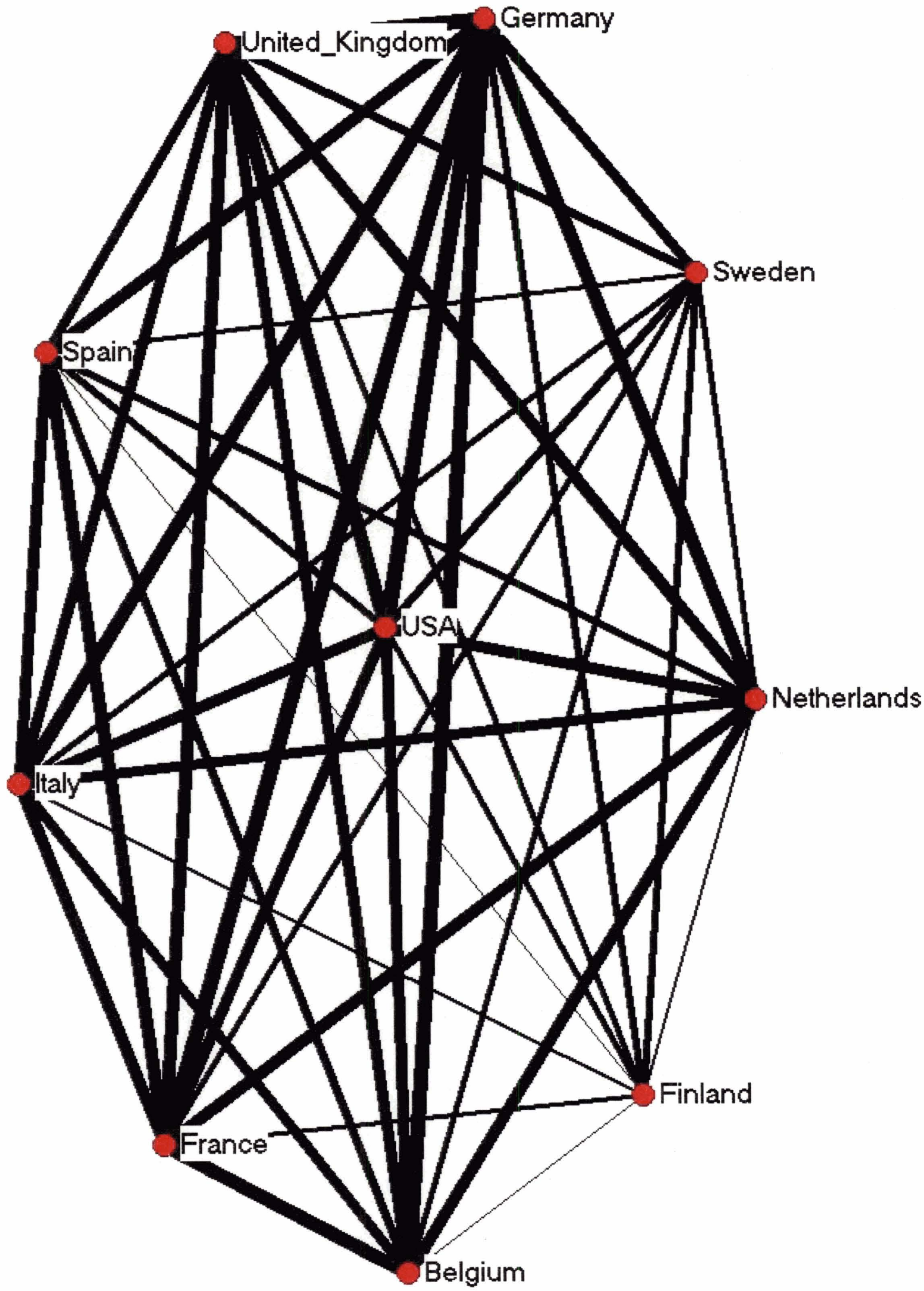


Figure 43: A k=10 Latent Clique in 2002, with Weighted Relationships and Country Variables

Robert Gilpin calls the time period following World War II the *Pax Americana*, where the United States assumed the leading role in the international system, a system which he identified as one of Hegemony and single-node domination (Gilpin, 1984). However, *Pax Americana* in terms of trade seems to be a post-1962 development. If we look at the degree distributions of the top ten countries in 1965 and 2000, it appears as though the United States has increasingly separated itself from the rest of the pack during this time period.

1965				**2000**
Degrees	**Country**		**Country**	**Degrees**
76	United Kingdom	1.	USA	116
75	USA	2.	Germany	88
67	W. Germany	3.	United Kingdom	84
52	France	4.	Italy	73
43	Italy	5.	France	72
41	Japan	6.	Netherlands	65
40	Netherlands	7.	Japan	54
32	USSR	8.	China	40
27	India	9.	Spain	40
22	Spain	10.	Russia	37

Table 3: Top Ten Countries in 1965 and 2000 in Terms of Degrees in the International Trade System

That this change has occurred in conjunction with the rise of free trade is puzzling. One of the purported benefits of free trade is that it should create a more stable system by increasing economic flows throughout the international system. The logic of free trade also suggests that through increased trade, the absolute wealth of a given nation will increase, benefiting the elements within a nation. However, the relative position of the nation in the international system changes as well. Free trade may be making some countries rise at the expense of isolating others. This may just be the tip of the iceberg: to fairly weigh in on the consequences of free trade in the international system, more research needs to be done using graph theory.

In 2002, CFinder identified sixteen different latent cliques: one k=10 clique, one k=9 clique, five k=8 cliques, one k=7 clique, one k=6 clique, four k=5 cliques, three k=4 cliques, and one k=3 clique. In previous years, we would usually only observe Scale-Free Subsystem within the lower-k cliques, typically finding Egalitarian Subsystems in abundance among the higher-k cliques. However, throughout the cliques in 2002, there is a rise in the frequency of Hub-Spoke Subsystems, or subsystems common to a Scale-Free Network, with a few Hub nodes and several Spoke nodes. In Figures 44 and 45, we display a k=7 clique with weighted relationships, with Figure 44 having no country labels for visual purposes. Observe the centrality of certain Hubs, surrounded by a larger coterie of Spokes. In 1962, the countries in this latent clique would have been far more equal: we would not have been able to readily identify Hubs or Spokes. Instead, we can now observe that the United States, the United Kingdom, and Germany are Hubs in this graph, while Ethiopia, Peru, and Lebanon are Spokes. Clearly, divides are becoming more prevalent in the subsystems, suggesting that divides may be more prevalent in the context of the international system as a whole.

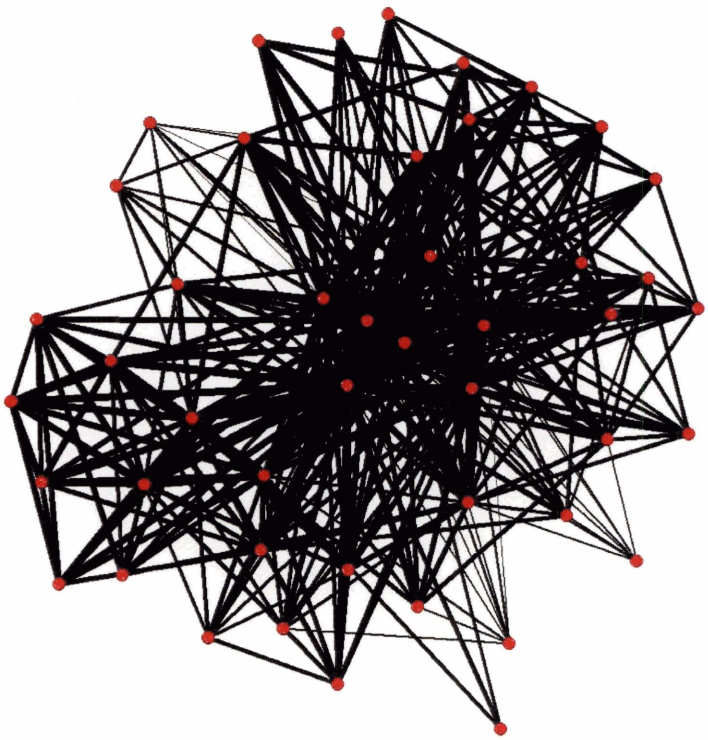


Figure 44: A *k*=7 Latent Clique in 2002

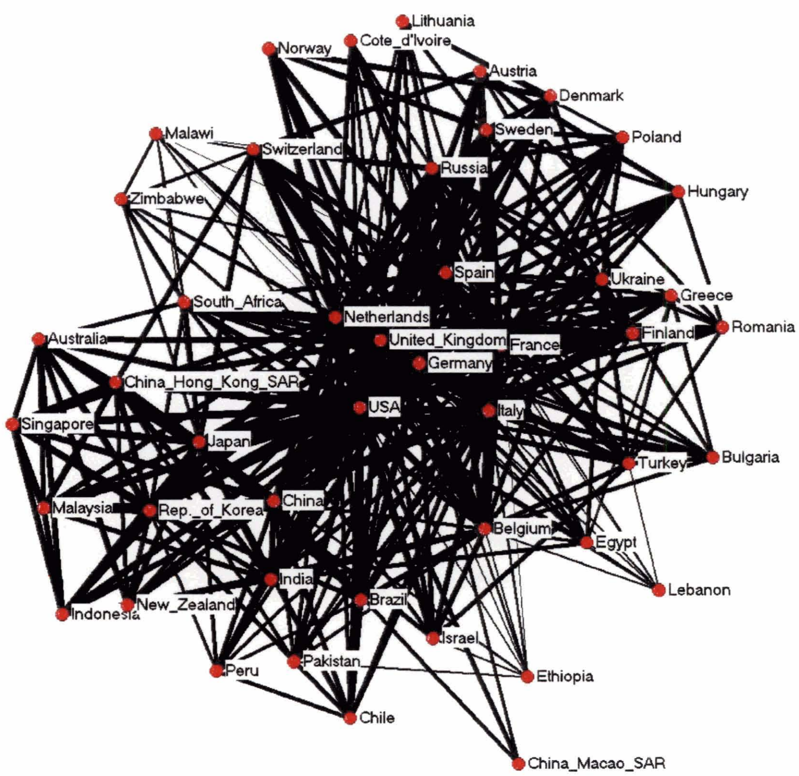


Figure 45: A Weighted *k*=7 Latent Clique in 2002, with Labels

Chapter Summary

Submacro systems cannot simply be defined along just one dimension: to capture all of the submacro systems prevalent in the international system, one must either examine all social, political, economic, and geographic groupings or one must use latent clique analysis. In this chapter, we have found some important characteristics by examining the structure of these latent submacro systems. Among these observations, we find that a high-level clique of Hubs exists at the top of the trade hierarchy. We also observe that certain countries serve vital inter-clique connecting roles, which make them particularly important for the stability and interaction of these groupings. We also see that some types of cliques are more homogeneous than others in terms of trade-sharing. Some cliques are Egalitarian Submacro Systems, while others resemble the international order by appearing as Hub-Spoke Submacro Systems. In 2002, several more Hub-Spoke Submacro Systems appeared, even amongst the higher-k cliques, suggesting that even among the rich nations of the world, hierarchies are forming and gradients are being created that did not exist before. Such changing dynamics may be prevalent throughout all types of cliques, both latent and formalized. In the next chapter, we further examine the findings of the submacro analysis, with the express desire of identifying the hierarchical structure of the international trade system. In the following chapter, we consider the commonalities between both latent and formalized subsystems. We further explore the effects of these subsystem characteristics upon nations and upon the international system.

CHAPTER 5: INTERDEPENDENCY IN THE INTERNATIONAL SYSTEM

Overview

In this chapter, we examine the roles of international organizations in the international trade system. We proceed by considering the best macro level organizational form for reducing contagion. We then examine the effects of trade blocs on member nations, finding that the principle of varying interdependence affects the success of trade blocs.

Stability in a Scale-Free Network

In Chapter 3, we provided evidence that the macro trading system adheres to a Scale-Free Network, meaning that it is a network in which there are a few large Hubs surrounded by many more inferior nodes, or Spokes (see Figures 14 and 15). What does a Scale-Free Network suggest for system stability? Cohen, Erez, ben-Avraham, and Havlin examine the Internet, also a Scale-Free Network, in the context of stability (2001). They find that if a node is randomly removed from such a network, the system should not be tremendously affected unless the node removed happens to be a Hub. Albert, et al., confirm these findings, showing that a Scale-Free Network is highly resilient to random events (2002). Since there are a small number of Hubs in such a network, a random event usually should affect Spoke countries, and therefore should not upset the system.

However, when a Hub does get removed, the entire system suffers tremendously. Newman discusses how the removal of a Hub affects the network's resilience (2003). By removing a Hub, the typical length of the paths between other nodes increases, ultimately making vertex pairs disconnected and separated (ibid). Flows drastically slow down, not just between the Hub and its corresponding nodes, but among all nodes in the system (Cohen, et al., 2001; Albert, et al., 2002; Newman, 2003). Fortunately, in a random setting, since a Hub is infrequently removed, a Scale-Free Network should be quite stable. However, Cohen, et al. and Albert, et al. both recognize that Internet Hubs are frequently targeted by hackers in non-random and intentional attacks (ibid). Similarly for the international trade system, the adverse effects of non-random targeting such as terrorism on trade are amplified when a Hub country is targeted.

A natural case study is formed by the 9-11 terrorist attacks, which shut down the United States' political and economic capitols for several days. These attacks affected the entire trade network long after the initial United States' shutdown, as trade slowed and relationships were redrawn. Recalling the normalized average degree of separation figure in Chapter 4, the average degree of separation began to increase in 2001. Were these attacks to occur in another non-Hub country, we doubt the macro stability would have been so drastically affected. Consider that since 9-11, there have been 14,098 terrorist incidents, with an estimated 19,418 casualties, according to the MIPT Terrorism Knowledge Base (2006).[90] While these incidents are indeed tragic, none of them affected the overall macro trade network as drastically as the attacks on the United States.[91]

Scale-Free Networks are incredibly resilient to random effects, but they are vulnerable to targeted attacks. Scale-Free Networks are also vulnerable to contagion effects, or cascading failures (Newman, 2003). Cascading failures are especially

[90] These numbers represent the number of terrorist incidents from September 12, 2001 to April 30, 2006.

[91] One who is suspicious of the claim that terrorist attacks on Hub countries impedes the international trade system can cite many examples of terrorist attacks against the United States that did not affect the trade system, including the Oklahoma City attacks and the various attacks on US embassies. However, in order for a terrorist attack to have the effect described above, the Hub needs to be removed from the system: the longer the amount of time the Hub is removed, the slower the flows in the international trade system. In the other cases, the United States was not so drastically removed from the system.

detrimental in Random Networks with Gaussian distributions of degrees, but if they can proceed through the hierarchies in a Scale-Free Network, the cascade may be detrimental to the macro system (Watts, 2002). To understand how cascading failures may affect the trade network, lets consider the different hierarchy structures in the international system.

In Chapter 3, we discussed the five hierarchies identified by Dodds, et al. in the international system (2004). In Figure 46, we re-display the hierarchies. These hierarchies are *Random, Random Interdivisional, Core-Periphery, Local Team, and Multiscalar*.

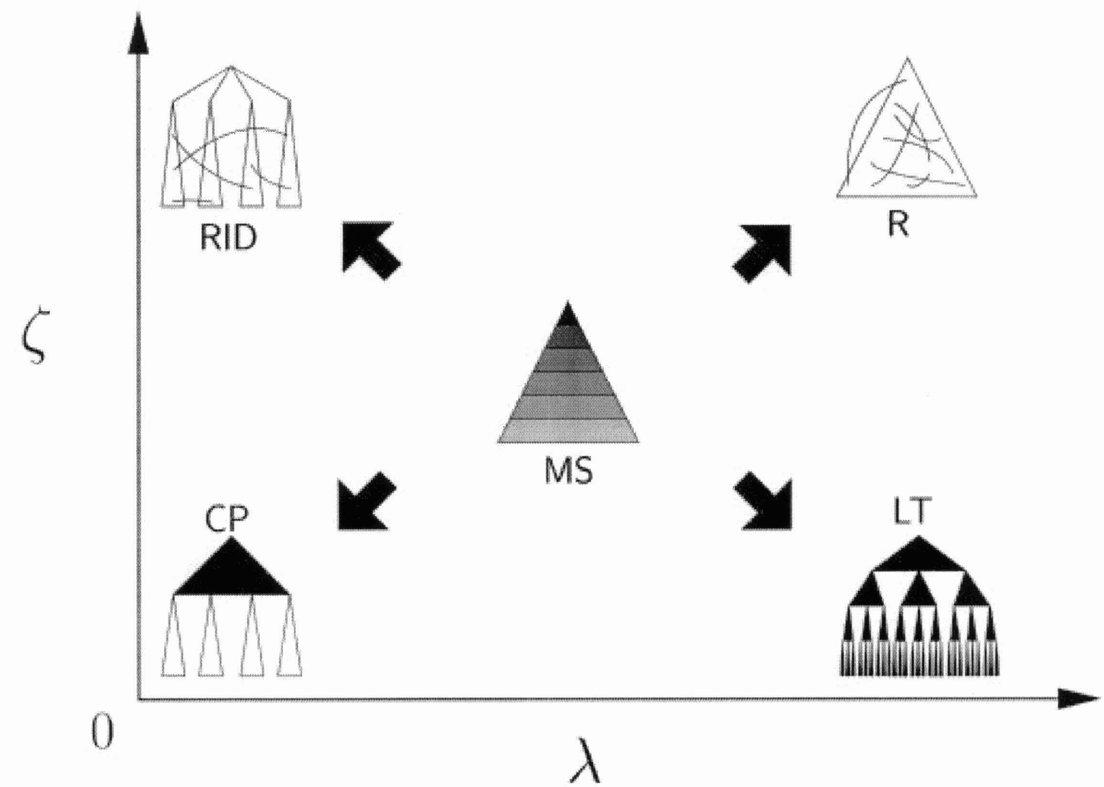


Figure 46: Possible Hierarchical Structures from Watts, et al., 2004

Looking at the macro system, we ruled out the possibility of a Random or a Random Interdivisional Hierarchy existing across the entire network, as we found that the macro system is actually a Scale-Free Network. However, Random Hierarchies and

Random Interdivisional Hierarchies do exist at the submacro level, as do Core-Periphery Hierarchies and Local Team Hierarchies. Networks can have a variety of hierarchies, and when a network has multiple hierarchies, it enters the Multiscalar region.

One should not simply accept the statement that all hierarchies are prevalent in the international trade system, however, as we have the means of demonstrating it. In order to determine the nature of the macro system, we have to examine the several international submacro systems. Three types of cliques emerge from our analysis, displaying a range of *interdependence*. Rosencrance and Stein identify at least three different ways in which interdependence has been previously conceived in IR:

> "In its most general sense, interdependence suggests a relationship of interests such that if one nation's position changes, other states will be affected by that change. A second meaning, derived from economics, suggests that interdependence is present when there is an increased national "sensitivity" to external economic developments...The most stringent definition comes from Kenneth Waltz, who argues that interdependence entails a relationship that would be costly to break" (1978: 2).

We adopt the most general sense of the term, that if one nation changes itself, other states will be affected by that change.[92] The amount that a nation will be affected by another nation depends upon the form of interdependence. In terms of latent cliques, interdependence ranges from cliques with one Hub and several Spokes to cliques with multiple Hubs and several Spokes to cliques with several countries of the same hierarchical type. In each case, if one nation changes itself, other states will be *differently* affected by that change.

The first clique formation we shall label a *Pure-Dependent Submacro System*. In this clique, a Hub country is crucial to tying the flow of international trade to the rest of

[92] In reading the literature, we were struck by the number of authors who would discuss interdependence without defining the term.

the clique and therefore, these Spoke countries are solely dependent upon the Hub. Take, for example, a *k*=4 latent clique from 2002, as shown in Figure 47. The other countries in the latent clique are functionally dependent upon the United States to connect to the larger trade network. Excluding the United States, the average clustering coefficient of the group is 0.6786, much higher than the United States' 0.4190 coefficient.[93] As a result, power is heavily concentrated with the United States and we would expect to see the United States able to coerce these other countries if necessary.

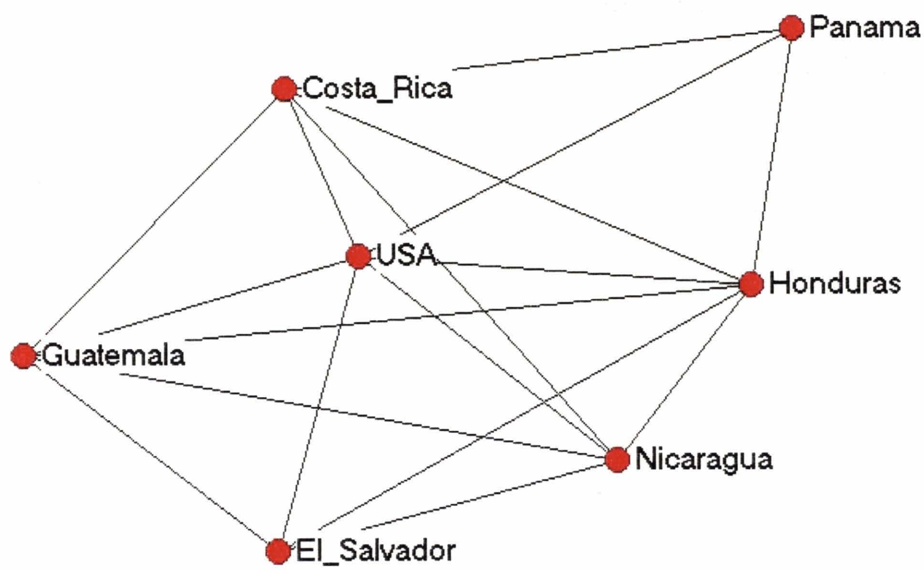


Figure 47: A *k*=4 Latent Clique from 2002, with Country Labels

Hirschman empirically demonstrates that large trading countries have a preference to interact with smaller trading countries (1980). Hirschman explains that given two countries, a strong one (Country A), and a weak one (Country B), Country A has an interest in monopolizing the trade of Country B, and Country B has an interest in "splitting its trade equally among as many countries as possible in order to escape too great a dependence on one or two great markets or supply sources" (ibid: 85-86). The

[93] This represents the United States' highest clustering coefficient. Again, we believe that part of this effect of increased United States insularity is due to the terrorist attacks the year before.

logic for such a struggle is simple: trade dependencies give the dominant country the ability to affect the weak country, both in terms of economic coercion as well as social and political coercion. In addition to statistical analysis, Hirschman also offers a convincing case study in Nazi Germany. Hirschman observes that the Nazis used trade relations to first penetrate, and then dominate countries in several areas, especially in Southeast Europe.

Hirschman's work is focused upon dyadic relationships, but his theories can be extrapolated for the rest of the international system, offering several interesting insights. For instance, having a large trade deficit is not so detrimental for a Hub if other countries are becoming increasingly dependent upon that country, particularly if that Hub is a Hegemon. The Hub is gaining relatively to the other countries in the system, making it more integral to the stability of the system. If that country collapses, other countries are equally in trouble.

This clique formation most closely conforms to a Random Interdivisional Hierarchy, but it may occur *within* a larger Local Team, Core-Periphery, or Multiscalar Hierarchy. When a Random-Interdivisional Hierarchy is in place, a certain country may prove crucial to tying the horizontal flow of trade between two cliques. In Figures 48 and 49, a hypothetical example is provided, stylized from real network analysis.[94] We have presented it to better explain the Gatekeeper relationship we briefly mentioned in Chapter 4. The left clique shows an Asian-based clique; the right clique includes several European nations. Notice how the United States serves as the key intermediary in trade between these two groupings. Such countries are *Gatekeepers*, as they have the ability to

[94] These images were made with incomplete data for 1965. When the missing data was included and the spring embedding displaying program was run, the relationship was not as apparent. Figures 44 and 45 best show what we are trying to explain, but they should be considered illustrative, not factual.

regulate interactions between the submacro groupings. Gatekeepers can influence other nations by their positions not just in the macro system, but also by their positions between cliques. Gatekeepers need not only be Hub countries. We observed Pakistan serving as one of many Gatekeepers in 1982. In the 1980s, aid flows to Afghanistan from the Soviets and the West made Afghanistan play a Gatekeeper role in the international aid system. Such a role as the intermediary helped Afghanistan avoid capitulating to Soviet coercion as the Western clique fought to protect its sovereignty during the Soviet invasion of the 1980s.

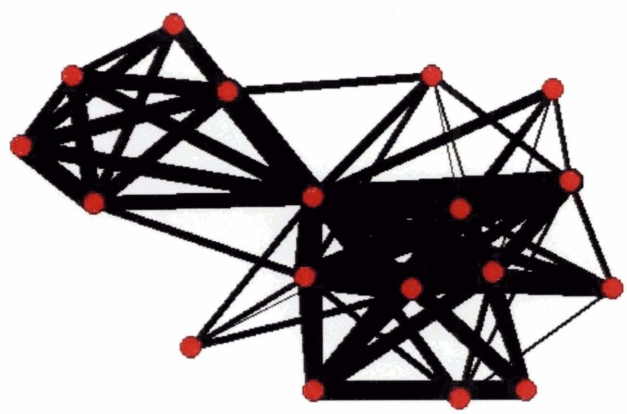


Figure 48: Hypothetical Trade Clique Interactions

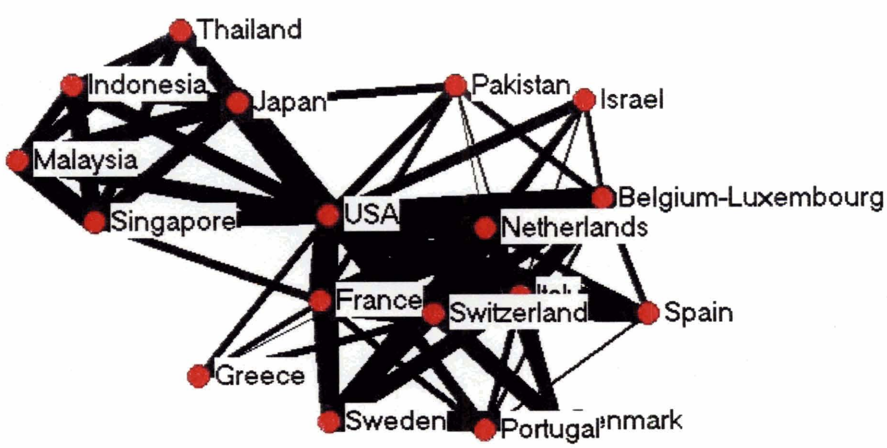


Figure 49: Hypothetical Trade Clique Interactions, with Country Labels

Applying Hirschman's logic to submacro system dynamics, dominant countries not only have an incentive to minimize other Gatekeepers, but they should strive to become Gatekeepers themselves. If a country can fully control a submacro system and serve as the submacro system's only link between those Spokes and the rest of the international order, that Hub country will rise in relative and absolute power. For the United States, such was the logic of the Monroe Doctrine of the 1800s. Discovering those isolated cliques in order to connect them with the larger world trade system also drives trade expansionism today in much the same way as colonialism and mercantilism influenced country policies over the last five-hundred years.[95]

Further examining Hirschman's paradigm, Hubs would have an interest in breaking down other Hubs' monopoly power, or at the minimum, Hubs would want to see trade relationships develop among a rival country's Spokes and the international system. For example, it is beneficial to the Europeans that Japan, China, and South Korea are increasingly competing against one another while vying for better positions in the macro system, so long as one of these countries does not emerge on top and so long as these countries do not join forces in some super-national structure. If China emerges as the dominant country in East Asian trading circles, with subordinates of the caliber of Japan and South Korea, China would instantly enjoy greater position in the trade system.

We do find cliques with multiple Hubs. In these cliques, Spoke countries are not completely dependent upon a sole Hub and connect to the international system through an alternate route. As a result, if one Hub introduces a form of coercion on the Spoke, the Spoke has the ability to resist by turning to the other Hub, tempering the coercive

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[95] The key difference being that a Hub country will typically tolerate a higher level of autonomy to a Spoke country's domestic sphere, recognizing that it is in the Hub country's interest to have the Spoke country enjoy and support the involvement of the Hub country.

ability of the original Hub. Within such a submacro clique, there is a system in effect whereby each Spoke has a level of autonomy from its multiple Hub partners, and thus we classify such clique relationships as a *Multi-Dependent Submacro System*. One such clique, a k=5 clique from 1984 is presented in Figure 50. Notice how West Germany and the United States, each with high clustering coefficients and significant trade participation across the world, share the markets of Costa Rica, Guatemala and El Salvador. In such a condition, the Spoke countries are stronger because if one Hub country engages in coercion, the Spoke countries may turn to the other Hub country for assistance. However, compared to the Gatekeeper relationship, if one Hub country cannot push the other Hub country out of the submacro system, the two Hub countries are likely to increasingly cooperate, forming an oligopoly (Hirschman, 1980).

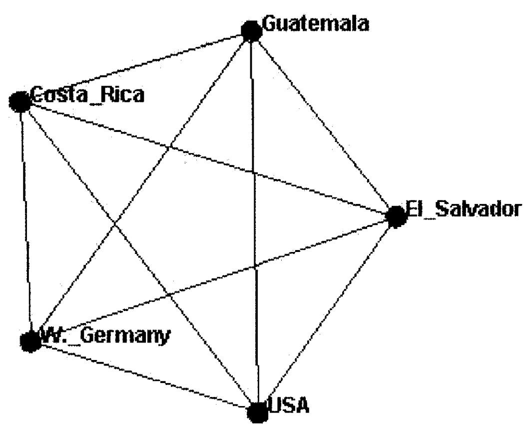

Figure 50: A k=5 Latent Clique from 1984, with Country Labels

Finally, there are latent cliques that are made up of countries which are mutually dependent upon one another. Most of the high value k-cliques are such communities, and they are usually solely comprised of Hub countries. The latent clique presented in Figure 51 is one such clique. This clique formation is an *Equal-Dependent Submacro System*, whereby the resilience of the system is highly contingent upon each of the members of the community. These upper-level cliques are the closest approximations of Egalitarian Networks observed in the international trade system.

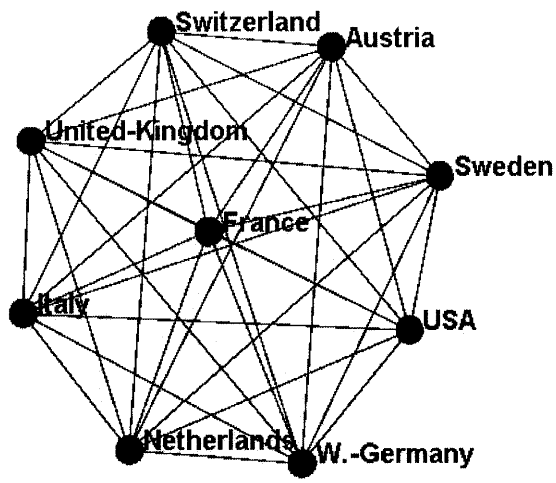

Figure 51: A k=9 Latent Clique from 1964, with Labels

In terms of hierarchical possibilities, such a clique displays high *homophily*, or high interconnection between its members. This clique is necessary for a Scale-Free Network, and it is necessary for Multiscalar, Local Team, and Core-Periphery Hierarchies. Such a small and exclusive latent clique would not be found in the Random or Random Interdivisional Hierarchies as it would not occur in a purely Random Network.[96]

Combined, this evidence suggests that a Multiscalar Hierarchy exists, as we do see elements of Random Interdivisional and Random Hierarchies, as well as elements of Core-Periphery and Local Team Hierarchies. Just as we would expect in a Multiscalar Hierarchy, we do observe some level of homophily, or horizontal trade, but we also

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[96] A clique like this one may occur in an Egalitarian Network if the population was limited to only these countries.

observe a significant amount of vertical trade as well. As one moves vertically up the hierarchy, higher and higher levels of homophily are present.

We shall now put the components together. Recall the upper echelon *k*-cliques and the countries with the top ten degree distributions in Chapter 4. The macro system is governed by a network of such Hubs heavily interacting with one another. Typically, the Hubs are European or Western, but in recent times, other countries such as India and China have joined the higher levels of trade. In Figure 52, we display the theoretical structure of the upper echelon, as justified by our macro and submacro level analyses. It is not surprising that such a structure resembles what we would expect in a Balance of Power System, with several Hubs of approximately equal trade capabilities.

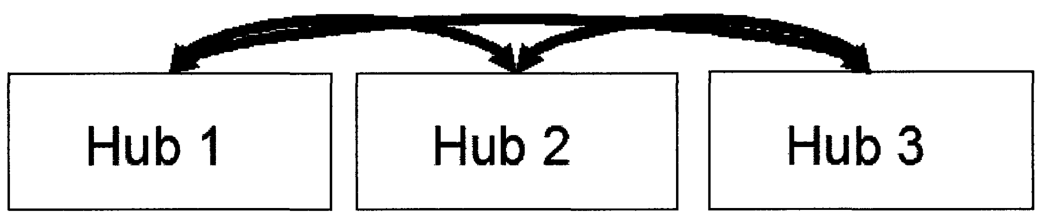

Figure 52: The Theoretical Upper-Echelon

In Figure 53 and Figure 54, we present two theoretical double-level, Multiscalar hierarchies distinct from those of Dodds, et al. In Figure 53, we offer an international system with only Pure-Dependent Submacro relationships in the vertical frame. In Figure 54, we depict an international system laden with Multi-Dependent relationships. The edge thickness in each Figure represents the homophily: notice that the edges between the Hubs are thicker than the edges between the Hubs and Spokes. Also, in the real-world hierarchy, there are many levels, with intermediary components connecting countries in a far more complex pattern than what is presented below. We posit that the international system lies somewhere in between these two structures, with the modern-day trend approaching Figure 54 as the degrees of separation between nations reduces. We suspect this transition because in our analysis, we do see a drop in the average degree of separation, and in the real-world we do hear of greater involvement by Hubs in so-called "emerging markets."

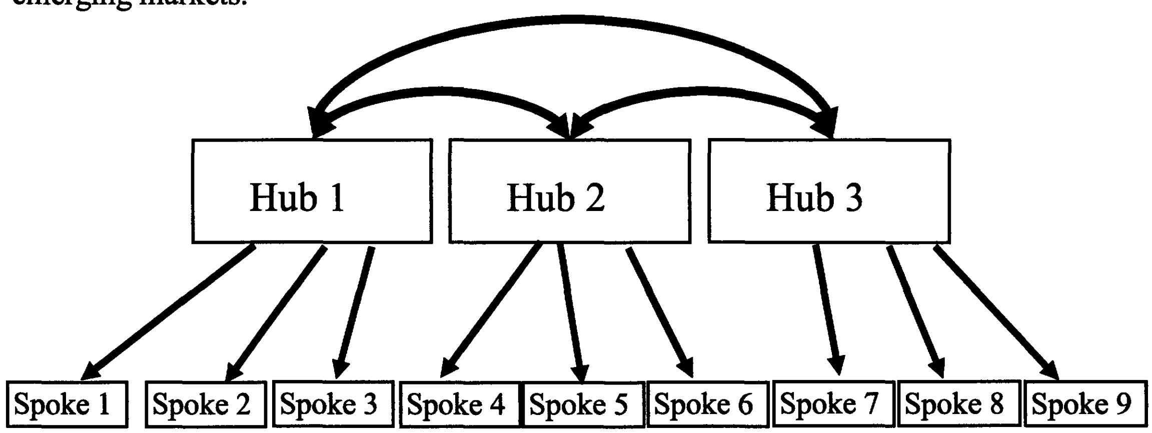

Figure 53: The Upper-Echelon with Spokes Connected Through Pure-Dependent Submacro Relationships

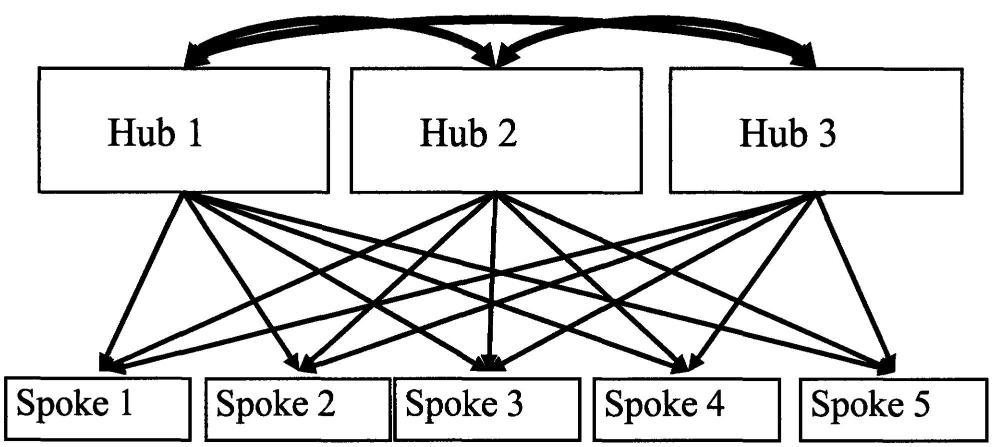

Figure 54: The Upper-Echelon with Spokes Connected Through Multi-Dependent Submacro Relationships

Reconsidering cascading failures, in either structure such contagion effects should tend to spread either horizontally or descend through the system. Additionally, due to the high homophily in the upper echelons of the trade hierarchy, the upper echelon members should be more or less resilient when faced with bottom-up disturbances depending on this homophily relative to the amount and depth of interconnections between the Hubs and the Spokes.

Some Shortcomings in Graph Theory

We closed Chapter 4 by mentioning that we are potentially observing increasing stratification in the higher echelons of the trade hierarchy. If this stratification were to increase substantially, the upper-most echelon would not be filled by a group of countries, but instead one country would occupy the upper spot. This change would be nothing short of a shift from a Balance of Power System to a Universal System of Hegemony (Kaplan, 1957). What would happen to system stability if we saw the rise of Hegemony? Graph theory is still an emerging discipline, and it was not initially developed as a tool for understanding the international trade network. For this project, we scanned the major journals in graph theory,[97] we read the defining books,[98] and we talked to scholars from across disciplines.[99] Between all of these sources, we were able to answer many questions utilizing the techniques of graph theory, but by analyzing international trade, we stumbled across several of the current limitations of the disciplined that should be addressed in the coming years. What follows are some observations on these limitations.

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[97] *The Journal of Social Structure, Physical Review Letters,* and *The Proceedings of the National Academies of the Sciences* are among those major journals.
[98] Barabási's *Linked: The New Science of Networks* (2002) and Watts' *Six Degrees: The Science of a Connected Age* (2003) are the best starting points.
[99] In addition to the biologist (Ramy Arnaout), the electrical engineer (Behram Mistree), and the mathematician (Han Yin Lin) mentioned in the acknowledgements, we also engaged in discussions of graph theory informally with several graduate students in MIT's Engineering Systems Division (ESD) and even with a Sloan doctoral candidate, all of whom had pursued approaches to graph theory in the contexts of their own fields.

If we saw a rise in Hegemony, we speculate that trade stability in such a Hegemonic System would depend upon the stability of the Hegemon, but we would also expect the countries in the next-highest echelon to somehow cooperate to resist the Hegemon. Further research in graph theory needs to be conducted in this arena to address issues of Hegemonic stability and other Multiscalar hierarchical possibilities.

Along these lines, more research in graph theory needs to be conducted on evolving networks.[100] Most networks are static in the sense that their structure does not change over time. From 1965 to 2000, we found that the overall structure of the international system has remained a Scale-Free Network, but we do recognize that there have been changes in hierarchical structures (especially in submacro groupings), and we also recognize that the hierarchical structure may be changing so drastically that the macro system may be affected.[101] Advances in understanding why networks change and understanding the ramifications of these evolving networks would be extremely relevant to our analysis.

Chapter Summary: Reconsidering the East Asian Crisis

In Chapter 1, we opened this thesis with a discussion about the spread of economic collapse across several East-Asian economies. During this event, looming in the background was the fear that the spread of economic collapse would afflict the larger countries in the Asian economic sphere, potentially bringing about international depression. Would such cascading failure have been possible? Our findings in Chapter 5 suggest that such failure would not have been possible as contagion rarely percolates

[100] Unfortunately, the title for such a work has already been taken by Dorogovtsev and Mendes, who have written a book entitled *Evolution of Networks* (2003), but the content of the book is about the evolution of graph theory rather than how networks may change.
[101] Rumored among students at ESD is that changing networks will soon be a primary focus of research in their labs.

upwards. Interestingly, we are supported by traditional statistical methodologies. Thanyalakpark and Filson find that the collapse of the Asian region's equity markets displayed interdependence, but little contagion effects (2001). Unfortunately, Thanyalakpark and Filson do not define interdependence, nor do they recognize variances in interdependence. Without considering trade hierarchy positioning, Thanyalakpark and Filson only paint half of the picture.

In the next chapter, we shall examine solutions for network stability at the macro level. We shall also examine the effects of formalized submacro institutions (in terms of trade blocs) on their member countries, finding again that interdependence affects not just the trade hierarchy of the member countries, but also the success of the trade bloc itself.

CHAPTER 6: INSTITUTIONS IN THE INTERNATIONAL SYSTEM

Overview[102]

From the World Trade Organization to the North American Free Trade Agreement to the Association of South-East Asian Nations, macro and submacro institutions have been formed to aid the flow of international trade and to encourage free trade where it did not exist beforehand. In this chapter, we consider policy solutions to contagions through institutions at the macro level, and then we consider the effects of submacro institutions in the form of trade blocs on member countries.

Macro International Institutions For Stability

The last chapter ended inconclusively: after a long analysis of macro and submacro systems, we offered no substantial recommendations to protect against cascading failures. We did find from the graph theory literature that economic failure in a Multiscalar Hierarchy should flow horizontally and top-down, but it will rarely spread in a bottom-up manner. Indeed, for contagion to spread upwards, a Hub needs to be overly dependent upon countries lower in the hierarchy, and if that is the case, the homophily between that Hub and other Hubs would be low, preventing failure from spreading horizontally. But we made no useful policy recommendations.

Until this point, we have avoided considering international institutions. In our analysis at the macro level, we purposely assumed that nations existed in an anarchic state to determine the most appropriate network structure. Had we assumed that an

[102] The research in this chapter is still a work-in-progress. In the interests of provoking a discussion, however, we have included as much findings from the data as possible, even if the analysis still leaves something to be desired. As a result, the reader should consider this argument a stylized description rather than a robust analysis.

international organization or some other overlying structure completely controlled the international trade system, a graph theory approach would not be advisable. Similarly, in our analysis at the submacro level, we examined latent submacro systems rather than formalized trade blocs or political alliances. Had we looked at institutions at either of these levels, we would not have been able to discover the network structure or the hierarchy of countries, and we would not have been able to identify the nature of stability in the trade system.

However, it is now useful to consider the effects of international institutions on the system's stability, and whether international institutions may contribute to the international system's capacity. In "Stability and Instability in the International System," Rosencrance defines capacity as "a generic term designating the total ability of the international system to contain disruption" (Rosencrance, 1963: 280). For Rosencrance, there are regulative and environmental forces which augment capacity. For our purposes, regulative forces stop economic failures before they happen; environmental forces control the spread and extent of economic failures. For both forces, international cooperation is needed, usually conceived in the form of international institutions.

In "International Institutions for Reducing Global Financial Instability," Rogoff makes just such an argument (1999). Rogoff examines possible institutional structures for maintaining equilibrium conditions and preventing cascading failures in financial markets. Even though he does not consider trade explicitly, Rogoff is concerned with economic stability, and therefore it is worth looking at the solutions that he identifies from the larger literature. Among these solutions are establishing various Lenders of Last Resort, who would offer loans to a country if the country were bordering on fiscal insolvency, establishing an International Bankruptcy Court which would restructure a fiscally insolvent country's debt so that all creditors could be paid without a mad scramble, and forming some sort of global financial hegemonic force by either creating a world monetary authority or by controlling capital flows. These institutions provide both regulative and environmental forces for increasing system capacity. But we must consider the externalities of preserving system capacity.

There are two ways in which an international institution may augment system capacity. First, if an institution is created that simply protects the system stability by equally protecting every nation, we may see the onset of a Random Network of international trade. Recall that a Random Network has a Gaussian distribution of trade relationships, with some countries having few or many degrees, but with most countries having a middle amount of degrees. Chance disturbances in a Random Network do have larger effects to the system as it is more likely that a random effect will involve a country ingrained in the system. In other words, where a random disturbance in a Scale-Free Network is likely to affect a country with only one or two degrees, a chance disturbance in a Random Network is likely to affect a country with more degrees. Additionally, Rogoff explains that by creating institutions that would protect every nation, we provide incentives to nations to take larger risks. These incentives encourage instability as a nation may decide to take larger gambles.

If the main purpose of such international tinkering is to maintain the system stability of the overall network, the best policy recommendation would ensure that the countries in the upper echelons of the trade hierarchy were protected from failure more so than the countries in the lower echelons. This introduces the second structure of an institution devoted to increasing system capacity. Creating such a protectorate mechanism opens up a Pandora's Box of problems however, as nations would not be protected equally. This may make the lower-level nations band together to overthrow the structure of the system.[103] Even if the lower-level nations did not band together, selecting the countries which belong to the "upper echelon" would be a contentious and bitter political struggle. Nations would not only have an incentive to improve their own trade relationships, but they would also have an incentive to sour competitor nations' trade positions. Amid this jockeying, there would be incentives to instability as countries would seek their own stability at the cost of the international system's stability.[104] Ensuring that the international trade hierarchy is maintained in its status quo form is dangerous in and of itself. When faced with the tradeoffs, perhaps preserving system stability through a macro institution is overrated.

Submacro Institutions in the International System

Whether or not international institutions promote stability or instability in the context of a trade hierarchy, certain international institutions have the ability to affect the wellbeing of their member states. The extent to which international groupings affect their member states, however, is a topic of hot debate. On the one hand, *institutionalists* and *integrationists* such as Keohane argue that supranational institutions play a vital role in transforming a nation's economic and political structures. Once countries cooperate in terms of trade, they will have no choice but to synchronize other capabilities, such as the legal system or the monetary system, with such spill-over effects increasing the strength

[103] Such lower-level cooperation is not without precedent. The term "Third-World" has come to represent developing countries, but originally it referred to a group of countries not allied with the West or the Soviets during the Cold War. They banded together to represent their interests in the international political system, and in so doing, they sought to break political Bipolarity into political Multipolarity.
[104] Forming a tragedy of the commons.

of the submacro structure at the expense of national autonomy. As a result, once a trade grouping is formed, we should see the member countries in that trade group progress towards unification in a political-economic institutional bloc such as the EU. On the other hand, *intergovernmentalists* argue that member countries only form trade groups to the extent that trade groups advance their individual interests (Moravcsik, 2005). Intergovernmentalists believe that joining a trade group will not necessarily result in unification, as member countries will maintain their respective autonomies if that is in their best national interest. Furthermore, in this framework, we would expect trade groups to be dissolved if the members were not prospering. Intergovernmentalists are cynical about the effects of spill-over, as they argue that countries may resist submacro unification. The core difference between the integrationists and the intergovernmentalists is whether trade blocs automatically help the member nations (Puchala, 1999). Integrationists argue that spill-overs are inevitable and the trade bloc will expand to political and social spheres because the member nations of the trade bloc will thrive in their formalized relationship. Intergovernmentalists argue that trade blocs do not always lead to increased wealth and better international positioning. Hence, institutionalists believe that supranational unification is inevitable while intergovernmentalists believe that unification is a state-controlled process that will only happen in certain situations.

At the heart of both frameworks is a belief that interdependence can yield common benefits (Keohane, 1984). In this literature, interdependence usually means mutual connections with between two or more countries. However, in our literature review, we did not find any evidence that integrationists or intergovernmentalists conceived of interdependence as a spectrum, as we found to be the case in Chapter 5. As a result, we find that unification occurs in certain situations and does not occur in others, suggesting that the intergovernmentalist framework may be correct. Let us examine further.

Figure 55 presents the global average clustering coefficient over time. Recall that the clustering coefficient is the likelihood that a country's partners trade with one another. Over time, the average global clustering coefficient has dropped, suggesting that certain Hubs are linking countries that were not previously connected.

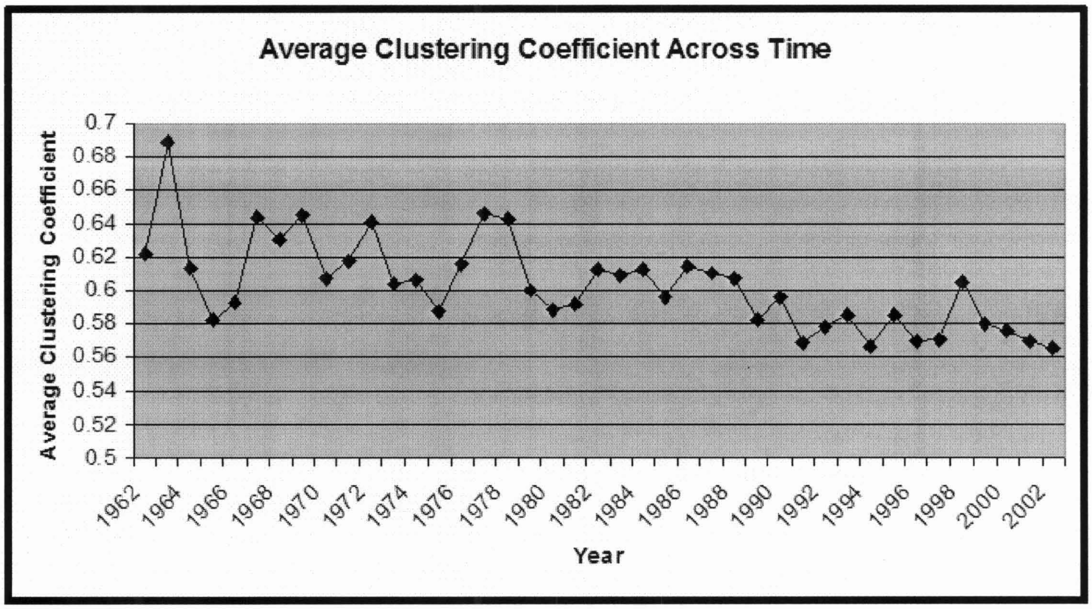

Figure 55: The Global Average Clustering Coefficient Across Time

If we treat trading blocs as their own separate systems, we find that the average clustering coefficient increases rather than decreases, regardless of whether or not they are officially linked in a trade bloc. This is not so surprising: countries that form trading blocs tend to share trade relationships even before they formalize such an institution. In Figures 56, 57, 58, 59 and 60, shown below, the data from five such trading blocs are presented: the Asian-Pacific Economic Cooperation (APEC), the Association of South-East Asian Nations (ASEAN), the EU, the Free Trade Agreement of the Americas

(FTAA), and the Southern Common Market (MERCOSUR).[105] To make these graphs, we took all of the member countries for each year even before they were members. With the EU, for instance, while only six countries were members in 1962, we included all 25 current EU members to calculate the 1962 observation. While the EU has gone through many incarnations and revivals since it was first formed in 1957, the FTAA formed in 1994 with all thirty-four current members joining at once. Similarly, all four members of MERCOSUR formally linked in 1994. APEC and ASEAN both experienced members join the trading group after formal inception, with APEC starting in 1989, and ASEAN starting in 1967.

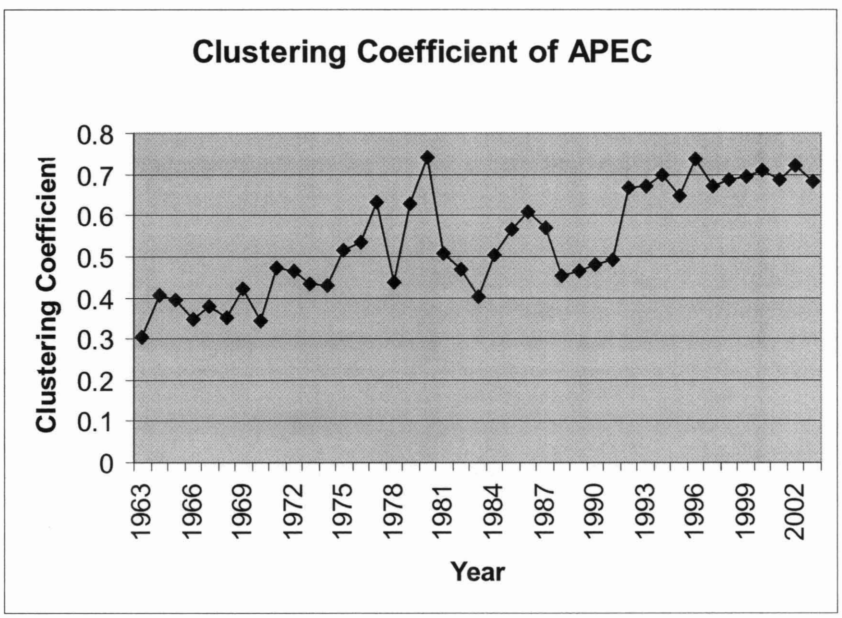

Figure 56: Clustering Coefficient of APEC Across Time

[105] We are currently performing this analysis for all the trade blocs included in UNCTAD and Comtrade to see whether this relationship holds across all trade groups. We should also calculate average clustering coefficients of latent cliques to observe whether such patterns are trade bloc-specific.

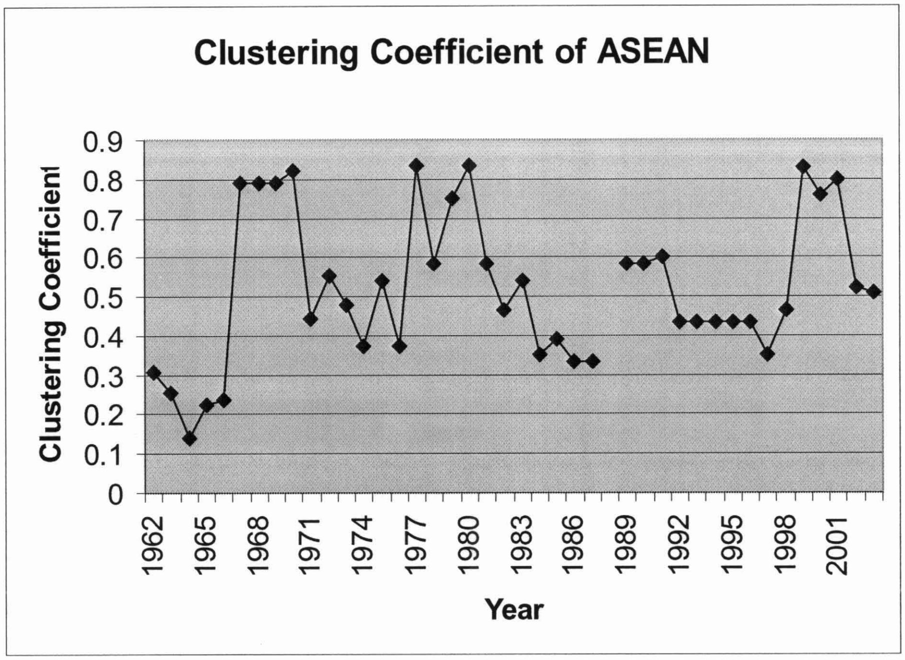

Figure 57: Clustering Coefficient of ASEAN Across Time

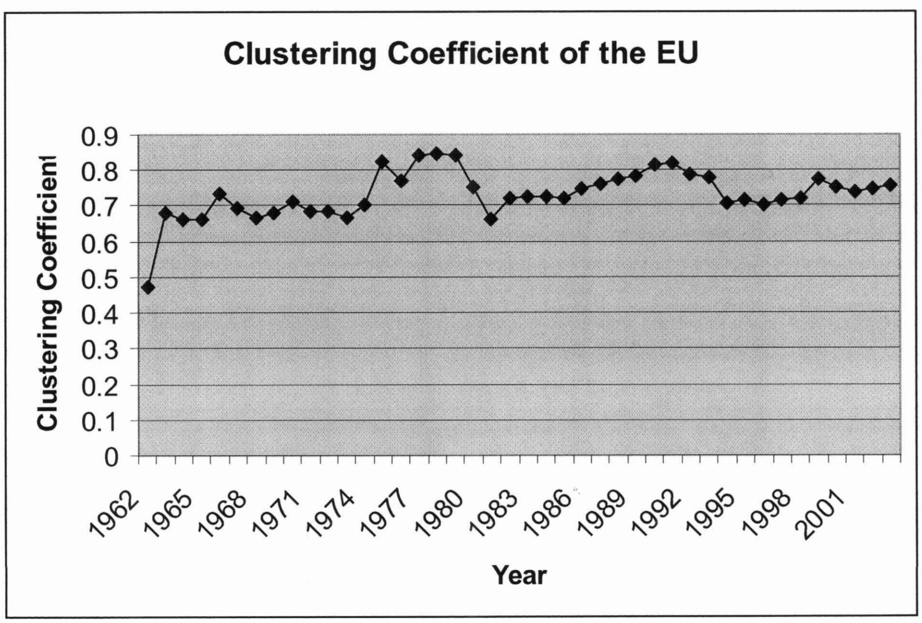

Figure 58: Clustering Coefficient of EU Across Time

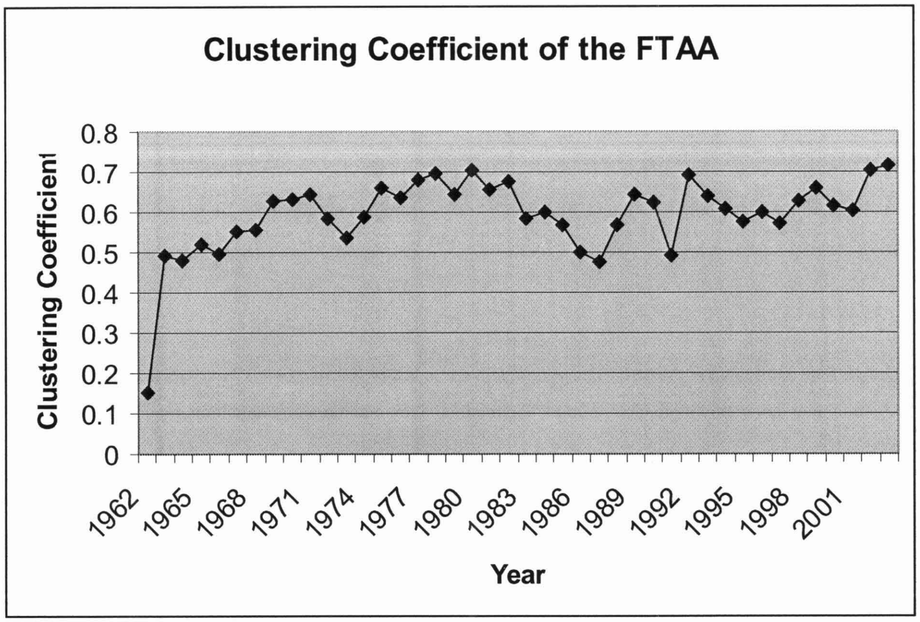

Figure 59: Clustering Coefficient of FTAA Across Time

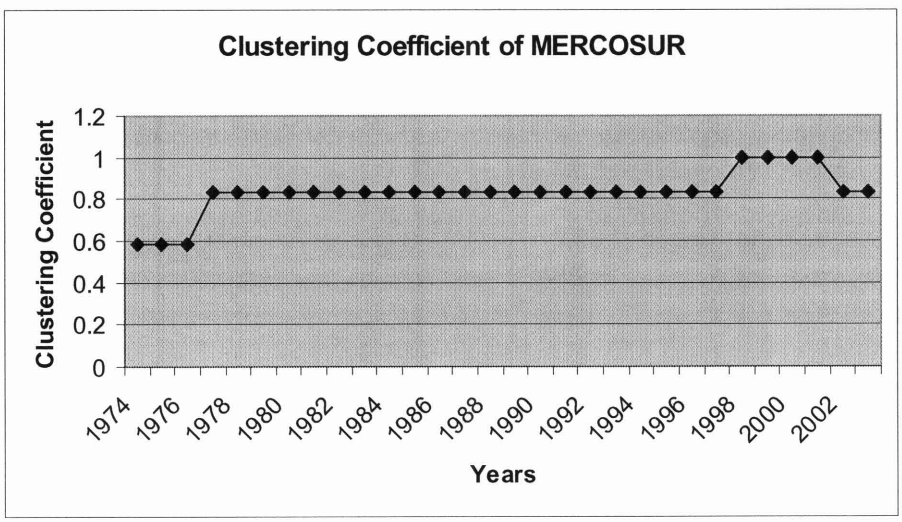

Figure 60: Clustering Coefficient of MERCOSUR Across Time

APEC's average clustering coefficient has increased over the past forty years; despite large-scale fluctuations due to fewer nation-members, ASEAN's average clustering coefficient also seems to be on the rise. However, throughout the EU's recent existence, the average clustering coefficient seems to have remained relatively constant. Similarly, examining the FTAA, the clustering coefficient average has stayed relatively constant: if the 1962 observation is removed, the average clustering coefficient before 1994 is 0.7392, while the average clustering coefficient from 1994 to 2003 is 0.7322. MERCOSUR evinces the same results, suggesting that countries do not always discover new trading partners once they are formally connected in a trade group.

Nonetheless, we do sometimes see an increase in intra-group trade, which can be considered as measures of the groups' homophilies. The following table is adapted from the UNCTAD Handbook of Statistics. The last column was calculated by taking the average year in which member countries joined the group. For the complete listing of countries required for the last column, Appendix B includes the countries in each trade bloc and their years of accession. Table 3 shows the Intra-Trade of Trade Groups as Percentage of Total Exports of Each Trade Grouping, in many cases chronicling the increase in intra-group trade with the onset of a trading bloc.[106]

Trade Group	**Acronym**	**1980**	**1990**	**2002**	**Year of Formation**	**Average Year of Country Accession**
EUROPE						
Baltic countries		..	..	13.1	..	..
European Free Trade Association	EFTA	1.1	0.8	0.6	1960	1960
European Union (15)	EU (15)	60.8	65.9	61	..	..
Euro Zone of the European Union	Euro Zone	51.4	55.1	49.8	2002	2002
European Union (25)	EU (25)	60.9	67.9	66.6	1957	1985.6
AMERICAS						

[106] The numbers in this table were calculated by UNCTAD, <u>not</u> by simply using our major trade relationship data.

Andean Group	ANCOM	3.8	4.1	10.6	1996	1996
Central American Common Market	CACM	24.4	15.3	11.5	1961	1961.8
Caribbean Community	CARICOM	5.3	8.1	13.5	1973	1977.3
Free Trade Area of the Americas	FTAA	43.4	46.6	60.7	1994	1994
Latin American Integration Association	LAIA	13.9	11.6	13.6	1980	1980
Southern Common Market	MERCOSUR	11.6	8.9	17.7	1994	1994
North American Free Trade Agreement	NAFTA	33.6	41.4	56	1992	1992
Organization of Eastern Caribbean States	OECS	9	8.1	3.8	1981	1982.9
AFRICA						
Economic Community of the Great Lakes Countries	CEPGL	0.1	0.5	0.7	1976	1976
Common Market for Eastern and Southern Africa	COMESA	5.7	6.3	5.6	1994	1994
Economic Community of Central African States	ECCAS	1.4	1.4	1.3	1983	1984.5
Economic Community of West African States	ECOWAS	9.6	8	11.1	1975	1975.1
Mano River Union	MRU	0.8	0	0.3	1973	1973
Southern African Development Community	SADC	0.4	3.1	8.8	1992	1992.1

Economic and Monetary Community of Central Africa	..	1.6	2.3	1.3	..	..
West African Economic and Monetary Union	UEMOA	9.9	13	12.6	1994	1994
Arab Maghreb Union	UMA	0.3	2.9	2.8	1989	1989
ASIA						
Association of South-East Asian Nations	ASEAN	17.4	19	22.8	1967	1980.7
Bangkok Agreement	Bangkok	1.7	1.6	7.4	1975	1979.3
Economic Cooperation Organization	ECO	6.3	3.2	5.5	1985	1989.9
Gulf Cooperation Council	GCC	3	8	5.8	1981	1981
Melanesian Spearhead Group	MSG	0.8	0.4	0.8	1988	1990
South Asian Association for Regional Cooperation	SAARC	4.8	3.2	3.9	1985	1985
INTERREGIONAL						
Asia Pacific Economic Cooperation	APEC	57.9	68.4	73.5	1989	1991.2
Black Sea Economic Cooperation	BSEC	5.9	4.2	13.9	1992	1992
Commonwealth of Independent States	CIS	..	..	18.9	1991	1991

Table 4: Intra-Trade of Trade Groups as Percentage of Total Exports of Each Trade Grouping

Of the five trading groups that we first considered, APEC, FTAA, and MERCOSUR all experience steep increases in intra-group trading once trade relationships are formalized. During this time period, intra-group trade also rises in the

EU and in ASEAN, though not as drastically. However, both of these trade blocs are much older and probably had high intra-group trade, even before formalization. At least eight other trade groups did not flourish when formalized. The Common Market for Eastern and Southern Africa (COMESA), the Economic Community of Central African States (ECCAS), the Economic Cooperation Organization (ECO), FTAA, the Latin American Integration Association (LAIA), the Organization of Eastern Caribbean States (OECS), the South Asian Association for Regional Cooperation (SAARC), and the Arab Maghreb Union (UMA) all remain relatively stagnant or drop in terms of intra-group trade when a trade bloc is formed. In Table 4, we present those trading groups that experience increased homophily with the onset of a trade grouping and those that see their intra-group trade remain stagnant or decrease.

Improvement	Indistinguishable	Stagnancy or Reduction
Andean	ASEAN	COMESA
APEC	Baltic	ECCAS
Bangkok	CACM	ECO
BSEC	CEPGL	FTAA
CARICOM	CIS	LAIA
GCC	ECOWAS	OECS
MERCOSUR	EMCCA	SAARC
MSG	EU	UMA
NAFTA	MRU	
SADC		
UEMOA		

Table 5: Successful and Non-Successful Trade Blocs

It seems as though in certain situations, institutionalization does make a difference in certain trade blocs, but not in others. Why do we see intra-group trade increase in some trade blocs while remaining constant or decreasing in others? Alternatively, why do we see the average clustering coefficient rise in some trade blocs while remaining constant in others?

The answers may lie in the memberships of these trading blocs. In Appendix B, we present a complete listing of the members in each bloc. For the purposes of simplicity, let us now examine four of these trading blocs, using a stylized approach. In Figures 61, 62, 63, and 64, we show the normalized average degrees of the member countries of four trade groups – APEC, FTAA, the North American Free Trade Agreement (NAFTA), and SAARC – before, during, and after trade formalization. In Chapters 2 and 3, we explained that each nation has a degree value which corresponds to the number of major trade relationships for a nation. We also argued that the number of degrees is a measure of the country's positioning in the trade system, with Hub countries having higher degrees and Spokes having fewer degrees.[107]

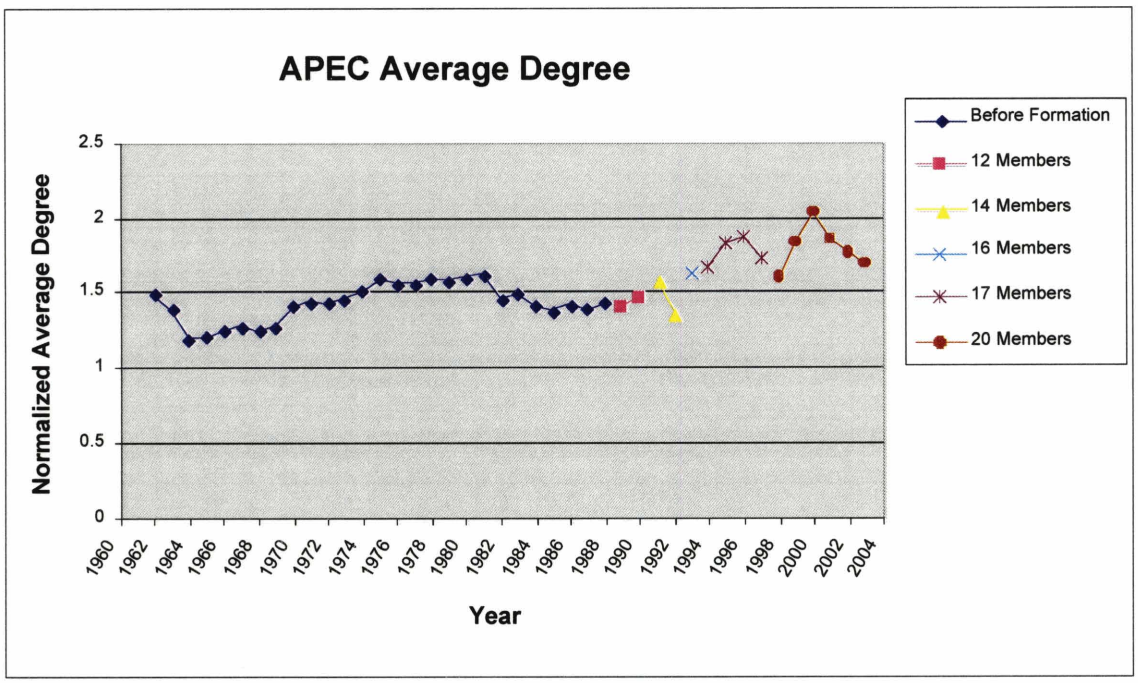

Figure 61: Normalized Average Degrees of Countries in APEC Across Time

[107] We normalized the average degrees because in 1962 there are fewer countries than in 2002. In order to show that our findings do not simply uncover this fact that we live in a world of more countries, we controlled this effect by dividing by the average number of degrees per year. Again, each chart is created by averaging the number of degrees of all of the *current* member countries for each year; as a result, even when there is no institution, there will be average degrees if any of the countries exist.

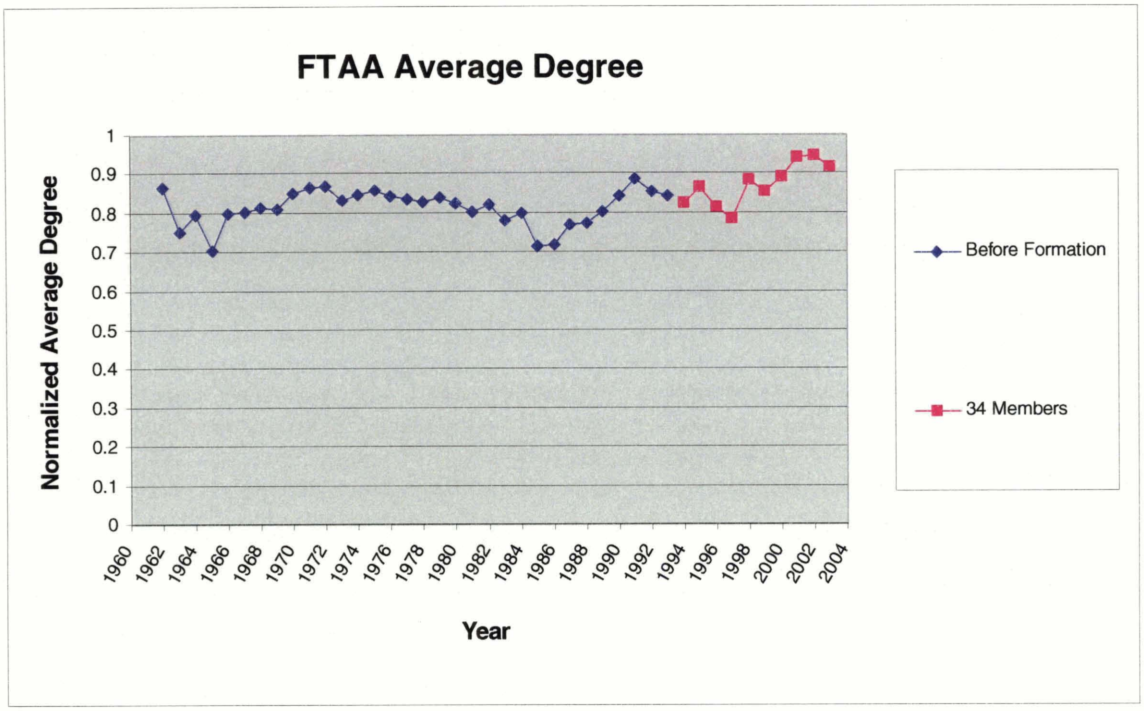

Figure 62: Normalized Average Degree of Countries in FTAA Across Time

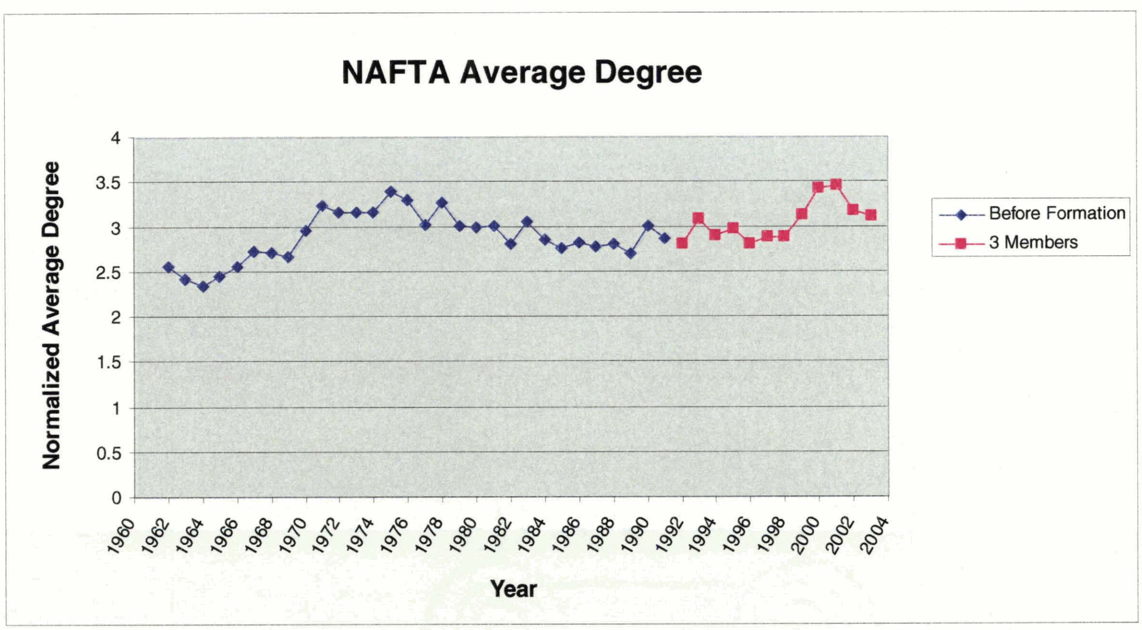

Figure 63: Normalized Average Degree of Countries in NAFTA Across Time

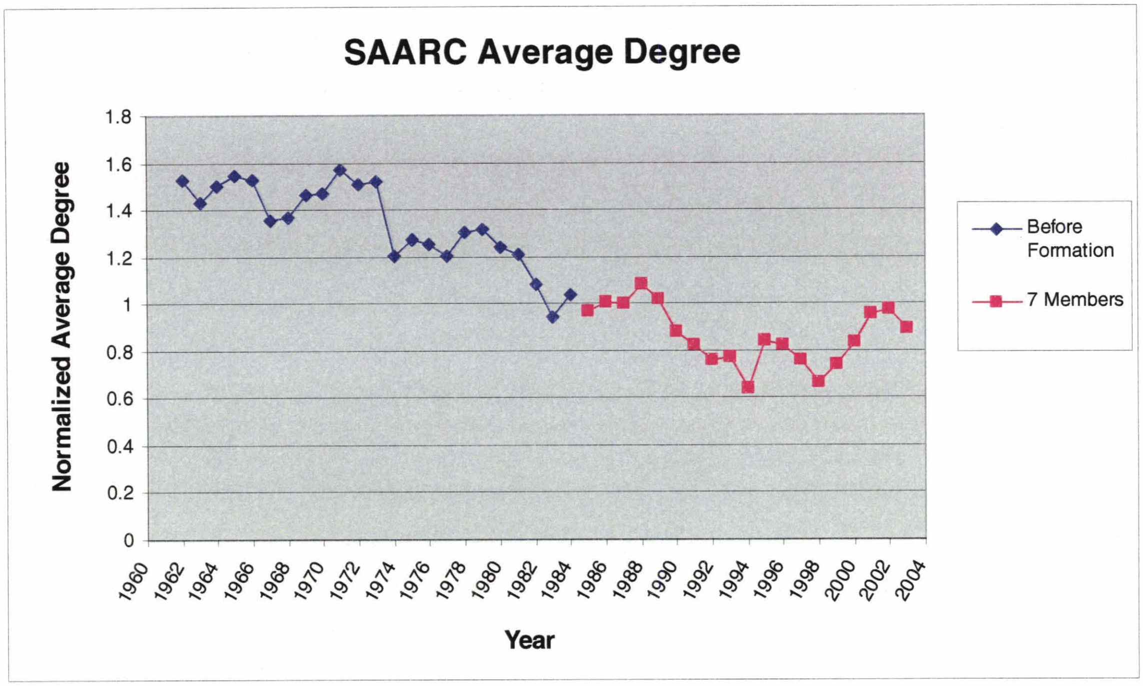

Figure 64: Normalized Average Degrees of Countries in SAARC Across Time

APEC, FTAA, and NAFTA all experience a rise in their average degrees, while SAARC experiences a decline, suggesting that the member countries of SAARC are dropping in the international trade system relative to other countries. However, these trade blocs may resemble other submacro groupings in that some blocs may be dominated by a strong power, while others are a composite of equal countries. Not surprisingly, the presence of the United States in the first three trade groups drastically affects the results of the previous figures. Figures 65, 66, 67, and 68 show the how the average degree changes for each country once it joins a trade grouping. Notice that most countries are relatively even, except for the presence of the United States in the first three charts. What we see is the dominance of the United States in APEC, in the FTAA, and even in NAFTA, while other countries remain relatively stagnant or drop. Following its accession into these three trading blocs, the United States in particular gains as Spoke countries increasingly engaged in trade relationships with this Hub. The United States takes the most advantage of trade bloc formalization.

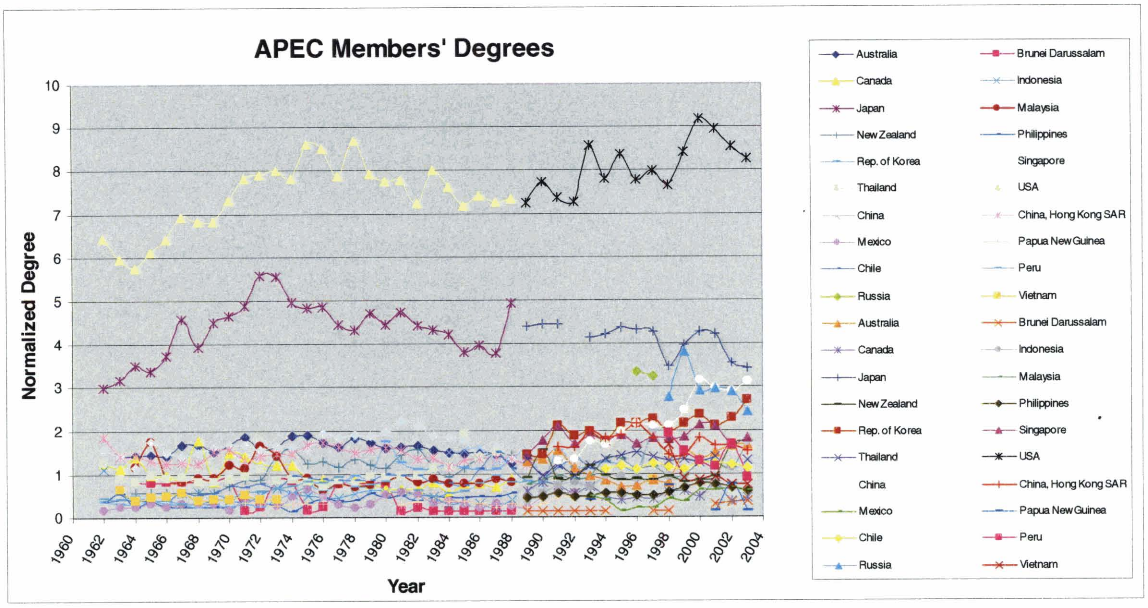

Figure 65: Degrees of Members in APEC Across Time

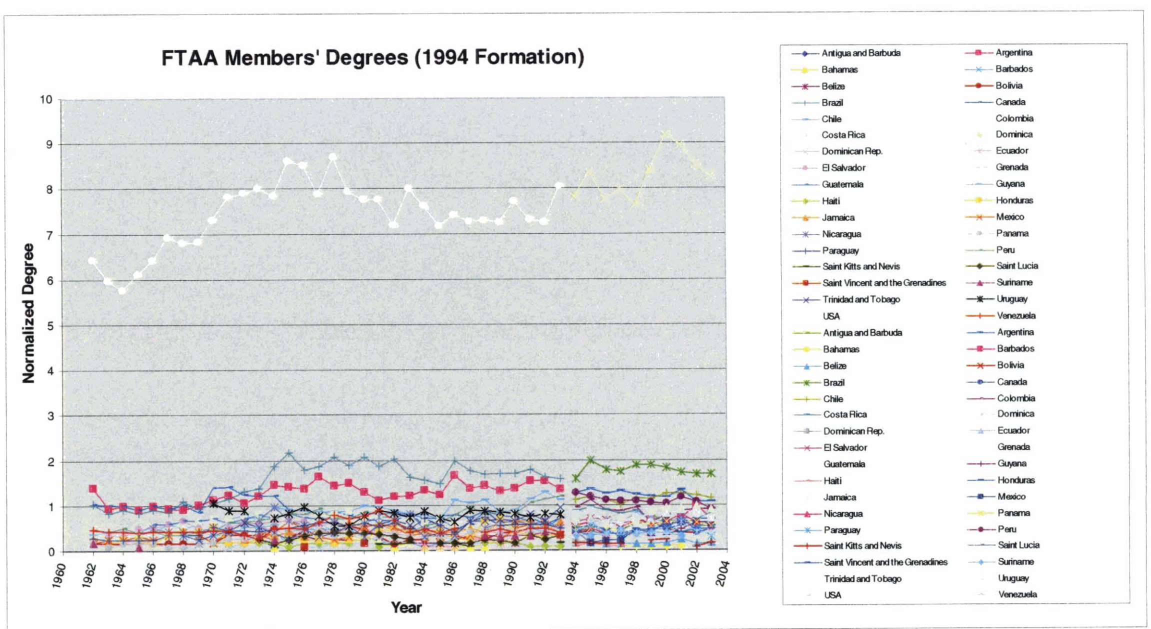

Figure 66: Degrees of Members in FTAA Across Time

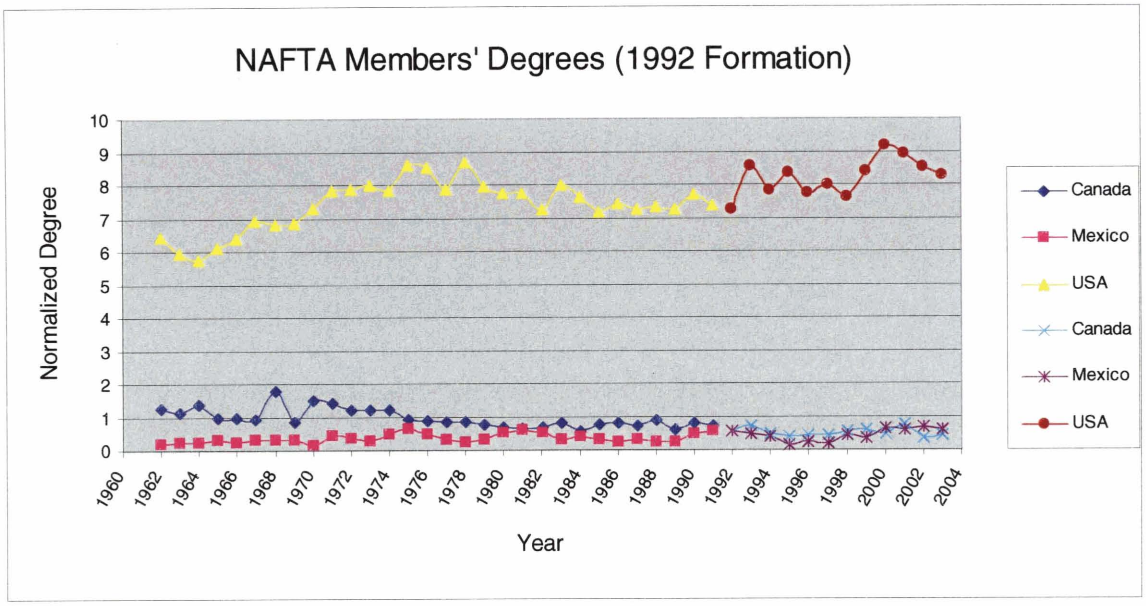

Figure 67: Degrees of Members of NAFTA Across Time

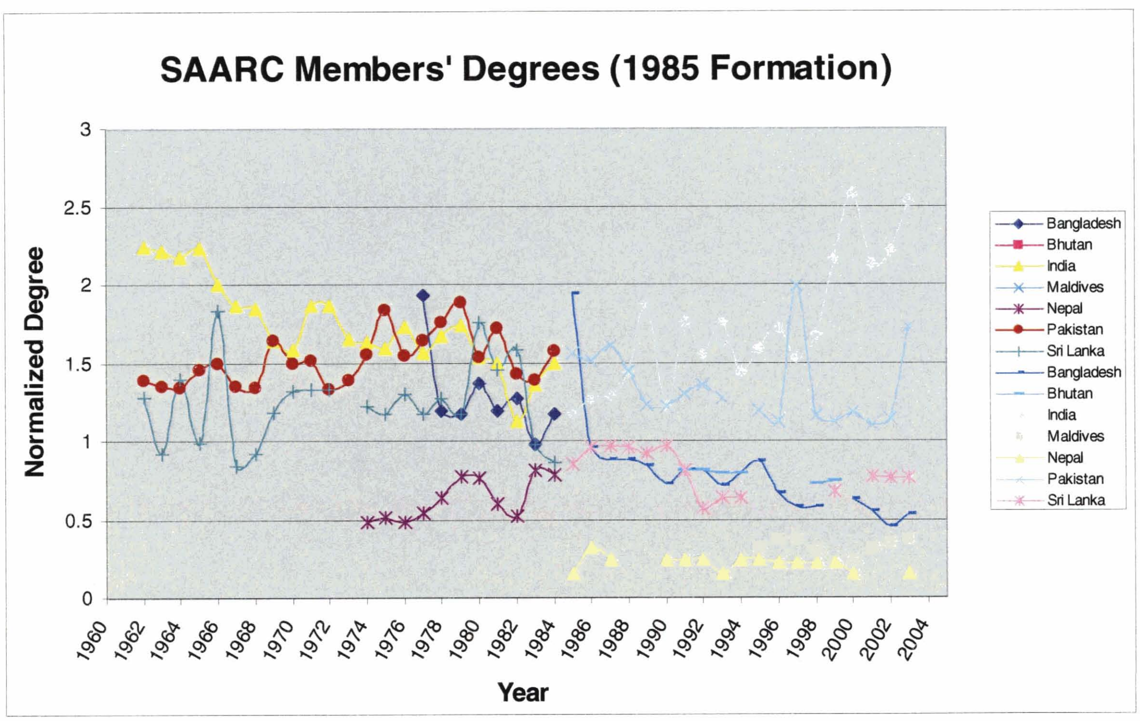

Figure 68: Degrees of Members of SAARC Across Time

If one includes the United States, the performance of SAARC's countries is much more similar to one another than the performance of countries in APEC, the FTAA, or

NAFTA. But if one removes the success of the United States from APEC, the FTAA, or even NAFTA, one finds a story similar to that of SAARC, with homogeneity and stagnancy among the non-Hub countries in the trading bloc. In Figure 69, we exclude the United States from the chart and again look at the countries of the FTAA.

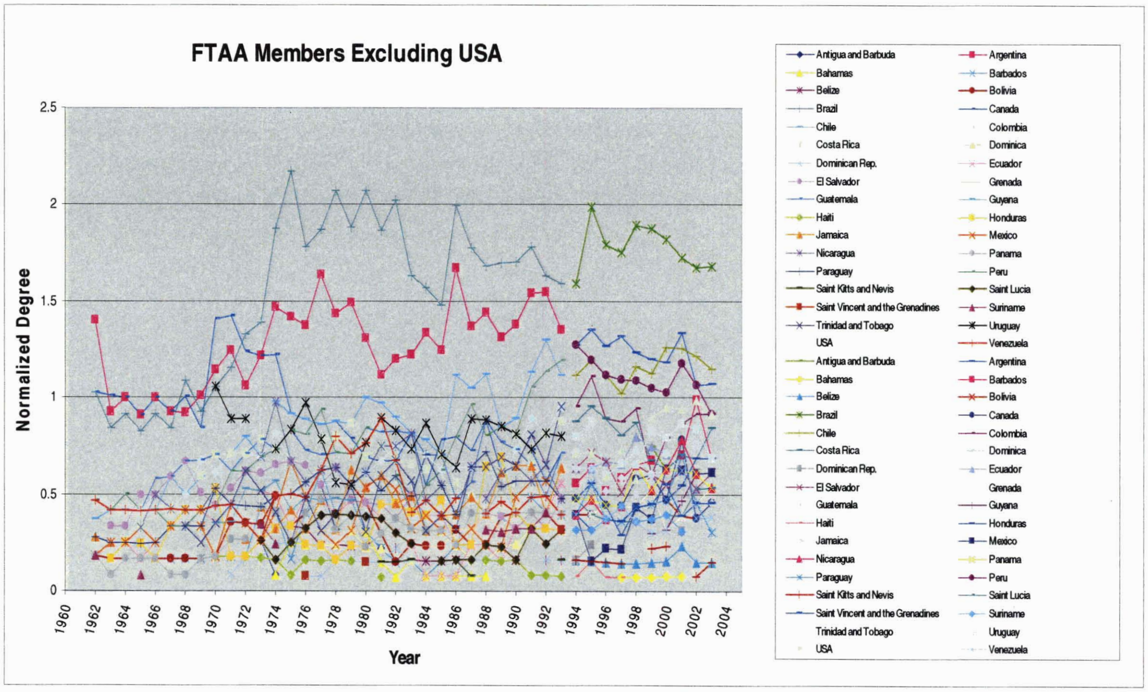

Figure 69: Degrees of Members in FTAA Across Time, Excluding the United States

This time, Brazil and Argentina are the crown jewels of the FTAA, representing the countries with the highest normalized degrees. But following FTAA formalization, both countries did not significantly deviate from their trajectories, consistently fluctuating over time. Only the United States prospered.

This pattern of Hub dominance in a trade group is to be expected. Consider Hirschman's discussion about how Hubs want to develop trade monopolization with Spokes in order to be able to exercise both economic and political power (1980). Formalizing a trade bloc allows the Hub to accomplish this activity, as the Spokes become increasingly dependent upon the Hub. When a singular Hub country is involved in the trade group, the Hub country enjoys a corresponding rise in degrees and intra-group trade increases, but we do not see non-Hub countries advance.

Even when countries are equal and there seems to be a high form of interdependence, the formalization of a trading group among the countries may not bring about success. Hub countries need not necessarily be member of a specific trade group to affect all of the members in the trade group. From 1980 to 2002, the OECS saw its intra-group trade decrease from 9% to 3.8%. These nations of the Caribbean were undoubtedly affected by their neighborhood Hub, the United States, which became more active in the Caribbean economies during this time period. COMESA, which is composed of several small African nations that were former colonial states, is still dominated by Hubs, with many of these countries still trading with their former imperialists.

Chapter Summary

When it comes to the integrationist framework versus the intergovernmentalist framework, we find that differences in interdependencies influence whether trade bloc formalization improves the conditions of the member states. Trade bloc formalization will not necessarily benefit all member states, and we must approach the integrationist framework with suspicion. When a trade group is formed with countries that are relatively equal with one another in terms of their hierarchical positions in the international trade system, they tend to form trade groups where all members have a chance of benefiting. When a trade group is formed with a dominant Hub member, the other members tend to flounder while the Hub country flourishes.

CHAPTER 7: SUMMARY AND FUTURE DIRECTIONS

An Alternative Understanding of the International System

This thesis contains three substantive departures from the previous scholarship in IR. First, we do not consider the international system as a single macro system nor do we consider it as a combination of separate submacro systems, nor do we consider it as a combination of separate dyadic interactions, but we approach the international system holistically, as a combination of these three different levels. Submacro system politics and power positioning affect the dynamics of the macro system, and we especially consider the consequences of such possibilities for understanding the international system. These submacro systems interact and overlap with each other through the Hubs that glue together the macro system.

This brings us to our second departure from traditional IR: rather than pre-determining the identity of the submacro structure, we identify and investigate latent cliques of countries to determine the nature of power in international relationships. In other words, we consider latent cliques of countries rather than formalized communities of countries. There are a whole slew of formalized submacro systems – trade blocs, political alliances, cultural communities, geographic groups – that have each received separate analyses. Instead of considering just one type of these formalized submacro systems, we recognize a range of types, and we must search for the commonalities among these systems. Therefore, to observe basic submacro system dynamics, instead of examining the formalized country communities, we examine country cliques latent within the larger system. While it is true that we look at dyadic trade relationships to determine these cliques, we find country cliques that were not necessarily formally grouped by a regional trade pact or by a trade accord.[108] Like formalized subsystems, latent cliques interact with each other and include members that are involved in other cliques. As a result of interactions among these submacro cliques, higher-level, macro system interactions are affected.

Our third and most substantial departure from previous scholarship is that we implement graph theory as a methodology. Applying graph theory to other recognized systems in international politics may further help us understand the contours of the international system, but it may also help us better understand dyadic relationships between two countries, or it may help us identify how non-country (third image) actors affect countries.

These departures help us discover many interesting findings, with important ramifications for IR, as well as for policy-crafting. In Chapter 3, we found that the macro level system of trade most closely resembles a Scale-Free Network. Therefore, macro system stability is highly dependent upon the health of a few Hub countries. Random shocks are unlikely to affect these Hub countries, however, targeted shocks against these Hubs may throw the international economy into depression. Along these lines, considering the international hierarchy, we find that contagion should typically only spread horizontally or from the top-down: only in rare circumstances may contagion percolate from the bottom-up. The presence of a Scale-Free Network also suggests that hierarchical properties of the international system cannot be captured without an analysis of the submacro system. To identify the hierarchy of the international trade system, in Chapter 4 we examined the latent cliques of the trade network.

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[108] The findings of the embedded subsystems reflect well upon formalized subsystems: some subsystems have dominant partners necessary for the equilibrium of the system, while other systems equally share the burden of stability (and the corresponding power).

Through an investigation of these latent cliques, in Chapter 5 we find that there are many different forms of interdependence among the submacro systems, leading us to believe that the hierarchy of international trade is Multiscalar. Some submacro systems have a dominant Hub, while other systems have several Hubs, while others simply contain a group of equal countries. In Chapter 6, we find that these variations of interdependence have noticeable impacts on formalized trade groups as well, with utility of the trade bloc for its member countries in improving relative positions and increasing trade, seemingly dependent upon the interdependence of the countries.

Future Possibilities

Throughout this thesis, we have discussed possible extensions for graph theory-based methods in political science and in IR. In this section, we contain our discussion to the possible extensions of this project. In terms of methodology, some of these queries would be best served with graph theoretic techniques combined with traditional statistical approaches, while others would benefit most from a combination of statistical analysis and case studies. We shall let the future researcher decide which tools are appropriate to answer which questions, but we would especially encourage the researcher to investigate the full possibilities contained within graph theory. Having made the plug, let us continue by examining possible extensions of research.

The most immediate extension to this project would involve classifying each of the submacro systems over the past forty years along a gradient of interdependence, ranging from Pure-Dependent to Equal-Dependent. To accomplish this task, we must recognize that such analysis is measuring homophily, and there are several approaches we could take. One may wish to apply to each of the submacro systems the same technique of degree distribution analysis that we implemented to inspect the macro system. However, as we noted earlier, this method does not currently reveal when a Scale-Free Network becomes a Hegemonic System, and therefore may not show when a Multi-Dependent Submacro System becomes a Pure-Dependent Submacro System.[109] One may therefore be inclined to use clustering coefficients or intra-clique trade as well.

After defining the various latent cliques, another useful exercise would be to investigate whether certain types of these embedded cliques give rise to formalized trade blocs more frequently than other embedded cliques. One hypothesis worth testing is whether trade blocs only succeed in conditions of a certain form of subsystem interdependence – when all the nations are relatively equal in terms of trade and in terms of their relative locations within the international system.[110] Alternatively, trade blocs may form more frequently among cliques that are heavily sheltered from outside involvement.

Among these trade blocs, some are composed of equal partners while other trade blocs contain partners that seem Hub-like compared to their trade bloc counterparts. A worthwhile investigation would involve examining trade blocs, and possibly other established submacro system groupings such as geographic regions, to see whether power variation only occurs in latent cliques or whether it is endemic to all submacro systems, formal and informal alike.

After defining the various latent cliques along the interdependent gradient, one may also wish to reconsider the macro system. Being able to classify the embedded

[109] One solution may be to define Hegemonies only when their degree distributions are outliers relative to other observations.
[110] Meaning their locations within both the macro system and the several subsystems that each country may be involved within.

cliques, one should be able to better classify the macro system and how it has changed over time. To this end, another interesting research project would include examining whether the prevalence of certain subsystem formations give rise to certain macro system formations, and vice versa. For instance, when the macro system becomes more Egalitarian, we may see a rise in the number of Equal-Dependent submacro systems; and when more subsystems become Pure-Dependent, we may be able to predict the onset of macro system-level Hegemony.

Future researchers should also wish to examine the implications of overlapping cliques. In our analysis, the United States was often the Gatekeeper between two cliques. Sometimes another type of nation may become the Gatekeeper between two cliques, especially in non-trade international systems.[111] During the 1980s, Afghanistan was sought after by both the Soviet Union and the United States, receiving healthy amounts of aid from both sides. Even when the Soviet Union invaded, the United States quickly came to Afghanistan's defense, showing the benefits of sitting between two submacro groups. Oppositely, Huntington warns us that we should be especially concerned for the Gatekeepers that sit along the fault lines of cultures (1996).

Finally, throughout this project, we have only examined networks with undirected edges. Trade does include directional flows, however, and analyzing relationships, not just in terms of trade amounts, but also in terms of direction, may shed more light on the international trade system. An analysis would be particularly interesting on this front if it

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[111] Some specific trade relationship case studies would be well worth the undertaking. In the 1500s, a small state in South India, Kerala, produced most of the world's spices, developing trade relations with several stronger powers. Kerala is now renowned for its high levels of social development and its healthy government. At a time when colonizers were dividing and conquering the rest of India, Kerala's success may stem from the strong institutions which the competing powers installed as a result of Kerala's Gatekeeper position.

tested the flow of something else along with trade, such as the flow of democracy or the flow of social values. Trade may aid the flow of such ideas and beliefs. Would the flows be different within different structures of the international system?

Conclusion

In this thesis, several ideas have been explored and several questions have been generated. In the terms of the future of IR, we hope to see more research that examines subsystems in the context of the macro and international systems, and we also hope to see more research that utilizes graph theory. Research along such lines will prove fruitful as it may help us test a whole host of propositions arising from international systems theory literature.

BIBLIOGRAPHY

1. Albert, R. and Barabási, A. “Statistical Mechanics of Complex Networks.” *Review of Modern Physics*: Vol. 74(1). (June, 2002): pp. 47-97.

2. Abbott, F. M. “NAFTA and the Legalization of World Politics: A Case Study.” *International Organization*: Vol. 54(3), Legalization and World Politics. (Summer, 2000): pp. 519-547.

3. Anderson, R. M. and May, R. M. (1991). *Infectious Diseases of Humans*. Oxford: Oxford University Press.

4. Barabási, A. L. and Albert, R. “Emergence of Scaling in Random Networks.” *Science*: Vol. 286. (1999): pp. 509-512.

5. Barabási, A. L. (2002). *Linked: The New Science of Networks*. Cambridge, MA: Perseus Publishers.

6. Barnett, M. and Duvall, R. “Power in International Politics.” *International Organization*: Vol. 59(1). (Winter, 2005): pp. 39-75.

7. Beck, N., King, G., and Zeng, L. “Improving Quantitative Studies of International Conflict: A Conjecture.” *American Political Science Review:* Vol. 94(1). (March, 2000): pp. 21-35.

8. Beck, N., King, G., and Zeng, L. “Theory and Evidence in International Conflict: A Response to de Marchi, Gelpi, and Grynaviski.” *American Political Science Review:* Vol. 98(2). (May, 2004): pp. 379-389.

9. Bennett, D. S. and Stam, A. C. “Research Design and Estimator Choices in the Analyses of Interstate Dyads.” *Journal of Conflict Resolution*: Vol. 44(5). (October, 2000): pp. 653-685.

10. Berton, P. “International Subsystems: A Submacro Approach to International Studies.” *International Studies Quarterly:* Vol. 13(4). (December, 1969): pp. 329-334.

11. Billington, G. G. “Interview: Datuk Seri Dr. Mahathir bin Mohamad.” *Executive Intelligence Review*: Vol. 26(8). (February 19, 1999).

12. Block, F. (2001). “Introduction.” In K. Polanyi’s *The Great Transformation: The Political and Economic Origins of Our Time*. Boston: Beacon Press.

13. Bueno de Mesquita, B. and Lalman, D. “Systemic and Dyadic Explanations of War.” *World Politics*: Vol. 41. (October, 1988): pp. 1-20.

14. Cohen, R., Erez, K., ben-Avraham, D., and Havlin, S. "Breakdown of the Internet under International Attack." *Physical Review Letters*: Vol. 86(16). (April, 2001): pp. 3682-3685.

15. Choucri, N., Electris, C., Goldsmith, D., Mistree, D., Madnick, S. E., Morrison, J. B., Siegel, M., and Sweitzer-Hamilton, M. "Understanding & Modeling State Stability: Exploiting System Dynamics." *MIT Sloan Research Paper* No. 4574-06. (January 2006).

16. de Marchi, S., Gelpi, C., and Grynaviski, J. "Untangling Neural Nets." *American Political Science Review:* Vol. 98(2). (May, 2004): pp. 371-378.

17. Denemark, R. A., Friedman, J., Gills, B. K., and Modelski, G. (2000). "An Introduction to World System History: Toward a Social Science of Long-Term Change." In R. A. Denemark, J. Friedman, B. K. Gills, and G. Modelski (Eds.) *World System History*. New York: Routledge.

18. Derényi, I., Palla, G., and Vicsek, T. "Clique Percolation in Random Networks." *Physical Review Letters*: Vol. 94. (April, 2005): 160202.

19. Dodds, P. S., Watts, D. J., and Sabel, C. F. "Information Exchange and the Robustness of Organizational Networks." *Proceedings of the National Academy of Sciences*: Vol. 100(12) (October, 2003): pp. 12516-12521.

20. Dorogovtsev, S. N., and Mendes, J. F. F. (2003). *Evolution of Networks: From Biological Nets to the Internet and WWW (Physics)*. New York: Oxford University Press.

21. Dornbusch, R., Park, Y. C., and Claessens, S. "Contagion: Understanding How It Spreads." *The World Bank Observer*: Vol. 15(2). (August, 2000): pp. 177-197.

22. Dunne, J. A., Williams, R. J., and Martinez, N. D. "Network Structure and Biodiversity Loss in Food Webs: Robustness Increases with Connectance." *Ecology Letters*: Vol. 5. (2002): pp. 558-567.

23. Etheredge, L. S. "What Next? The Intellectual Legacy of Ithiel de Sola Pool." *MIT Communications Forum*. Accessed online: http://web.mit.edu/comm-forum/papers/etheredge.html#6 (April, 2006).

24. Friedman, T. (2005). *The World is Flat*. New York: Farrar, Straus and Giroux.

25. Gilpin, R. (1981). *War and Change in World Politics*. Cambridge, UK: Cambridge University Press.

26. Goldstein, J. (1988). *Long Cycles: Prosperity and War in the Modern Age*. New Haven, Yale University Press.

27. Goodman, J. S. "The Concept of "System" in International Relations Theory." *Background*: Vol. 48(4). (February, 1965): pp. 257-268.

28. Guare, J. (1990). *Six Degrees of Separation*. New York: Random House.

29. Hauert, C. and Doebeli, M. "Spatial Structure Often Inhibits the Evolution of Cooperation in the Snowdrift Game." *Nature*: Vol. 428(8). (April, 2004): pp. 643-646.

30. Hirschman, A. O. (1980). *National Power and the Structure of Foreign Trade.* Los Angeles, CA: University of California Press.

31. Holme, P., Huss, M., and Jeong, J. "Network Hierarchies of Biochemical Pathways." *Bioinformatics*: Vol. 19(4) (2003): pp. 532-538.

32. Huberman,B. A. (2001). *The Laws of the Web.* Cambridge, MA: The MIT Press.

33. Huntington, S. (1996). *The Clash of Civilizations and the Remaking of World Order.* New York: Touchstone Press.

34. Inglehart, R. and Carballo, M. "Does Latin America Exist? (And is There a Confucian Culture?): A Global Analysis of Cross-Cultural Differences." *PS: Political Science and Politics*: Vol. 30(1). (March, 1997): pp. 34-47.

35. Kaplan, M. A. (1957). "Systems Theory." In J. C. Charlesworth (Ed.), *Contemporary Political Analysis*. New York: The Free Press.

36. Kaplan, M. A. (1960). *System and Process in International Politics*. New York: John Wiley & Sons.

37. Kaufman, S. J. "The Fragmentation and Consolidation of International Systems." *International Organization*: Vol. 51(2). (Spring, 1997): pp. 173-208.

38. Keohane, R. O. (1984). *After Hegemony: Cooperation and Discord in the World Economy.* Princeton, N.J.: Princeton University Press.

39. Keohane, R. O. "Problematic Lucidity: Stephen Krasner's 'State Power and the Structure of International Trade.'" *World Politics*: Vol. 50(1). (March, 1997): pp. 150-170.

40. Krebs, R. R. "Perverse Institutionalism: NATO and the Greco-Turkish Conflict." *International Organization*: Vol. 53(2). (Spring, 1999): pp. 343-377.

41. Krempel, L., and Plümper, T. "The Dynamics of International Trade by Combining the Comparative Advantages of Multivariate Statistics and Network Visualizations." *Journal of Social Structure*: Vol. 4. (December 2002): pp. 1-22. Available online: http://www.cmu.edu/joss/content/articles/volume4/KrempelPlumper.html (Accessed May, 2006).

42. Kupchan, C. A. "NATO and the Persian Gulf: Examining Intra-Alliance Behavior." *International Organization*: Vol. 42(2). (Spring, 1988): pp. 317-346.

43. Lebow, R. N. "The Long Peace, the End of the Cold War, and the Failure of Realism." *International Organization:* Vol. 48(2). (Spring, 1994): pp. 249-277.

44. Mansfield, E. D., and Milner, H. V. "The New Wave of Regionalism." *International Organization*: Vol. 53(3). (Summer, 1999): pp. 589-627.

45. Maslov, S., and Sneppen, K. "Specificity and Stability in Topology of Protein Networks." *Science*: Vol. 296. (2002): pp. 910-913.

46. Mastanduno, M. "Economic Statecraft, Interdependence, and National Security: Agendas for Research." *Security Studies*: Vol. 9(1/2). (Autumn, 1999-Winter 2000): pp. 289-310.

47. Marsden, P. V. "Egocentric and Sociocentric Measures of Network Centrality." *Social Networks*: Vol. 24(4). (October, 2002): pp. 407-422.

48. McGrath, C. and Blythe, J. "Do You See What I Want You to See? The Effects of Motion and Spatial Layout on Viewer's Perception of Graph Structure." *Journal of Social Structure*: Vol. 5. (2004). Available online: http://www.cmu.edu/joss/content/articles/volume5/McGrathBlythe/

49. MIPT Terrorism Knowledge Base. Available online: http://www.tkb.org/Home.jsp (Accessed May, 2006).

50. Modelski, G. (2000). "World System Evolution." In R. A. Denemark, J. Friedman, B. K. Gills, and G. Modelski (Eds.), *World System History*. New York: Routledge.

51. Moravcsik, A. "The European Constitutional Compromise and the Neofunctionalist Legacy." *Journal of European Public Policy*: Vol. 12(2). (April, 2005): pp. 349-386.

52. Newman, M. E. J. "The Structure and Function of Complex Networks." *SIAM Review*: Vol. 45(2). (March, 2003): pp. 1-58.

53. Newman, M. E. J. "Fast Algorithm for Detecting Community Structure in Networks." *Physical Review Letters E:* Vol. 69. (2004): 066133.

54. Oppenheim, A. V., Wilsky, A. S., and Nawab, S. H. (1997). *Signals and Systems: Second Edition.* Upper Saddle River, New Jersey: Prentice Hall.

55. Ortiz, C. (2005). *Geographic Information Systems and Geopolitics: A Proof of Concept Information Visualization in Political Science Research.* S.B. Thesis, Department of Political Science, MIT.

56. Palla, G., Derényi, I., Farkas, I., and Vicsek, T. "Uncovering the Overlapping Structure in Complex Networks in Nature and Society." *Nature*: Vol. 35(9). (June, 2005): pp. 814-818.

57. Piepers, I. "Dynamics and Development of the International System: A Complexity Science Perspective." (April, 2006). Unpublished Manuscript.

58. Pool, I. de S., and Kochen, M. "Contacts and Influence." *Social Networks*: Vol. 1. (1978): pp. 1-51.

59. Puchala, D. J. "Institutionalism, Intergovernmentalism and European Integration: A Review Article." *Journal of Common Market Studies*: Vol. 37 (2). (June, 1999): pp. 317-331.

60. Putnam, R. D. "Tuning In, Tuning Out: The Strange Disappearance of Social Capital in America." *PS: Political Science and Politics*: Vol. 28(4). (December, 1995): pp. 664-683.

61. Putnam, R. D. (1993). *Making Democracy Work: Civic Traditions in Northern Italy.* Princeton, NJ: Princeton University Press.

62. Radelet, S., and Sachs, J. (2000). "The Onset of the East Asian Financial Crisis." In *Currency Crises*, P. Krugman (Ed.). National Bureau of Economic Research. Chicago: University of Chicago Press.

63. Rodrigue, J. P. (2005). *The Geography of Transport Systems.* Available online: http://people.hofstra.edu/geotrans/index.html (Accessed May, 2006).

64. Rosencrance, R. (1963). *Action and Reaction in World Politics.* Boston: Little, Brown and Company.

65. Rosencrance, R., and Stein, A. "Interdependence: Myth or Reality." *World Politics*: Vol. 26(1). (October, 1973): pp. 1-27.

66. Russett, B. "The Mysterious Case of Vanishing Hegemony; or, is Mark Twain Really Dead?" *International Organization*: Vol. 39(2). (Spring, 1985): pp. 207-231.

67. Shen-Orr, S. Milo, R., Mangan, S., and Alon, U. "Network Motifs in the Transcriptional Regulation Network of Escherichia coli." *Nature Genetics*: Vol. 31. (2002): pp. 64-68.

68. Schirm, S. A. (2002). *Globalization and the New Regionalism.* Malden, MA: Blackwell Publishers.

69. Shive, S. "An Epidemic Model of Investor Behavior." (January, 2006): Unpublished Manuscript.

70. Singer, J. D. "The Level-of-Analysis Problem in International Relations." *World Politics*: *The International System: Theoretical Essays*. Vol. 14(1), (Oct., 1961): pp. 77-92.

71. Stiglitz, J. E., and Yusuf, S., Eds. (2001). *Rethinking the East Asian Miracle.* New York: Oxford University Press.

72. Thanyalakpark, K., and Filson, D. "Testing for Contagion During the Asian Crisis." *Claremont Colleges: Working Papers in Economics* (2001).

73. UNCTAD. (2006). *Handbook of Trade Statistics Online.* Available at: http://www.unctad.org/Templates/Page.asp?intItemID=1890&lang=1 (Accessed May, 2006).

74. Walt, S. M. "Alliance Formation and the Balance of World Power." *International Security*: Vol. 9(4). (Spring, 1985): pp. 3-43.

75. Waltz, K. (1954) *Man, the State, and War.* New York: Columbia University Press.

76. Watts, D. J. (2003). *Six Degrees: The Science of a Connected Age.* New York: W. W. Norton & Company.

77. Watts, D. J. "A Simple Model of Global Cascades on Random Networks." *Proceedings of the National Academy of Sciences*: Vol. 99(9) (April, 2002): pp. 5766-5771.

78. Wikipedia. (2006). "Scale-Free Networks." *Wikipedia Website.* Available online: www.wikipedia.org (Accessed June, 2006).

79. Wikipedia. (2006). "1962." *Wikipedia Website.* Available online: www.wikipedia.org (Accessed June, 2006).

80. Wikipedia. (2006). "1982." *Wikipedia Website.* Available online: www.wikipedia.org (Accessed June, 2006).

81. Wikipedia. (2006). "2002." *Wikipedia Website.* Available online: www.wikipedia.org (Accessed June, 2006).

82. World Bank. (1993). *The East Asian Miracle: Economic Growth and Public Policy.* New York: Oxford University Press.

83. World Bank. (2006). "Definitions and Causes of Contagions." *World Bank Website.* Available online: http://www1.worldbank.org/economicpolicy/managing%20volatility/contagion/definitions.html#herding (Accessed June, 2006).

84. Yusuf, S. (2001). "The East Asian Miracle at the Millennium." In *Rethinking the East Asian Miracle*, J. E. Stiglitz and S. Yousif, Eds. New York: Oxford University Press.

APPENDIX A: SOME NOTES ON DATA METHODOLOGY

In this project, we originally sought to answer the question: "what is the world?"[112] While this question lacked direction and purpose, we started considering graph theory and trade while seeking to answer it. Eventually, we realized that a question would not be a practical way of framing the research contained in the preceding pages as a question usually implies a thesis, and in this work, we present system structures rather than an argument.

To get to the point of identifying the international system, much needed to be done with data. All export data was compiled from UN Comtrade data from 1962-2003.[113] We excluded 2004 because not all trade relationships had been reported at the time of the analysis, while we started our observations with 1962 as this was the earliest year that Comtrade offered. In order to compile the data online, Behram Mistree wrote a computer program which interacted with the Comtrade website, and then gathered and sorted the information. The program was then instructed to remove observations that were not countries. For instance, the data includes "Special Categories," "Asia, nes," and the South African Customs Union, all of which were not countries. These were all removed.[114]

Following the collection and programmed processing of the data, the data was further processed. Finding certain quirks in the data, we had to combine varying labels for the same country: for instance, where India had not been included due to a labeling

[112] This question was constructed by Behram.
[113] We used the online database, but we checked several of the numbers against the print edition of Comtrade. We also used the print edition to add observations for the Soviet Union, which were inexplicably missing from the online datasets.
[114] It should be noted that during part of the research, the program was not fool-proof and we did have to go back by hand and delete several observations.

difference in the earlier years, we renamed "India, excl. Sikkim," which was present at that point, as "India;" where the label for the United States before 1981 was listed as "USA (before 1981)" we switched it to "USA." A complete list of terminology adjustments is presented in the table below. Other from these changes, the data in our datasets entirely reflects what is contained in the US Comtrade database.[115]

USA (before 1981) to USA
Fmr USSR to USSR
India excl. Sikkim to India
Fmr Fed. Rep. Of Germany to W. Germany
Peninsula Malaysia to Malaysia
Réunion to Reunion
East and West Pakistan to Pakistan
CÃ´te d'Ivoire to Cote d'Ivoire
Côte d'Ivoire to Cote d'Ivoire
Fmr Yugoslavia to Yugoslavia
Fmr Dem. Rep. Of Germany to E. Germany
Fmr Dem. Yemen to S. Yemen
Fmr Ethiopia to Ethiopia
Lao People's Dem. Rep. To Lao
TFYR of Macedonia to Macedonia
Viet Nam to Vietnam
Fmr. Rep. Of Vietnam to Vietnam
Fmr Arab Rep. Of Yemen to N. Yemen
United Rep of Tanzania to Tanzania
Russian Federation to Russia
Rep. of Tanzania to Tanzania
Fmr Panama excl. Canal Zone to Panama
Fmr Tanginyika to Tanginyika
Delete Special Categories
Delete Free Zones
Delete Fmr Panama-Canal-Zone
Delete Other Asia, nes
Delete EU, nes
Delete Areas, nes
Delete Caribbean, nes
Delete Oceania, nes
Delete Other Africa, nes

[115] The data in the online Comtrade database and the data in the published version of the Comtrade database are reasonably similar with the notable exception that some observations for the USSR are not in the online version. We manually added these observations.

After organizing the data, we placed it in four different formats. First, we made dyadic relationships of every major trade relationship between every country from 1962-2003. We made two separate sets of these dyadic relationships, one where we included and indicated non-existent relationships, and another set where we excluded relationships that were zero. These dyadic relationships were especially useful for running CFinder, Netdraw, and Pajek.

The second format was laid out to show the average number of degrees for each country over time. Just eye-balling the figures in the average degree lists from 1962-2003 shows many interesting patterns: for instance, Saudi Arabia and several other oil countries excel while other countries lose trade independency. We plan on using this data for future studies.

In the third format, we listed the nodal clustering coefficient for each country over time. Given three countries where A and B trade, and B and C trade, he nodal clustering coefficient shows the likelihood that A and C trade. This is determined along the following equation:

$$C_i = \frac{\text{number of triangles connected to vertex } i}{\text{number of triples centered on vertex } i},$$

(From Newman, 2003).

In order to determine the overall clustering coefficient of the network rather than the node, we looked at the average clustering coefficient of each year.

In the final format, we listed the average degree of separation for every country over time. The average degree of separation is computed by counting the number of relationships divided by the number of relationships possible. The nodal average degree of separation gave rise to the worldwide average degree of separation, and to the normalized average degree of separation. One of the big challenges with our data was that from 1962-2003, several new countries formed and began to flourish. To normalize the average degree of separation, we divided by the total number of countries involved during that year. The values of the normalized average degrees of separation for the international system are displayed in the table below.

Year	Average Degree Separation	Number of Countries Sampled	Normalized Average Degree of Separation
1962	2.37643	84	0.02829
1963	2.05854	81	0.02541
1964	2.08302	81	0.02572
1965	2.14675	87	0.02468
1966	2.17869	92	0.02368
1967	2.1443	96	0.02234
1968	2.14605	97	0.02212
1969	2.16495	98	0.02209
1970	2.2086	114	0.01937
1971	2.18681	117	0.01869
1972	2.19108	119	0.01841
1973	2.15952	122	0.0177
1974	2.19486	126	0.01742
1975	2.252	131	0.01719
1976	2.14184	131	0.01635
1977	2.14542	131	0.01638
1978	2.10787	128	0.01647
1979	2.15286	128	0.01682
1980	2.13965	127	0.01685
1981	2.09112	121	0.01728
1982	2.06028	115	0.01792
1983	2.07931	117	0.01777
1984	2.06343	111	0.01859
1985	2.06423	111	0.0186

1986	2.0708	109	0.019
1987	2.16636	106	0.02044
1988	2.09542	108	0.0194
1989	2.08308	111	0.01877
1990	2.06881	112	0.01847
1991	2.10523	111	0.01897
1992	2.13472	110	0.01941
1993	2.13492	115	0.01856
1994	2.1315	116	0.01838
1995	2.28307	133	0.01717
1996	2.26601	138	0.01642
1997	2.30147	145	0.01587
1998	2.31227	144	0.01606
1999	2.30501	152	0.01516
2000	2.27686	163	0.01397
2001	2.32558	160	0.01453
2002	2.37357	153	0.01551
2003	2.30077	149	0.01544

After our data was prepared in these three formats, our data was stored in Microsoft Excel files and textfiles. We especially had to put the dyadic data into textfiles so that CFinder, Netdraw, and Pajek could read them. In order to identify submacro cliques, we would take the data in a given year, organize it so that it could be read by CFinder, and then ran CFinder. Less than a second after running the program, CFinder would list several cliques and would provide initial graphing.[116] When these graphs were simple enough to follow, they were used. If the graph images were not easily readable, we would filter the original data using either Excel or Stata to include only the country relationships pertinent to visually representing the clique that had already been identified. Then we would organize the data for Netdraw or Pajek, both established computer programs for graphing networks. We chose Netdraw and Pajek over other software

[116] CFinder was consistent in the number of communities it produced.

(notably GraphViz) because they both were easier to use and were both compatible with Windows.[117]

Once the graph data was entered in Netdraw or Pajek, we would run a *spring embedding function* to display the network. The spring embedding function seeks to minimize the distance of all of the edges in a network while allowing a certain amount of space between the nodes. Each program makes available several different display functions; we experimented with several of these before deciding on the spring embedding function. We would also weight the size of the edges based upon the natural logarithm of the export amount.

[117] Netdraw seems to be based upon Pajek. In our experience, it had a better user interface and ran better than Pajek.

APPENDIX B: A LIST OF THE MEMBERS OF TRADE BLOCS AND THEIR YEARS OF ACCESSION

In Chapter 6, we discuss the effects of trade blocs on various member states. The countries we included in each trade bloc are listed in the table below, with their years of accession. This table is derived from the UNCTAD Handbook on Statistics (2006).

EUROPE:

Group	**Year of Accession**
EFTA (European Free Trade Association) 3	
Iceland	1960
Norway	1960
Switzerland	1960
Euro Zone (of EU) 12	
Austria	2002
Belgium	2002
Finland	2002
France	2002
Germany	2002
Greece	2002
Ireland	2002
Italy	2002
Luxembourg	2002
Netherlands	2002
Portugal	2002
Spain	2002
EU (European Union) 25	
Austria	1995
Belgium	1957
Cyprus	2004
Czech Republic	2004
Denmark	1973
Estonia	2004

Finland	1995
France	1957
Germany	1957
Greece	1981
Hungary	2004
Ireland	1973
Italy	1957
Latvia	2004
Lithuania	2004
Luxembourg	1957
Malta	2004
Netherlands	1957
Poland	2004
Portugal	1986
Slovakia	2004
Slovenia	2004
Spain	1986
Sweden	1995
United Kingdom	1973

AMERICAS:

Group	**Year of Accession**
Andean Group (ANCOM) 5	
Bolivia	1996
Colombia	1996
Ecuador	1996
Peru	1996
Venezuela	1996
CACM (Central American Common Market) 5	
Costa Rica	1962
El Salvador	1961
Guatemala	1961
Honduras	1961
Nicaragua	1961
CARICOM (Caribbean Community) 15	

Antigua and Barbuda	1974
Bahamas	1983
Barbados	1973
Belize	1974
Dominica	1974
Grenada	1974
Guyana	1973
Haiti	1997
Jamaica	1973
Montserrat	1974
Saint Kitts and Nevis	1974
Saint Lucia	1974
Saint Vincent and the Grenadines	1974
Suriname	1995
Trinidad and Tobago	1973
FTAA (Free Trade Area of the Americas) 34	
Antigua and Barbuda	1994
Argentina	1994
Bahamas	1994
Barbados	1994
Belize	1994
Bolivia	1994
Brazil	1994
Canada	1994
Chile	1994
Colombia	1994
Costa Rica	1994
Dominica	1994
Dominican Republic	1994
Ecuador	1994
El Salvador	1994
Grenada	1994
Guatemala	1994
Guyana	1994
Haiti	1994
Honduras	1994
Jamaica	1994
Mexico	1994
Nicaragua	1994

Panama	1994
Paraguay	1994
Peru	1994
Saint Kitts and Nevis	1994
Saint Lucia	1994
Saint Vincent and the Grenadines	1994
Suriname	1994
Trinidad and Tobago	1994
United States of America	1994
Uruguay	1994
Venezuela	1994
LAIA (Latin American Integration Association) 12	
Argentina	1980
Bolivia	1980
Brazil	1980
Chile	1980
Colombia	1980
Cuba	1980
Ecuador	1980
Mexico	1980
Paraguay	1980
Peru	1980
Uruguay	1980
Venezuela	1980
MERCOSUR (Southern Common Market) 4	
Argentina	1994
Brazil	1994
Paraguay	1994
Uruguay	1994
NAFTA (North American Free Trade Agreement) 3	
Canada	1992
Mexico	1992
United States of America	1992
OECS (Organization of Eastern Caribbean States) 9	
Anguilla	1995
Antigua and Barbuda	1981

British Virgin Islands	1984
Dominica	1981
Grenada	1981
Montserrat	1981
Saint Kitts and Nevis	1981
Saint Lucia	1981
Saint Vincent and the Grenadines	1981

AFRICA:

Group	**Year of Accession**
CEMAC, former UDEAC(Central African Customs and Economic Union) 6	
Cameroon	1994
Central African Republic	1994
Chad	1994
Congo	1994
Equatorial Guinea	1994
Gabon	1994
CEPGL (Economic Community of the Great Lakes Countries) 3	
Burundi	1976
Democratic Republic of the Congo	1976
Rwanda	1976
COMESA (Common Market for Eastern and Southern Africa) 19	
Angola	1994
Burundi	1994
Comoros	1994
Democratic Republic of the Congo	1994
Djibouti	1994
Egypt	1994
Eritrea	1994
Ethiopia	1994
Kenya	1994
Madagascar	1994

Malawi	1994
Mauritius	1994
Rwanda	1994
Seychelles	1994
Sudan	1994
Swaziland	1994
Uganda	1994
Zambia	1994
Zimbabwe	1994
ECCAS (Economic Community of Central African States) 11	
Angola	1999
Burundi	1983
Cameroon	1983
Central African Republic	1983
Chad	1983
Congo	1983
Democratic Republic of the Congo	1983
Equatorial Guinea	1983
Gabon	1983
Rwanda	1983
Sao Tome and Principe	1983
ECOWAS (Economic Community of West African States) 15	
Benin	1975
Burkina Faso	1975
Cape Verde	1977
Côte d'Ivoire	1975
Gambia	1975
Ghana	1975
Guinea	1975
Guinea-Bissau	1975
Liberia	1975
Mali	1975
Niger	1975
Nigeria	1975
Senegal	1975
Sierra Leone	1975

Togo	1975
MRU (Mano River Union) 3	
Guinea	1973
Liberia	1973
Sierra Leone	1973
SADC (Southern African Development Community) 14	
Angola	1992
Botswana	1992
Democratic Republic of the Congo	1992
Lesotho	1992
Malawi	1992
Mauritius	1992
Mozambique	1992
Namibia	1992
Seychelles	1992
South Africa	1994
Swaziland	1992
United Republic of Tanzania	1992
Zambia	1992
Zimbabwe	1992
UEMOA (West African Economic and Monetary Union) 8	
Benin	1994
Burkina Faso	1994
Côte d'Ivoire	1994
Guinea-Bissau	1994
Mali	1994
Niger	1994
Senegal	1994
Togo	1994
UMA (Arab Maghreb Union) 5	
Algeria	1989
Libyan Arab Jamahiriya	1989
Mauritania	1989
Morocco	1989
Tunisia	1989

ASIA:

Group	Year of Accession
ASEAN (Association of South-East Asian Nations) 10	
Brunei Darussalam	1984
Cambodia	1999
Indonesia	1967
Lao People's Democratic Republic	1997
Malaysia	1967
Myanmar	1997
Philippines	1967
Singapore	1967
Thailand	1967
Viet Nam	1995
Bangkok Agreement 6	
Bangladesh	1975
China	2001
India	1975
Lao People's Democratic Republic	1975
Republic of Korea	1975
Sri Lanka	1975
ECO (Economic Cooperation Organization) 10	
Afghanistan	1992
Azerbaijan	1992
Iran, Islamic Republic of	1985
Kazakhstan	1992
Kyrgyzstan	1992
Pakistan	1985
Tajikistan	1992
Turkey	1985
Turkmenistan	1992
Uzbekistan	1992
GCC (Gulf Cooperation Council) 6	

Bahrain	1981
Kuwait	1981
Oman	1981
Qatar	1981
Saudi Arabia	1981
United Arab Emirates	1981
MSG (Melanesia Spearhead Group) 4	
Fiji	1996
Papua New Guinea	1988
Solomon Islands	1988
Vanuatu	1988
SAARC (South Asian Association for Regional Cooperation) 7	
Bangladesh	1985
Bhutan	1985
India	1985
Maldives	1985
Nepal	1985
Pakistan	1985
Sri Lanka	1985

INTERREGIONAL:

Trade Group	**Year of Accession**
APEC (Asia-Pacific Economic Cooperation) 21	
Australia	1989
Brunei Darussalam	1989
Canada	1989
Chile	1994
China	1991
China, Hong Kong SAR	1991
China, Taiwan Province of	1991
Indonesia	1989
Japan	1989
Malaysia	1989
Mexico	1993

New Zealand	1989
Papua New Guinea	1993
Peru	1998
Philippines	1989
Republic of Korea	1989
Russian Federation	1998
Singapore	1989
Thailand	1989
United States of America	1989
Viet Nam	1998
BSEC (Black Sea Economic Cooperation) 11	
Albania	1992
Armenia	1992
Azerbaijan	1992
Bulgaria	1992
Georgia	1992
Greece	1992
Moldova, Republic of	1992
Romania	1992
Russian Federation	1992
Turkey	1992
Ukraine	1992
CIS (Commonwealth of Independent States) 12	
Armenia	1991
Azerbaijan	1991
Belarus	1991
Georgia	1993
Kazakhstan	1991
Kyrgyzstan	1991
Republic of Moldova	1991
Russian Federation	1991
Tajikistan	1991
Turkmenistan	1991
Ukraine	1991
Uzbekistan	1991