

POWER TRANSITION THEORY AND THE GLOBAL ARMS TRADE: EXPLORING CONSTRUCTS FROM SOCIAL NETWORK ANALYSIS

David Kinsella

Hatfield School of Government
Portland State University
kinsella@pdx.edu

Abstract

Structural dimensions of the international system are key elements in power transition theory. Most theoretical applications to date have examined the distribution of power, and fluctuations in that distribution, as a precursor to global and regional warfare. Somewhat less attention has been paid to the coalitional structure of the international system in applied research. In this paper I suggest that certain concepts from power transition theory, including those that rely on information about alliance membership, might also be operationalized by examining the global arms trade using tools developed for social network analysis (SNA). I focus in particular on the SNA concepts of centrality, structural equivalence, and group cohesion.

Power Transition Theory and the Global Arms Trade: Exploring Constructs from Social Network Analysis

Theories of world politics address a myriad of international issues and phenomena, but war, its causes and consequences, is second to none in commanding the attention of empirical research. Of the handful of theoretical frameworks that can be called “structural” – that is, those that find causal explanation in the distribution of military, economic, political, and/or cultural power among actors in the international system – power transition theory has probably undergone the most extensive and thorough evaluation by scholars partial to quantitative methods of measurement and analysis. Most effort has been directed to the operationalization of military and economic power, which simply reflects the primacy of that concept in the theory. Other concepts, namely those pertaining to the coalitional structure of the international system, as well as states’ orientation toward the international status quo, have received somewhat less scrutiny.

In this paper I want to suggest that applied research in the tradition of power transition theory might profit by considering the structural dimensions of the global arms trade when operationalizing certain theoretical constructs. System leadership, contenders for leadership, and the coalitions most closely tied to leaders and contenders are fairly reflected in the patterns of arms transfers between states. Elsewhere I have argued that the global arms trade bears some resemblance to transactions within the sorts of social networks studied by sociologists (Kinsella 2003). The descriptive measures developed as part of the repertoire of techniques known as social network analysis (SNA), when applied to the arms trade, could be employed by researchers engaged in testing power transition theory and extending its empirical scope.

I begin by briefly discussing the global arms trade as a manifestation of the coalitional structure of the international system and highlight the relevance for power transition theory. I then turn to parallels between the arms transfer “network” and networks of individuals interacting in other social settings. The second half of the paper presents some rudimentary structural indicators of the arms trade, and here again I try to suggest the utility of these indicators for applied research in the power transition tradition.

International Competition and the Arms Trade

In a pathbreaking study of the arms trade, researchers at the Stockholm International Peace Research Institute identified three patterns of arms supply. The hegemonic pattern, which they said was epitomized by the United States and Soviet Union during the cold war, involves the use of arms transfers “to support a particular group in power, or to prevent the emergence of an alternative group which might be willing to accept the dominance of another country” (SIPRI 1971, 17). This purpose is recognized clearly by recipients as well as suppliers. Julius Nyerere, the former president of Tanzania: “the selling of arms is something which a country does only when it wants to support and strengthen the regime or group to whom the sale is made. What-

ever restrictions or limits are placed on that sale, the sale is a declaration of support – an implied alliance of a kind” (quoted in Landgren-Bäckström 1980, 231).¹

For power transition theory – as well as for balance of power theory, its closest rival among the state-centric perspectives on war and peace – international coalitions, however they are forged, are important. States benefit to varying degrees from the international order, or status quo, understood as the formal and informal rules that underpin the economic, political, and military relations between nations during a particular period. Those who on balance perceive that the international order is conducive to their national aspirations, are designated by power transition theory as “satisfied” states; those who perceive significant impediments to their aims are “dissatisfied.” Because the system leader, or dominant state, wields disproportionate influence over the international rules of the game, satisfied states have a greater stake in that state’s continued leadership. Dissatisfied states are more likely to throw their lot in with one of their own who has acquired the capability to mount a credible challenge to the system leader, in the hopes that the international order can be remade to their benefit (Organski 1968; Kugler and Organski 1989; Tammen et al. 2000).

Power transition theory was originally developed to explain great power politics and major wars, which are predicted to occur during periods when there is rough parity between the capabilities of the dominant state and the challenger – that is, when a transition in the international order looms. Testing of the theory has been mainly a dyadic exercise, since, as a historical matter, dominant states and their challengers are readily identifiable, as are the wars they fought. The central preoccupation has been on how best to model the dynamics of the power transition itself and to relate this to the outbreak or deterrence of major power war (e.g., Werner and Kugler 1996; Kaldera 1996, 2001). With attempts to extend power transition theory beyond the realm of great power politics comes a new empirical challenge: how do we judge minor states’ orientation toward the international order, and how do we operationalize their membership in coalitions of satisfied or dissatisfied states? (e.g., Lemke 1996, 2002).

In applied research, satisfaction and dissatisfaction with the status quo is sometimes inferred from alliance patterns (Kim 1992, Lemke and Reed 1996). Following Bueno de Mesquita (1981), those states with alliance portfolios – consisting of defense pacts, non-aggression pacts, and ententes – similar to the portfolio of the system leader are presumably content with the international order and have less to gain from the leader’s defeat. However, difficulties arise when testing power transition theory at the periphery of the international system because there is so little variation in minor power alliance portfolios that these states cannot be effectively distinguished based on the standard measures of alliance correspondence (Lemke 2002, 100-101).

It is possible that this problem can be overcome by operationalizing satisfaction and dissatisfaction based on arms transfer patterns. Like alliances, arms transfers signal a relationship between supplier and recipient. Although some transfers involve little more than the minimal obligations attending typical international market transactions, arms transfer relation-

¹ SIPRI (1971) also identified the industrial pattern of supply, where exporting states are concerned with maintaining the economic viability of their own defense industries, and the restrictive pattern of supply, where producing states seek to minimize their involvement in local conflicts by refusing to equip actual or potential belligerents.

ships often indicate a similarity in foreign policy outlook and a security commitment on the part of the supplier. This congruence may be most evident during periods of intense global competition, like the cold war, when the international system seems to be approaching a power transition.

The Arms Transfer Network

In referring to the arms transfer *network*, I mean to distinguish it from an arms *market*. A market is a social entity that governs transactions between producers and consumers by way of a price mechanism, and economists typically locate pure markets at one end of a range of possible arrangements for the exchange of goods and services. This is the anarchic end. No authority is exercised in a pure market; economic production is governed by prices, which result from individual decisions affecting supply and demand. At the hierarchical end are organized social entities like firms. Within a firm, economic production is governed by an entrepreneur, whether an individual or a collective, who directs the allocation of resources within the organization. One of the questions that has occupied economists is: Under what circumstances do markets give rise to hierarchical organizations as a means of coordinating economic exchange?

The classic treatment of this issue is by Coase (1937, 392), who maintained that “the operation of a market costs something and that, by forming an organization and allowing some authority (the ‘entrepreneur’) to direct the resources, certain marketing costs are saved.” In contemporary scholarship, these sorts of costs are termed “transaction costs,” and they generally derive from the inefficiencies associated with incomplete information (e.g., Williamson 1981). Some economic transactions involve uncertainties – e.g., about continued access to specialized inputs into the production process – and although these might be handled by entering into contracts, the continual negotiation and renegotiation of contracts is costly. Such transaction costs, at least some of them, can be eliminated if the parties enter into an exchange relationship governed according to the bylaws of a hierarchical organization. Under these circumstances, firms will realize efficiencies not available in the open market and economic production and exchange will become more profitable.

Where should we locate the global arms trade on the anarchy-hierarchy continuum? In the international system, states can be treated as the analogues to firms in the market (Waltz 1979). Their internal affairs are organized hierarchically, but sometimes they choose, in their external affairs, to collaborate with others as members of intergovernmental organizations. Such collaboration is initiated with the signing of treaties or charters, which are essentially contracts. Occasionally, states have taken small steps toward vertical integration, whereby certain international organizations are endowed with a degree of supranational authority over their activities in specific functional areas. But no such entities exist today that direct or coordinate the arms transfer policies of supplier states. The closest approximations, both of which seek to set limits on the conventional arms trade, are the Wassenaar Arrangement and the Missile Technology Control Regime (MTCR). However, both agreements bear more resemblance to arm’s-length contracts (largely unenforceable) among independent firms than they do hierarchical arrangements in which supranational authority can be exercised over member states’ arms-supply

decisions. Wassenaar and the MTCR are no different from other arms control agreements in this respect.

Patterns of economic exchange governed by more than market forces but by less than hierarchical organizations have been of considerable interest to sociologists. Granovetter (1985), for instance, has echoed the common criticism of the neoclassical economic approach to organization as offering a utilitarian and “undersocialized” conception of human action in which little allowance is made for the impact of social relations on economic exchange (except as a drag on the efficient allocation of resources). At the same time, early sociological correctives tended to propose “oversocialized” conceptions of behavior whereby individuals simply, and somewhat robotically, internalize societal norms, also leaving little room for the impact of ongoing social relations (see also Wrong 1961). For Granovetter and others, economic behavior is governed not only by institutional arrangements designed to discourage malfeasance and reduce transaction costs, or by a “generalized morality” instilled through the socialization process, but also by trust. Economic action is embedded in ongoing social interaction and more emphasis needs to be placed on “the role of concrete personal relations and structures (or ‘networks’) of such relations in generating trust and discouraging malfeasance” (Granovetter 1985, 490).

In departing from transaction-cost explanations, sociologists who study economic organization are not abandoning the notion of rational action. They are suggesting that social constraints, or “embeddedness,” often makes seemingly nonrational behavior appear quite reasonable. Many economic transactions “aim not only at economic goals but also at sociability, approval, status, and power” (Granovetter 1985, 506). In realm of world politics, those studying the arms production and transfer system have frequently observed that the arms acquisition policies of both developed and developing states don’t always make sense in terms of either military or economic efficiency. The “rationality” of those procurement patterns becomes apparent only when taking into account less material motives like status, prestige, and the symbols of modern statehood (e.g., Kaldor 1981; Suchman and Eyre 1992; Eyre and Suchman 1996; Wendt and Barnett 1993; Kinsella and Chima 2001). And no less an authority than Hans Morgenthau (1985, 86-87), realism’s chief exponent, believed that “prestige, however exaggerated and absurd its uses may have been at times, is as intrinsic an element of the relations between nations as the desire for prestige is of the relations between individuals.”

Inquiry into the role of social relations in the emergence of various forms of economic organization is of fairly recent origin in sociology. But much of the research that has been done on interpersonal relations in economic life focuses on the creation and maintenance of social networks. Less anarchic than markets, networks of economic actors are at the same time not hierarchically organized. Where price serves as a control mechanism in markets and authority serves that function within a vertically integrated firm, personal relationships, typically characterized by trust and a norm of reciprocity, are the glue that binds a social network together. It may well be that, under conditions conducive to social networks, hierarchically organized social entities are not required as a means of reducing uncertainty and managing transaction costs, but from a sociological point of view that begs some important questions. What are those conditions? To what extent can they be explained by the social, cultural, and political practices that

embed economic interaction? Alternatively, to what extent can they be explained by the nature of particular forms of economic exchange?

Powell (1990) addresses the last of these questions, maintaining that some forms of exchange are inherently more social than others. They depend not so much on formal authority, but on shared interests and ongoing relationships. In network forms of exchange, “the entangling of obligation and reputation reaches a point that the actions of the parties are interdependent.” The pattern of interaction “looks more like a marriage than a one-night stand, but there is no marriage license, no common household, no pooling of assets” (Powell 1990, 301). Whereas market transactions are undertaken to maximize returns in the short and medium term, network exchanges are sequential and contribute to an overall pattern of enduring interaction. Much of what is exchanged in social networks is difficult to price – know-how and styles of production, for example – so the flow of information through networks is often “richer” than what is transmitted by the price mechanism in markets or by controlled channels of communication within a vertically integrated firm. Finally, because the mechanism of governance rests largely on trust and obligation, network forms of organization function well when composed of homogenous groups of actors. The opportunism and guile contributing to high transaction costs in the impersonal market setting is less common among those sharing professional, ethnic, or ideological backgrounds, and thus hierarchical governance structures are less likely to emerge.

The arms trade is characterized by some of the same features found in network forms of economic organization. Decisions to supply and purchase weaponry are often elements in ongoing arms-transfer relationships. In the case of state-sanctioned transfers, they are elements of more general military relationships. The supply of finished weapons systems can be accompanied by instruction in the operation and maintenance of equipment, construction of support facilities, and other forms of technical assistance. Arms transfers are, in many instances, embedded in relationships of mutual defense – e.g., weapons flows between members of formal military alliances like NATO – or in less formal commitments by suppliers to the security of recipient states. Those more general military relations, whether formal or implied, may also involve basing and overflight rights, military training and joint exercises, the coordination of strategy and tactics, the sharing of military intelligence, and other forms of collaboration intended to enhance the security of both parties to the transaction. While particular arms-transfer agreements may take the form of arms-length contracts, much of their meaning is lost if they are extracted from this “social context.” Instead of contracts, they may actually resemble long-term investments in mutually beneficial interstate relationships.

Consistent with Powell’s (1990) description of exchanges within networks, it is difficult to attach a value to the political and military commitments that often accompany arms transfers between states. In addition to interstate commitments, weapons supplies embody the transfer of military technology, and many deals include arrangements for the licensed production of military equipment by the recipient. This flow of technology and know-how between states, which is also hard to price, is an important feature of the contemporary arms trade and has had a measurable impact on the emergence of a “third tier” of arms producers in the international system (Krause 1992; Bitzinger 1994; Kinsella 2000). Thus, the information and meaning embodied in arms transfers can be substantially richer than what might be indicated by the market or military-use value of the weapons themselves.

Much more is involved in these transactions than a shipment of some increment of destructive capability from one to another state. Because arms transfers are indicative of the supplier's commitment to the recipient's security, as well as the recipient's expectation (perhaps backed up with certain concessions) that it can count on this commitment into the future, the most significant and enduring arms-transfer relationships link states with congruent foreign policy orientations. During the cold war, for instance, the United States and its allies tended to supply arms to states whose policies were generally in accord with the global political-economic status quo, while the Soviet Union and its allies tended to supply dissatisfied or revisionist states (Kinsella 1994, 1995). There was, then, in the arms-transfer network a certain homogeneity among states with the closest and most dependable ties. Such shared foreign policy orientations are not unlike the shared backgrounds (professional, ethnic, religious) that help sustain social networks comprised of individuals.

Although the particular characteristics of the global arms trade suggest parallels to social networks, I believe that the network concept itself is generally compatible with power transition theory's point of departure compared to other structural theories in the realist tradition. Waltz (1979, 114) acknowledges that international politics is "flecked with particles of government and alloyed with elements of community," and that such systems can be thought of as being "more or less anarchic." However, he cautions that the presence of hierarchical elements within the international system does not change its fundamental ordering principle, which he insists is anarchic. Power transition theory, on the other hand, begins by rejecting this very argument: "the first assumption is that the international system is hierarchical rather than anarchical" (Lemke and Kugler 1996, 8). The hierarchical dimensions of the international system that neorealists downplay but power transition theorists highlight – those evidenced by shared commitments to a particular international order – are the just the sorts of organizing mechanisms highlighted by social network theorists.

Social Network Analysis

The focus of social network analysis (SNA) is less on the attributes or behavior of actors than it is on the structural dimensions of their social environment, which are distilled from the overall pattern of relationships or exchanges among the actors. The "social network" itself is defined as the group of actors and the relationships or interactions that link them, and SNA methods are applied once it is assumed (or demonstrated) that a group of actors constitutes a network. That is, SNA is not a means of distinguishing networks from other forms of social organization, like anarchical or hierarchical forms, nor does it provide a way to assess how "networky" a given social grouping is or is not. The premise of SNA is that the organization of a set of interrelated actors bears some resemblance to a social network and that it is therefore useful to examine its structural features.²

² The most authoritative and comprehensive guide to the methods of social network analysis is probably Wasserman and Faust (1994). For a briefer overview, see Scott (2000).

For my purposes, the unit of analysis is the arms-transfer relationship connecting two states. States, then, are the *actors* in the network and the existence of a relational *tie* or *link* is indicated by whether one state in the dyad supplied weapons to the other state. An arms transfer is a *directed* tie in that it represents the flow of military resources from one actor to another. Such directional information is not always relevant for an analysis of interstate military relationships; arms flows may be simply an indicator of more general and mutually beneficial security ties between a supplier and a recipient.³ However, in this study, if a state is neither a supplier nor a recipient of arms transfers, then it remains outside the network. For any given year, the data analyzed consists of a square “sociomatrix” in which there is both a row and a column for each actor in the network. A cell in the matrix contains a 1 if the state represented by row i , designated n_i , transferred arms to the state in column j , designated n_j , in which case $x_{ij} = 1$; otherwise $x_{ij} = 0$. The main diagonal of the sociomatrix, where $i = j$, is ignored.⁴ The presence or absence of an arms-transfer relationship is based on data collected by the Stockholm International Peace Research Institute, which is released annually in the institute’s yearbook, *Armaments, Disarmament and International Security*.

Actor Centrality: Leader and Contenders

In most empirical applications of power transition theory, system leadership and potential leadership are operationalized on the basis of material capabilities (e.g., the composite capabilities index developed by the Correlates of War project). Yet the theory also defines the system leader and contenders for system leadership in reference to their influence over other states in the system with similar orientations toward the international status quo. Of course, I am suggesting that an arms supply relationship is a useful measure of such influence.

The *outdegree* of state i , $d_o(n_i)$, is the number of other states to which n_i has transferred arms; *indegree*, $d_i(n_j)$, is the total number of states supplying arms to n_j . That is,

$$d_o(n_i) = \sum_{j=1}^g x_{ij} \quad \text{and} \quad d_i(n_j) = \sum_{i=1}^g x_{ji},$$

which are, respectively, the row i and column j totals of the sociomatrix. If there are g states in the network, the maximum number of directed ties between states is $g(g-1)$. In most social

³ Some SNA methods are adapted from graph theory in mathematics, so networks are often referred to as graphs consisting of nodes or vertices (actors) and lines or edges (ties). See Barnes and Harary (1983) and Harary, Norman, and Cartwright (1965).

⁴ There are SNA procedures that work with valued data – in the present context, for example, the total dollar equivalent of arms transferred between states – but my analysis is based only on binary data indicating the presence or absence of an arms transfer in a particular year. Some more elaborate techniques, including some statistical estimators, make use of information about the attributes of actors as well as their ties. See Wasserman and Faust (1994, chaps. 10 and 15).

networks, certain actors are more prominent than others, maybe because they are elites, and the evidence of their prominence is often the number and type of social ties they maintain with other actors. In the arms trade network, the leading arms suppliers occupy such positions of prominence. The *centrality* of a network actor is sometimes indexed as its outdegree or indegree (or both), but since these measures are greatly affected by the number of actors in a network, it is useful to normalize the index, especially for purposes of cross-temporal comparison. Thus, a normalized centrality index for arms suppliers, $C'(n_i)$, can be computed as

$$C'(n_i) = \frac{d_o(n_i)}{g-1} .$$

If a state supplied weapons to every other state in the network, it would have a centrality measure of 1. The centrality index for recipients is computed similarly, except that indegree, $d_i(n_j)$, is used in the numerator.⁵

Figures 1 and 2 each consist of diagrams of the arms trade network at four points since the end of World War II: 1955, 1970, 1985, and 2000. The “sociograms” shown in Figure 1 give an overview of the network and we can see that the most central actors resemble airport “hubs” in an air transportation network. These sociograms can be rearranged to further highlight prominent and peripheral actors. For the diagrams in Figure 2, each state is displayed in concentric rings corresponding to its centrality as an arms supplier. Most states are not arms suppliers, so they appear around the perimeter of the graphs. In all four years, and indeed throughout the entire period, the United States has been the supplier with the highest centrality measure, so it appears in the center of each graph. The lines connecting the nodes of the graph indicate the presence of an arms-transfer relationship during the year, so the diagrams also give a sense of the changing density of the network over time. Of the four years drawn, the arms trade network was densest in 1985.

[Figures 1 and 2 about here]

⁵ The idea of centrality can also be generalized to an entire network. A more centralized arms-trade network is one in which there are relatively few suppliers of relatively high centrality. A centralized network can also be conceived as one with few actors with high indegree centralities, but to the extent the arms trade network has become more or less centralized over time, it is due to the centrality of suppliers, not recipients. For arms suppliers, an index of network *centralization* starts with the deviation between each actor’s outdegree, or number of clients, and the outdegree of the supplier with the largest number of clients (which, for the 1950-2000 period, is always the United States, the system leader). This deviation is summed over all actors and expressed relative to the sum of deviations that is the maximum possible for a network of g actors:

$$C = \frac{\sum_{i=1}^g [d_o(n^{\max}) - d_o(n_i)]}{(g-1)^2} ,$$

If all actors were suppliers with similar centrality measures, the centralization index would be close to 0; when a single supplier dominates the network, the index is close to 1.

Another pattern apparent from Figure 2 is that over time other suppliers have moved closer to the center. Throughout the period, Britain consistently has been a fairly central supplier, but it is France that has come closest to rivaling the United States. Russia, of course, was the main ideological alternative to the Western arms suppliers, and in terms of the volume of its arms supplies, it really did rival the United States. But in terms of the number of states with whom it maintained arms-transfer relationships, it has been somewhat less central than France, at least since the late 1960s, and more on par with Britain. The diagrams also show the emergence of lesser second- and third-tier arms suppliers closer to the perimeter of the graphs. China, for instance, is identified by power transition theorists as the most likely challenger to the United States for system leadership. In Figure 3, annual centrality measures for the United States, Russia, and China are plotted over time.

[Figure 3 about here]

Structural Equivalence: Leader and Contenders

A different kind of mapping can shed light on the structural positions of arms suppliers and recipients. A “position” in a social network is understood as a particular set of relations with particular groupings of actors. Two or more actors who occupy similar positions in the network structure have similar relations with those groupings. Two or more actors are *structurally equivalent* if they have exactly the same ties to all other actors in the network. Rarely are actors structurally equivalent, except in trivial ways, so the task for SNA is to determine how close actors’ positions are to one another.

The Euclidean distance between actors i and j , d_{ij} , is measured based on the presence or absence of relations with all other actors in the network. This distance can be computed with respect to either directed or undirected ties, but my interest here is directed ties – i.e., arms supplies from i and j to the $g - 2$ other states, as well as arms receipts by i and j . Therefore,

$$d_{ij} = \sqrt{\sum_{k=1}^g (x_{ik} - x_{jk})^2}$$

for $i \neq k$ and $j \neq k$. This is simply the total difference between row i and row j of the sociomatrix. For structurally equivalent actors, $d_{ij} = 0$, and for all other pairs, $d_{ij} > 0$. The maximum Euclidean distance between a pair of actors, occurring when the pair has different ties to all $g - 2$ other actors, is $\sqrt{2(g - 2)}$. The pairwise distances between arms suppliers is used to construct a symmetric $g \times g$ matrix, $\mathbf{D} = \{d_{ij}\}$, and this new distance matrix becomes the raw data for a map of the arms trade network in two-dimensional space. For purposes of visualization, the distances between the actors on this map should correspond as closely as possible to the Euclidean distances in \mathbf{D} , and to that end multidimensional scaling (MDS) can be employed to obtain each actor’s coordinates in two dimensions from the distance matrix.

Figure 4 shows the network maps for the years 1955, 1970, 1985, and 2000. Each state’s position is determined by essentially two discrete bits of information: the number of links to

other states, whether as a supplier or a recipient, and the identity of those other states. All the diagrams include a large clump of states near the intersection of the two axes, which represents these states' network positions as arms recipients and not suppliers. As can be seen from the 1955 map, far from that position, and far also from each other, are the United States and Britain. No other arms suppliers had significant numbers of clients, so they remain relatively close to the origin. Compared to the other suppliers, the U.S. and Britain supplied a large number of states, but mainly different states, which accounts for structural dissimilarity. By 1970, the network's supplier structure had changed significantly. Now the greatest distance is found between the two superpowers, with France and Britain occupying similar middling positions between them. The scaling procedure positions suppliers with overlapping client portfolios along the same radial. Other Western suppliers are still rather close to the origin, given that the Western arms trade was dominated by the U.S., Britain, and France. Within the other cold war bloc, Czechoslovakia by this time emerged as a significant arms supplier, although still some distance from Russia.

[Figure 4 about here]

There was no radical change in this basic supplier structure through 1985, shortly before the cold war began to unravel. However, France had come to occupy a more central position in the network, still midway between the superpowers, while Britain's position had gravitated closer to the American radial, suggesting an increased similarity in their client bases. Since the end of the cold war, a more pronounced structural shift has taken place. The greatest positional distance remains that between the former cold war rivals, an indication of the endurance of cold war arms-transfer relationships. But now most other major arms suppliers are arrayed, somewhat loosely, around the same radial along with the United States. The U.S. still transfers weapons to many more states, but many recipients of American arms are also importing arms from European and other suppliers.

These findings seem to reinforce and amplify what is implied by the general pattern of network decentralization. The structure of the contemporary arms trade allows for a good deal more competition among suppliers than is suggested by the huge share of global arms exports currently coming from the United States. Several other major suppliers now maintain arms-transfer relationships with a largely overlapping set of recipient states. The supply of weaponry tends to signal more than an arms-length market transaction between supplier and recipient, so the potential exists for increased arms flows through the network's existing channels. At the same time, the strong ideological element characterizing many of the relationships established and maintained during the cold war has vanished. Consequently, the economic motives behind states' arms-supply policies have gained in relative importance. The global arms trade will retain key properties of a social network, but its changing structure may also provide for a smoother functioning of the price mechanism in both the production and transfer of weaponry.

Now, power transition theorists surely do not need to consult the structure of the global arms trade to help them identify the system leader and the potential challengers to the international status quo. On the other hand, applied research might profit from broadening the concept of power to incorporate, in addition to material capabilities, some measure of global prominence or influence. The state's centrality in the arms trade network is one candidate. Likewise,

researchers may want to construct a time-variate measure of leadership contention, one based on the coalitional structure of the international system. One possibility is the structural distance between contenders and the system leader as global arms suppliers. Figure 5 plots these distances for Russia, China, France, and Britain over the 1950-2000 period (in five-year intervals).

[Figure 5 about here]

Group Cohesion: Satisfied and Dissatisfied States

Earlier I mentioned that one of the difficulties encountered when extending power transition theory to the periphery of the international system is operationalizing satisfaction and dissatisfaction with the existing international order. Concordance between a state's alliance portfolio and that of the system leader has been used, but Lemke (2002) points out that this indicator does little to distinguish states comprising the system's local hierarchies. However, shared orientation toward the status quo might be measured using one of the *group cohesion* indices developed by social network analysts.

Group cohesion has been operationalized in multiple ways; I want to focus on the *clique*. The sociograms shown in Figure 1 are also referred to as graphs, and a subgraph is simply a subset of network nodes along with any links between them. A clique is a subgraph consisting of at least three nodes, each linked to all others, and meeting the additional condition that there are no nodes in the network that are also linked to each of these nodes. The subgraph is said to be "complete" and "maximal." In 1980, for example, in an arms trade network comprised of 117 nodes and 300 links, there were 107 cliques. The United States, Canada, and Ecuador were a clique, as were Russia, China, and Romania. The United States was a member of 69 of the 117 cliques; Russia, 15; China, 2; France, 21; and Britain, 21. In lieu of alliance similarity, we might operationalize satisfaction with the status quo as clique comembership with the system leader (or with its major power allies), and dissatisfaction as clique comembership with the contender(s) for system leadership.

There are other variations on the clique construct (see Wasserman and Faust 1994, 256-267). Most of them ease the requirements for membership in the group. In the case of an *n*-clique, the nodes are linked directly *or indirectly* by a path of *n* or fewer links. For $n > 1$, both the number and size of cliques increases; so too will the variation in states' clique comembership counts. One downside of *n*-cliques is that group cohesion is also diluted. One corrective is to allow indirect links, but to exclude nodes when their indirect links to other members of the clique involves a nonmember. Cliques meeting this requirement have been dubbed *n*-clans. Requirements for group membership can be relaxed further by allowing in nodes that are connected to some minimum number of other group members rather than all group members (*k*-plexes or *k*-cores).

The usefulness of these and other group cohesion constructs for power transition research remains to be demonstrated. I doubt that any of them can be judged appropriate – whether applied to the arms trade or some other coalitional indicator – without doing the computations,

assessing their face validity, and comparing the measures to alternatives like the τ_b and S scores used as indicators of alliance similarity (see Signorino and Ritter 1999). I do not attempt such an analysis here, but Table 1 does show some correlations between clique comembership counts for the 1950-2000 period. For each state involved in the arms trade, as a supplier and/or recipient, the number of clique memberships they share with the United States, France, Britain, Russia, and China was computed for five-year intervals. As the table suggests, comembership in U.S., French, and British cliques is positively correlated, ranging between .45 and .70. All three are satisfied powers, so the association is what we would expect. Correlations between comembership in these satisfied states' cliques and those of contenders like Russia and China are generally low – slightly negative for comembership with Russia, slightly positive for comembership with China. I would have expected to observe moderate to strong negative relationships in both cases. However, comembership in cliques involving Russia and China is positively correlated (.49), as expected, suggesting that dissatisfied states seek out others of their ilk in the global arms trade.

[Table 1 about here]

The last two lines in Table 1 are correlations with two commonly used proxies for satisfaction with the international status quo, both of which measure the correspondence between a state's alliance portfolio and that of the system leader, the United States. The correlations with membership in U.S., French, and British arms trade cliques are positive but fairly modest, while the correlations with membership in Russian and Chinese cliques are negative, though even more modest. The coalitional structure of global arms trade does seem bear some resemblance to the alliance structure of the international system, but the correspondence is not strong – a matter deserving further investigation.

Conclusion

Network forms of organization are nonanarchical and nonhierarchical. Relations among actors in networks are guided by mechanisms of “governance without government,” and such mechanisms are manifest in many realms of international and transnational relations (e.g., Rosenau and Czempiel 1992). In contrast to some other structural realist frameworks, power transition theory emphasizes precisely this notion of order over anarchy. Applied research in this tradition is therefore amenable to the constructs and empirical tools developed for social network analysis.

In this paper I have argued that the global arms trade should be understood not as a market but as a network, one that shares some important properties with networked forms of organizations studied by sociologists. I have also suggested that the application of social network analysis to the global arms trade may be of some use to power transition research. In particular, the arms trade can serve as an indicator of the coalitional structure of the international system, one perhaps more nuanced than formal alliance patterns. Because power transition theory conceptualizes system leadership not only in terms of material capabilities, but also in terms of global influence, the centrality of major suppliers in the arms transfer network could be incorporated into power transition models as an indicator of this coalitional dimension of

leadership. The structural distance between suppliers is another potentially useful indicator. For instance, China is most often identified as a potential challenger to U.S. leadership in the coming decades based on its material capabilities (Tammen et al. 2000, chap. 7). However, further narrowing of the structural distance between these two major powers might suggest an increasingly compatible orientation toward the international status quo. Indeed, assessing a state's satisfaction or dissatisfaction with the international order remains a significant puzzle for empirical research, especially as the theory is used to explain stability and instability in the periphery of the international system. Here too network analytic constructs, those relating to group cohesion, may offer some alternatives to the problematic measures currently available.

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Table 1 Correlations for Clique Comemberships, 1950-2000.

	U.S.	Britain	France	Russia	China
Britain	.69				
France	.65	.45			
Russia	-.06	-.06	-.04		
China	.09	.01	.22	.49	
Alliance (τ_b)	.34	.25	.22	-.16	-.07
Alliance (S)	.34	.24	.22	-.13	-.02

Note: For correlations with the alliance measures, $n = 1042$; for other correlations, $n = 1057$. Correlations over .06 are statistically significant.



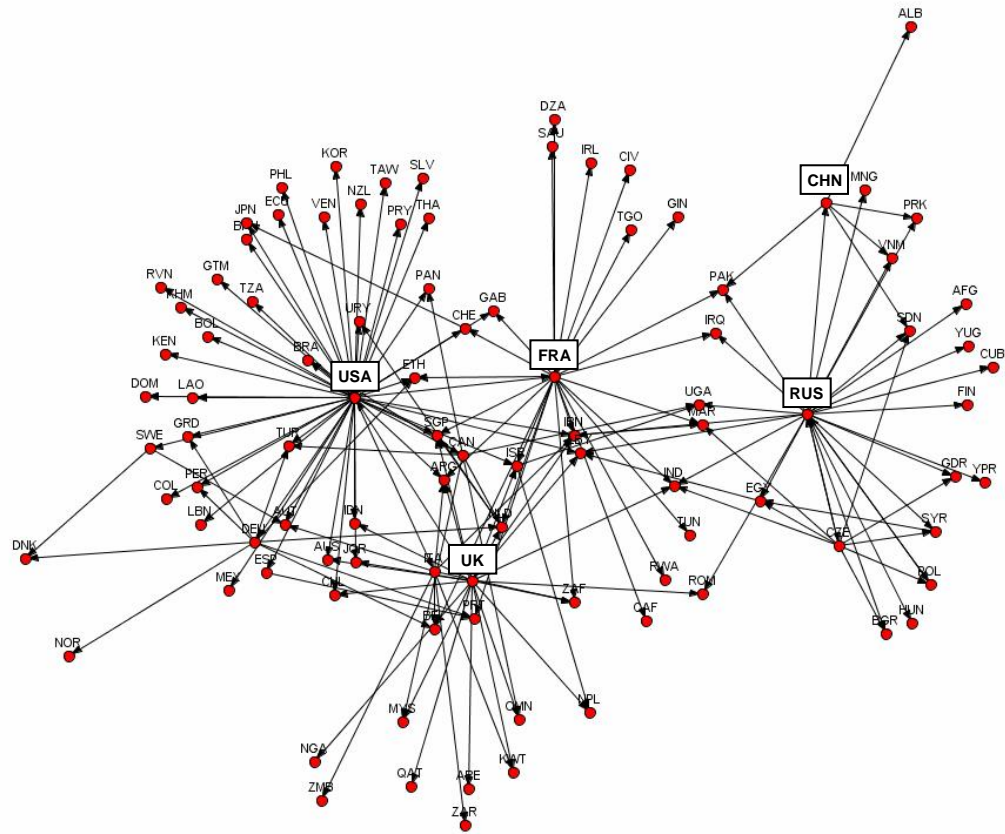


Figure 1b: Supplier Sociogram, 1970





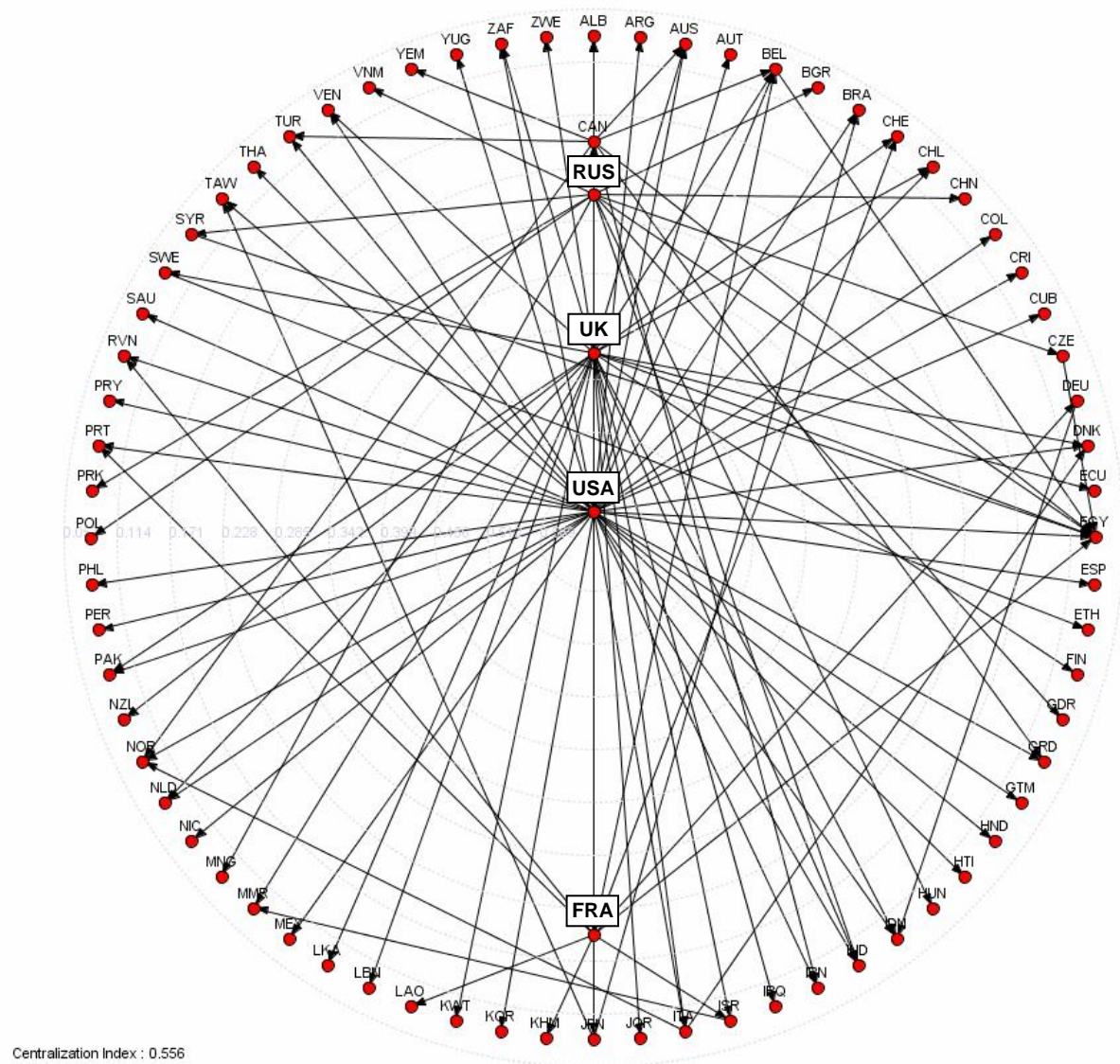


Figure 2a: Supplier Centrality, 1955

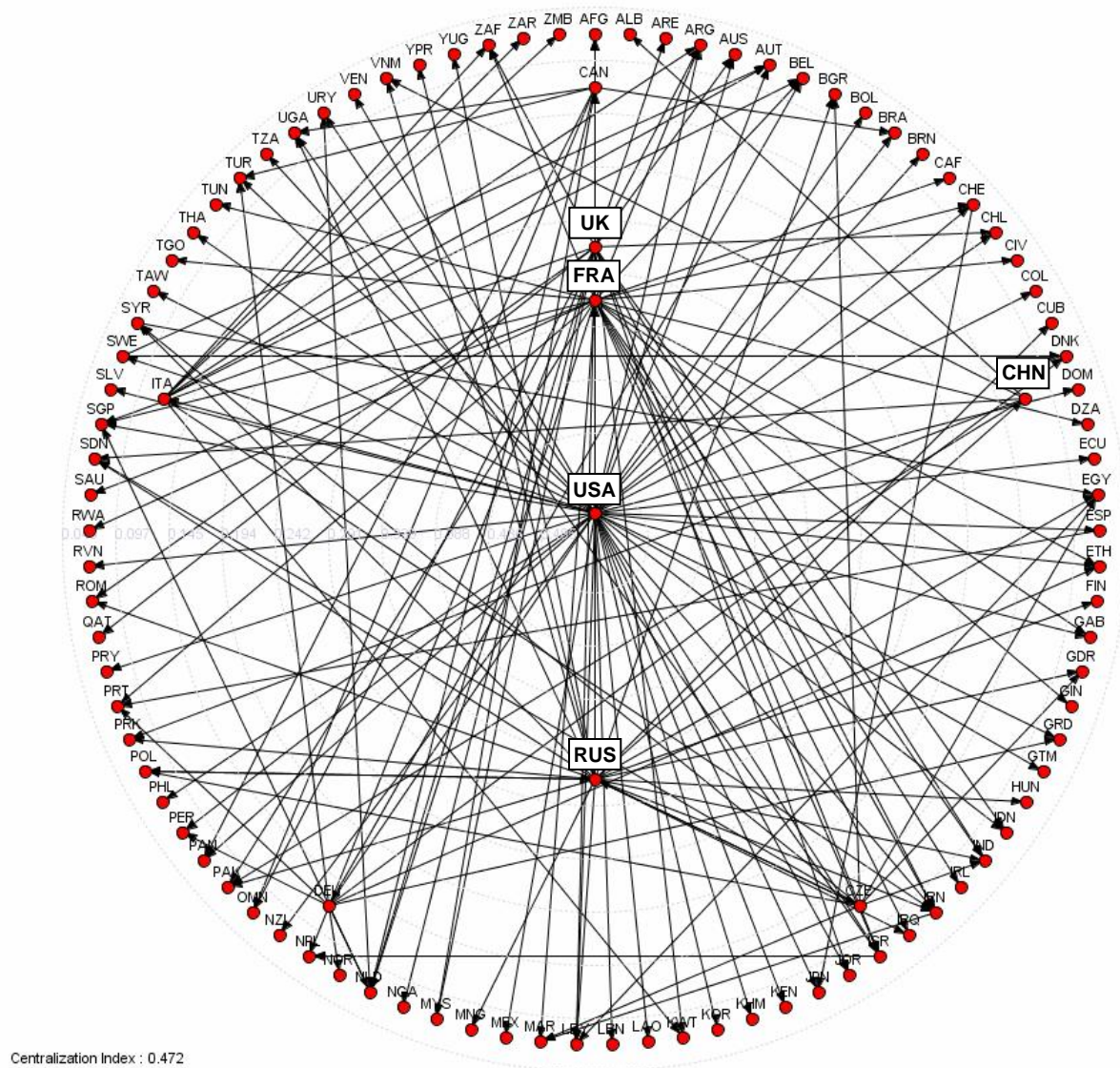


Figure 2b: Supplier Centrality, 1970

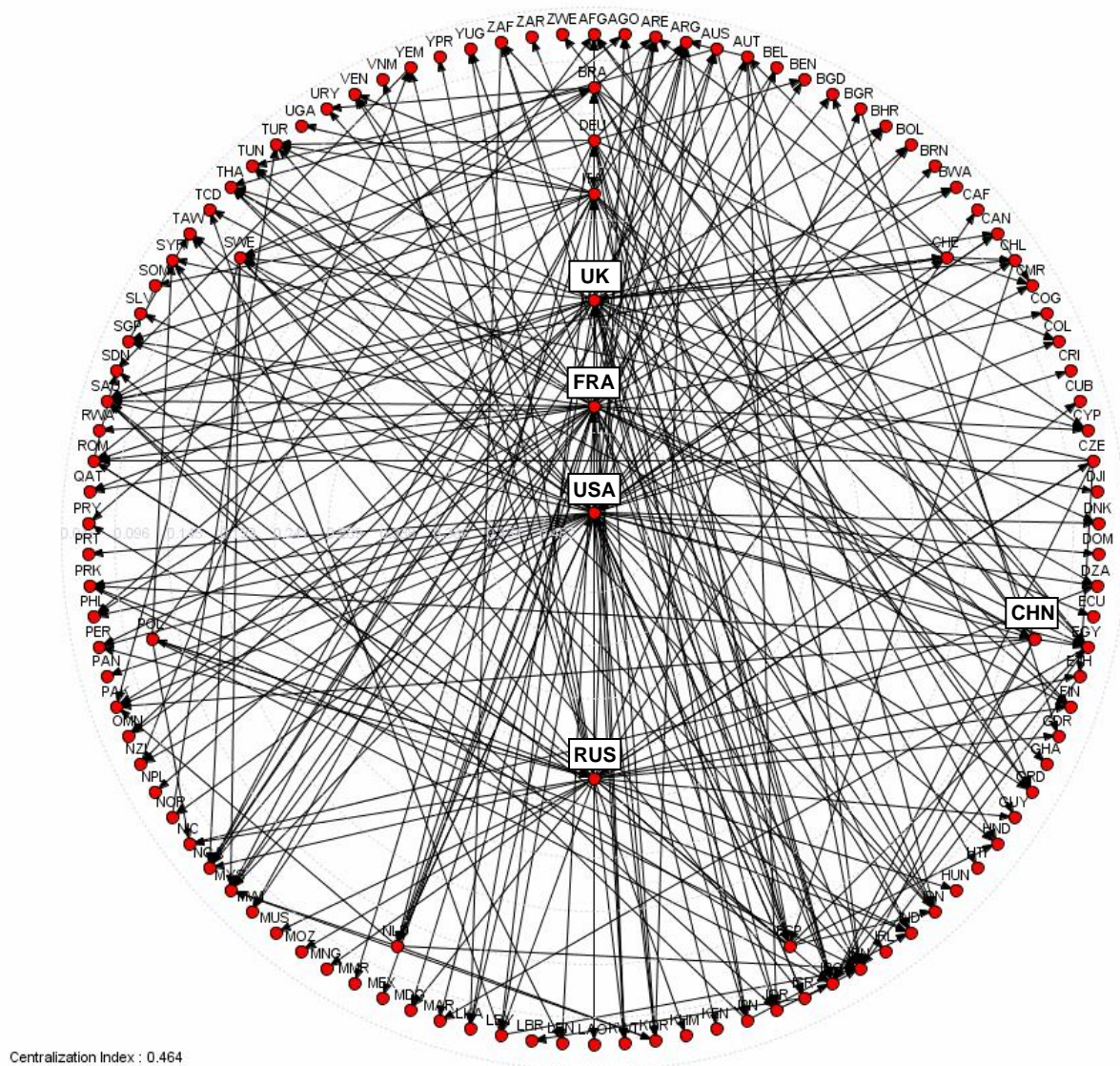


Figure 2c: Supplier Centrality, 1985

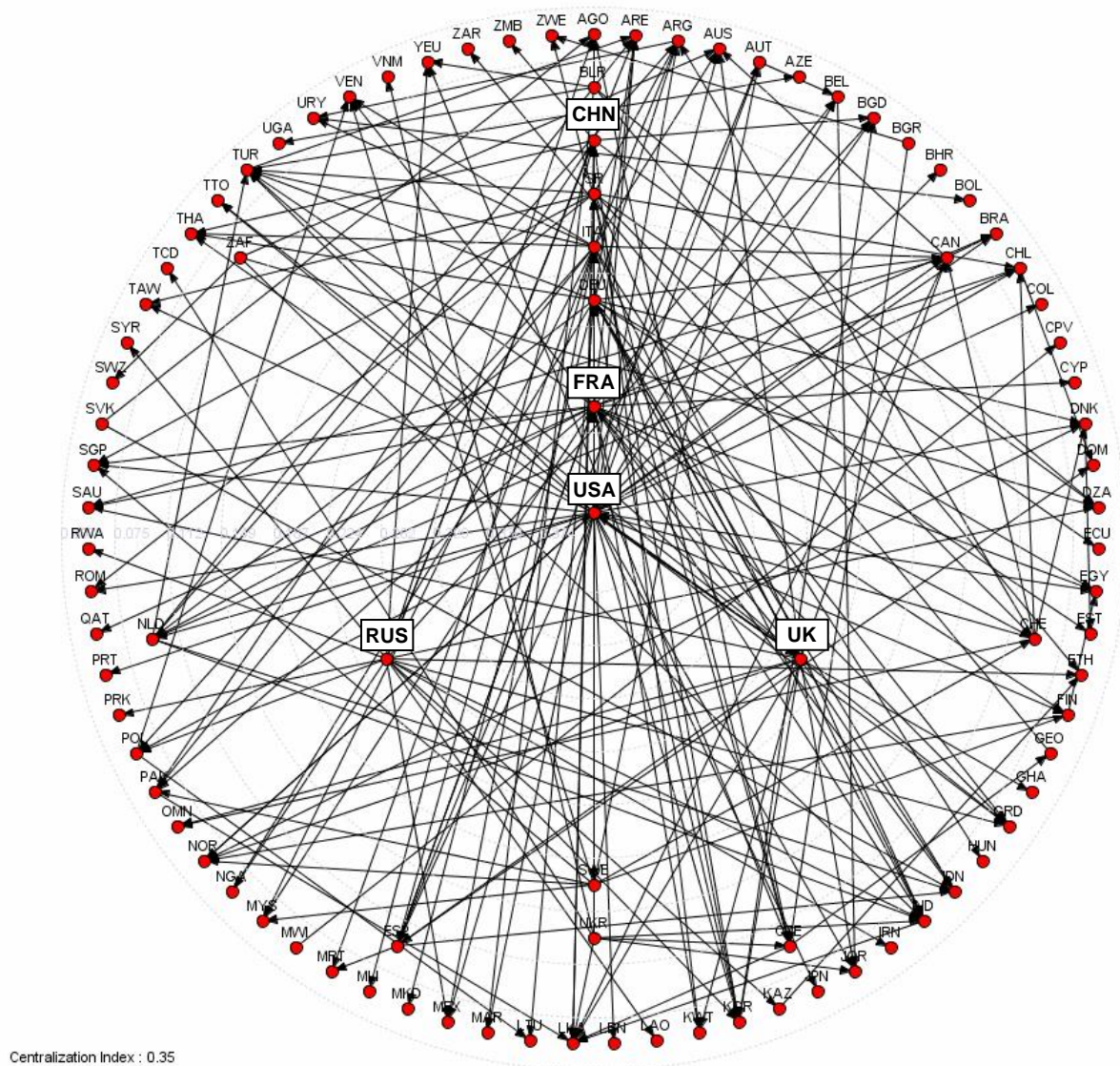


Figure 2d: Supplier Centrality, 2000

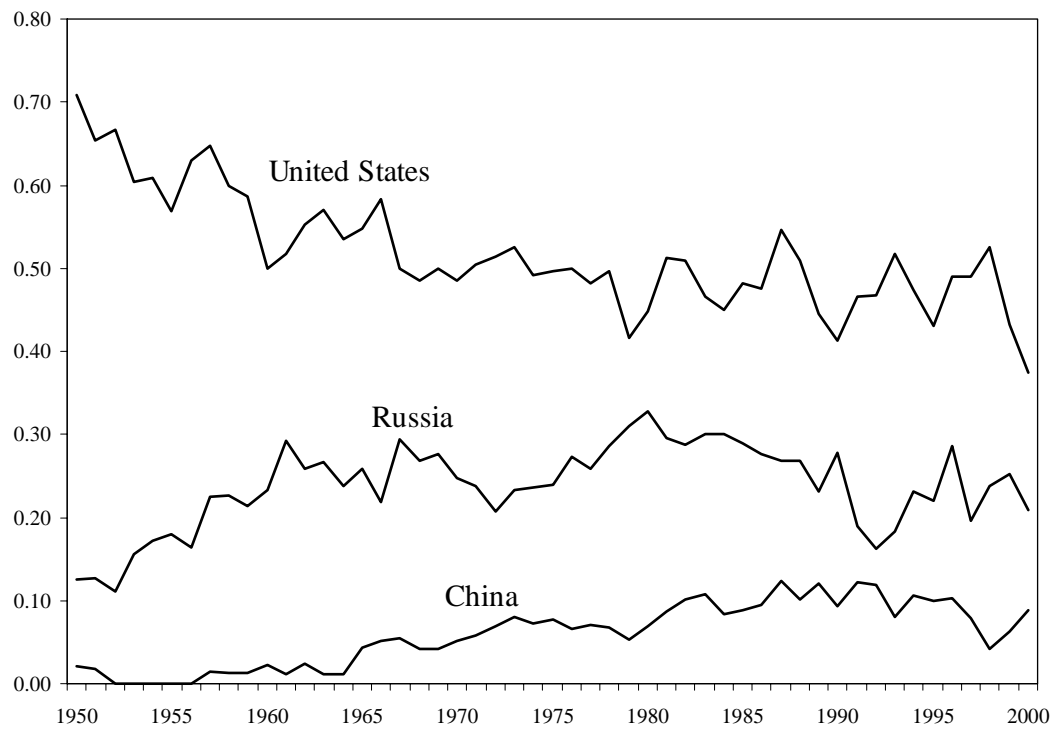


Figure 3: Centrality in the Arms Trade Network: System Leader and Contenders

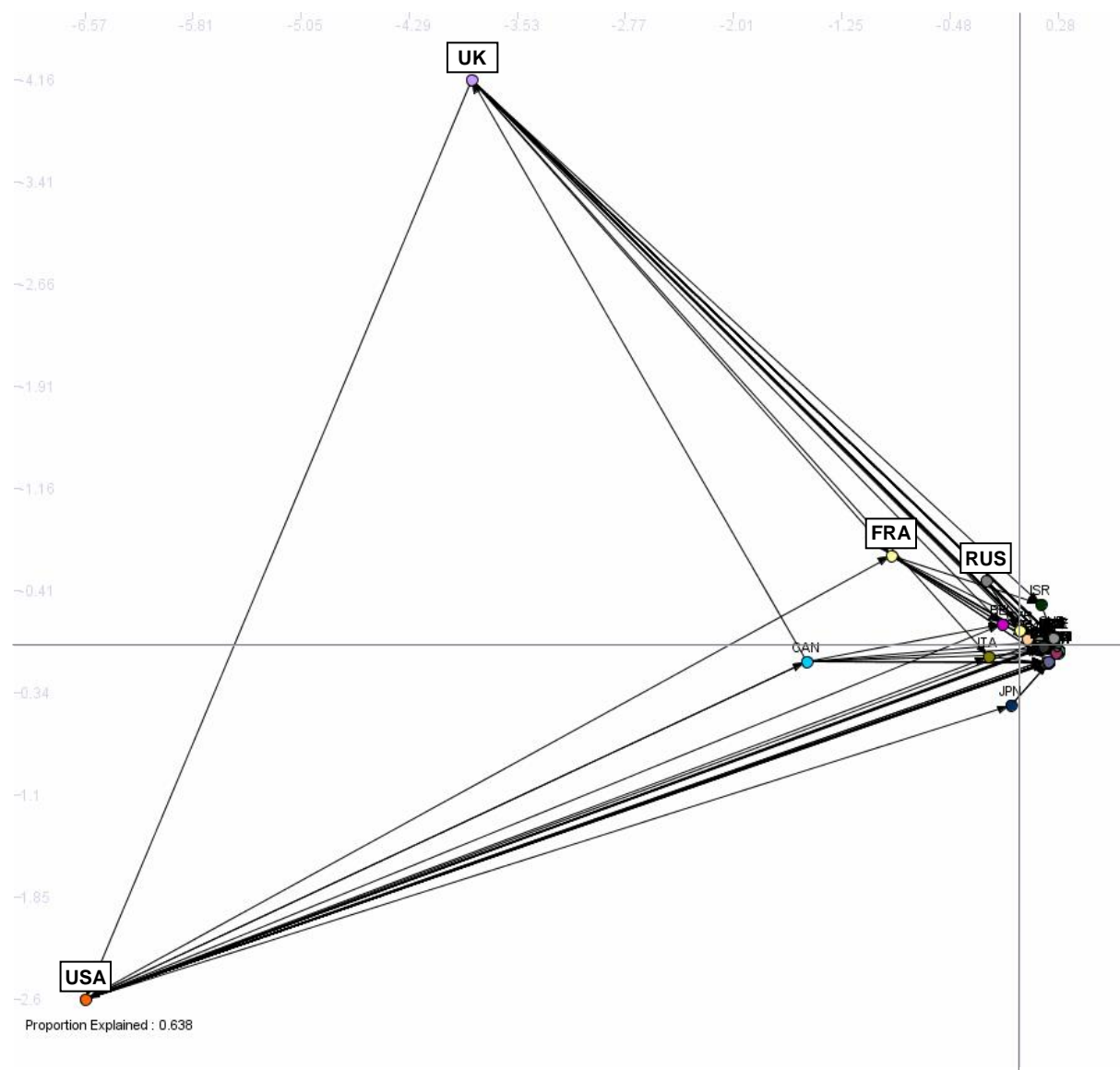


Figure 4a: Structural Positions of Suppliers, 1955

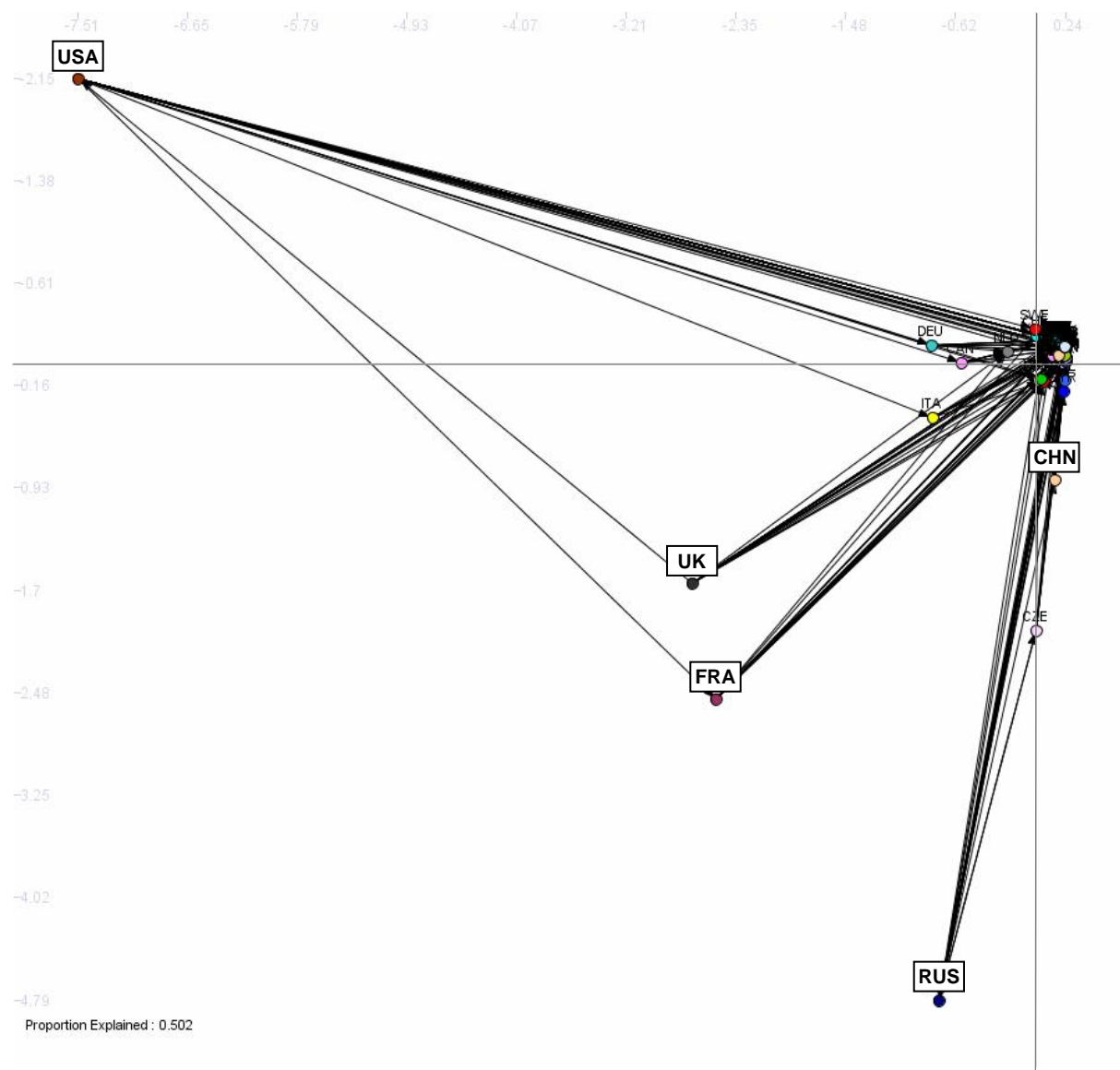


Figure 4b: Structural Positions of Suppliers, 1970

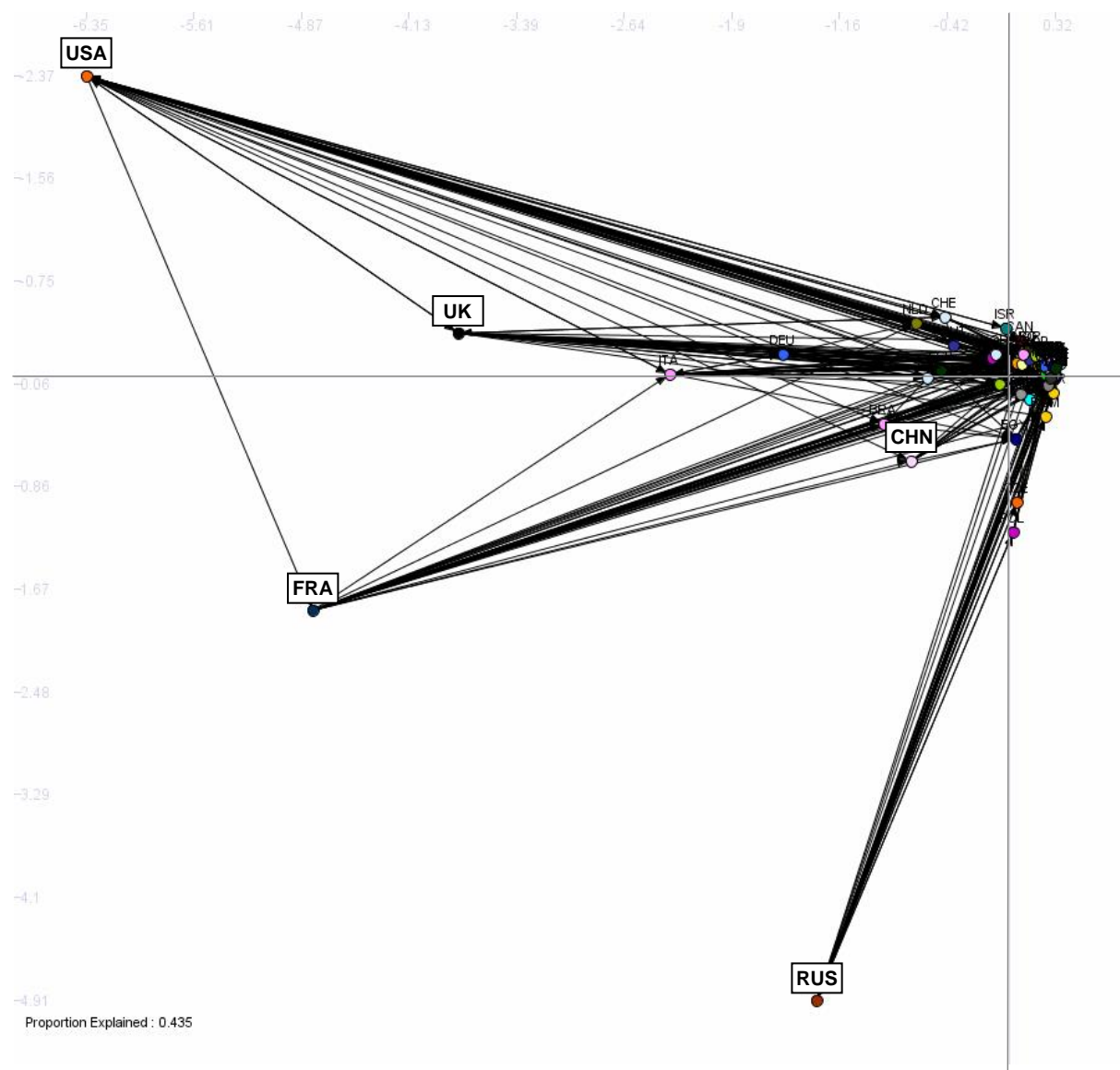


Figure 4c: Structural Positions of Suppliers, 1985

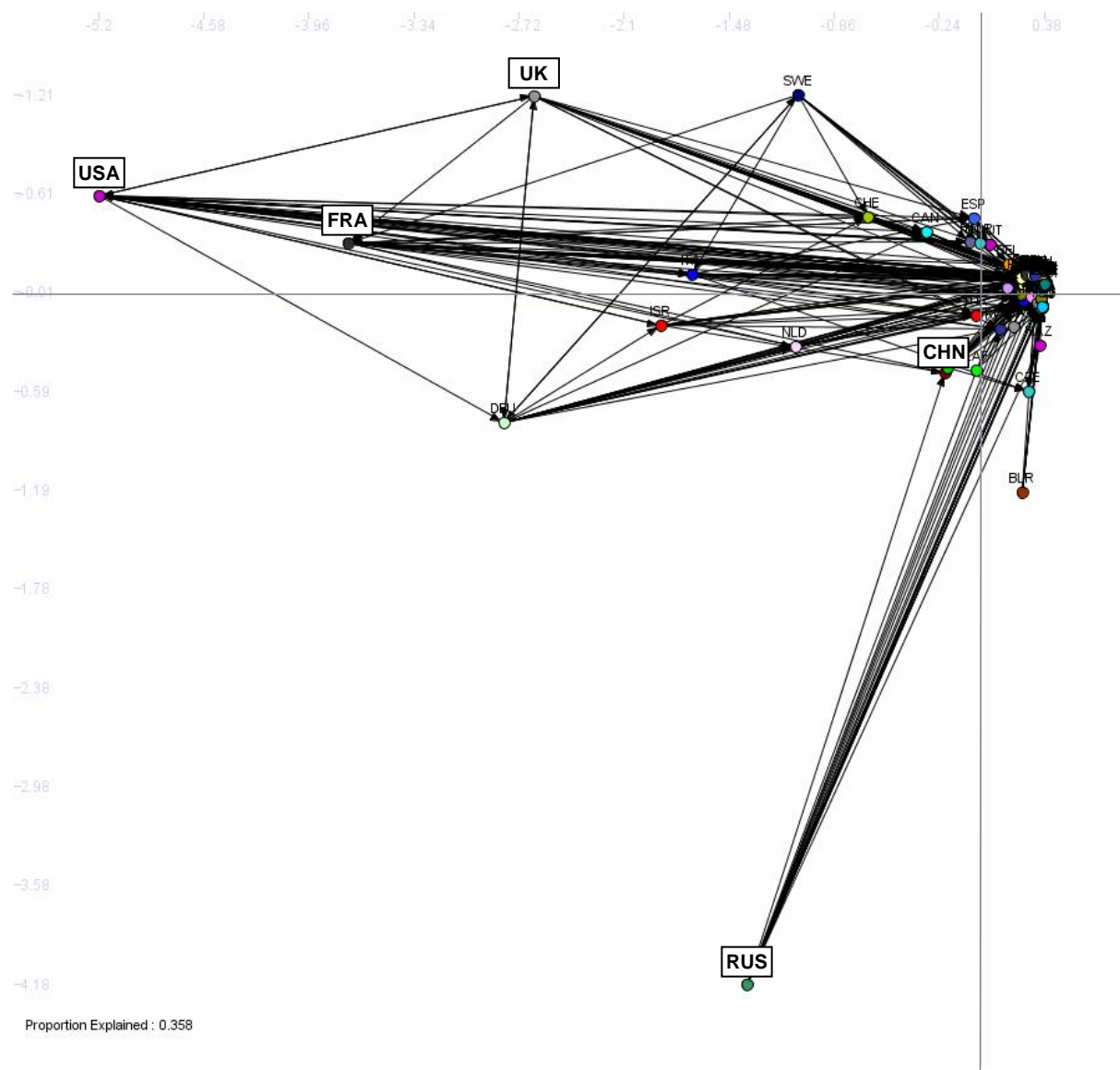


Figure 4d: Structural Positions of Suppliers, 2000

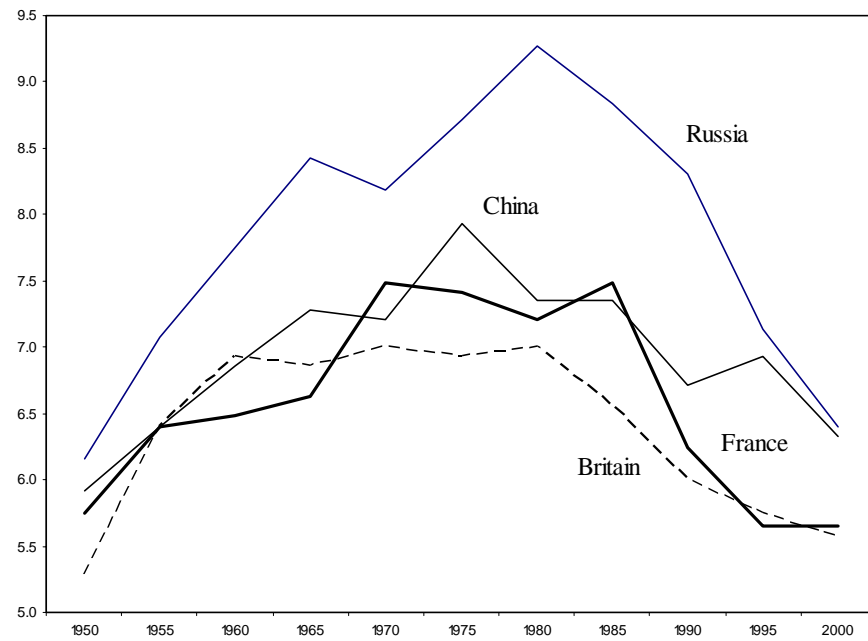


Figure 5: Structural Distance from the United States, 1950-2000