

Trade Networks and the Kantian Peace

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Abstract

Classical-liberal arguments about the pacifying effects of international trade are revisited, and it is argued that they consistently rely on the ability of trade to provide ‘connections’ between people and to create a perceived ‘global community’. The classical-liberal view on trade and peace can be given natural expression and be further developed if it placed in a network perspective. Dependency and openness are commonly used to test for any pacifying effects of trade in the current literature, but these measures fail to capture some of the classical liberals’ key insights. Several network measures are introduced in order to test whether trade linkages reduce interstate conflict. These measures applied to trade flows are incorporated in the Russett and Oneal Triangulating peace model. The main results are that (1) trade networks are indeed pacifying in that both direct and indirect trade linkages matter, (2) direct linkages are generally more important than indirect trade linkages, but the latter can be seen as partial substitutes for direct linkages, and (3) as the global trade network has become more dense over time, the importance of indirect links by way of specific third countries has declined, and the general ‘embeddedness’ of states in the trade network has become more relevant.

Introduction

Following Doyle (1986) and Oneal & Russett (1997), it has become commonplace to trace arguments about the pacifying effect of trade back to the classical liberals and in particular to the work of Kant. In his *Perpetual Peace* (1795), Kant pays only scant attention to trade in the Third Definitive Article on ‘universal hospitality’; and trade is also logically subordinated to the First Definitive Article on the *republican* (or ‘democratic’) peace. In contrast, economic freedoms and especially free trade were considered vital to interstate peace by 19th and early 20th century liberals like Cobden, Mill, Angell, and Schumpeter. We argue that in this tradition trade is particularly important because of its ability to generate ‘connections’ between people that promote communication and mutual understanding.

Because trade allows people *to enjoy in common* things that would be unavailable to them otherwise, it enables people to perceive a (global) community. Based on these ideas, the flow of goods between countries creates a *network* of ties and communication links. If countries are more ‘embedded’ in this network, they should also be more peaceable.

For that reason our central research question is: do trade *networks* reduce interstate conflict? Consider a pair (or dyad) of countries *A* and *B*. One link in the trade network is the direct one between these two countries. It is this link that most of the current literature has focused on, but we wish to emphasize that networks also create indirect linkages. For instance, both countries may trade with a third country *C*, and trade then connects country *A* also *indirectly* to *B*. Since the trade channels provide for information flows alongside the goods and services trade, the indirect linkages arguably matter. Trade also provides third countries, like *C*, with a stake in preventing the escalation of any conflict between *A* and *B*. Thus to capture the effects of trade on conflict between members of a dyad we have to go beyond measures of direct trade links.

Network measures are clearly distinct from other, more commonly used, measures of trade such as dependency and openness. Dependency is fundamentally a dyadic concept and ignores possible indirect links through the rest of the international system. The classical liberals were, however, aware that communication could occur via intermediaries and argued that indirect links might facilitate mediation of conflicts. Further, dependency measures a country's vulnerability (or opportunity costs) of trade which derives from trade shares. Consequently, if a country increases its trade but simultaneously diversifies its trading partners, dependency may well decrease and conflict should then become more likely. Classical liberals would have considered such an effect of globalization perverse. In contrast network variables do not rely on trade shares, but on the overall volume of economic activity among countries. Gartzke & Li (2003: 568 – 9) have suggested using openness instead of dependency, but openness is essentially a monadic concept. For example, during the Cold War, countries in both the East and West had relatively open economies even when trade between the blocs was very limited. In this case, openness largely ignores the East-West trade constraints. By construction, network variables are always relational. Applying network variables to trade makes it not only possible to distinguish direct from indirect effects—where chains can vary in their length or number of intermediaries—but also identify specific bottlenecks in interstate linkages.

The importance given to transnational linkages by the classical liberals resonates most clearly in the work of Deutsch and his associates on security communities. Deutsch et al (1968) argued that among the necessary conditions for integration of territorial units into an amalgamated security community are mutual compatibility of main values, a distinctive way of life, unbroken links of social communication, mobility of persons, and multiplicity of communication and transaction. They noted that these can be related to trade and associated communication flows. Though they actually gathered relevant data, they did not use formal network methods.

Recently there has been growing interest in the use of network methods in the literature on peace; e.g., Hafner-Burton and Montgomery (2006) derive clusters of nations in an affiliation network based on co-membership of intergovernmental organizations (IGOs). Dorussen & Ward (2007) argue that co-membership in IGOs provide linkages that reduces the probability of militarized conflict in a dyad. Maoz et al (2003ab; 2004; 2006) provide the most comprehensive attempt to re-orientate the literature from a network perspective. They see the international system as a set of co-evolving networks of alliances, ethnic links, IGO co-memberships, democratic networks, and trade links (2003a).¹

As far as we are aware, Maoz et al (2003b; 2006) are the only other studies that empirically test propositions about *trade* and peace derived from a network perspective. They use structural equivalence to measure affinity, i.e., similarity of preferences, between members of the dyad, which they expect to reduce the chances of war.² Maoz et al. (2006) also apply degree centrality to alliance, trade and ethnic networks. In a monadic research design they find the expected number of militarized disputes a state is involved in per year falls with centrality in trade and ethnic networks, although centrality in alliance networks is generally insignificant. They also find that inconsistency between a nation's positions in different networks increases the likelihood that they will be involved in conflict.³ States, particularly those with large capabilities, are thought to seek to balance their status across different areas in order to achieve overall prestige—if necessary by means of force (Maoz et al, 2006: 4). We see our research is as largely complementary to their view that structural equivalence and degree centrality in the trade network reduces conflict, because both views are consistent with liberal theory. In contrast, status inconsistency seems more related to 'realist' concerns. Arguably, trade networks may actually promote the flow of information as well as generate concerns about relative status, because these processes might take place at different social levels—the former between citizens

of countries and the latter between statesmen versed in mercantilist or realist ways of thinking about trade.

We test empirically the liberal thesis that specific trade linkage and, more generally, the ‘embeddedness’ of countries in the international trade network help determines their peacefulness. We use network measures to assess the extent to which countries are directly and indirectly interconnected through the trade network for the period 1948 – 2002. The main results are that (1) the trade network is indeed pacifying in that both direct and indirect trade links matter, (2) direct links are generally more important than indirect trade links, but the latter can be seen as partial substitutes for direct links, and (3) as the global trade network has become more dense over time, the important on indirect links by way of specific third countries has declined, and the general ‘embeddedness’ of states in the trade network seems to have become more relevant.

Revisiting Classical-Liberal Thought on Trade and Peace

In this section we show that the classical liberal’s view of trade and peace can be given natural expression and be further developed if it is placed within a network perspective. Also, we elaborate upon our argument that the way that the effect of trade on peace has been operationalized in the recent literature fails to capture some of the classical liberals’ key insights. Finally we propose a number of hypotheses which we think follow naturally when classical liberal thinking is recast in network terms.

Mutual Versus Relative Dependence The roots of the classical-liberal argument about trade and peace lie in the ‘universal economy’ doctrine (Viner, [1959] 1991: 42), which provides a moral justification for trade because it forms the basis for social relationship. For example, in the *Orations III*, Libanius wrote: “God did not accord all things to all parts of the earth, but he has divided his gifts among

different countries, so that people should have need one of the other, in order that from their mutual dependence they should be led to maintain society (community) together.” (quoted in Viner, [1959] 1991: 42).⁴ Classical liberals inherited the view that mutual dependence is crucial to peace. For example, Montesquieu argues that:

Peace is the natural effect of trade. Two nations who traffic with each other become reciprocally dependent; for if one has an interest in buying, the other has an interest in selling; and thus their union is founded on their mutual necessities. (Montesquieu, [1748] 1949: 316)

Along similar lines, the Belgium liberal de Laveleye ([1872] 1978: 380) writes: “What insulates men disposes to war; whatever brings them into relation with each other inclines them to peace. And nothing tends to secure such intimate relations between nations as commerce.” Cobden (1835) equally emphasized the capacity of commerce to create ‘relations’ between people.

In a recent study, Gartzke (2007: 170) claims that “of the elements of global capitalism, trade is arguably the least important in mitigating warfare.” Admittedly, it is easy to identify alternative elements of global capitalism, like the development of liberal domestic as well as international economic institutions or financial integration. Regardless, revisiting the major relevant classic-liberal texts, trade emerges as the essential economic factor mitigating warfare. To use Cobden’s famous expression: commerce is “the great panacea” (Cobden, [1835] 1978: 357). Trade is crucial because it allows for access to goods without any use of force. Trade (along with production) and appropriation are seen as substitutes for acquiring wealth (Rosecrance, 1986; Skaperdas & Syropoulos, 1996). Trade allows people to consume goods that they cannot feasibly produce themselves. For example, Angell

(1912) argues that as the trading system becomes more efficient, it gives countries access to goods without having to resort to use of force or direct occupation. Tellingly, most classical liberals, and in particular Cobden⁵, were vehemently non-interventionist and non-imperialist. Trade also creates a powerful constituency with self-interest in peace, because merchants want to maintain profitable trade relations. The classical liberals emphasized that these effects applied to both countries involved in trade. In their view, the total number of merchants in both countries and total amount of trade an average citizen is exposed to are more important than the dependency of a particular country in the dyad. Even when the flow of goods or services is one way, people are involved at both ends and self-interest in peace is created.

While classic liberals emphasized mutual dependence, the recent literature emphasizes *relative* dependence – the dependence of the least dependent country in the dyad. Russett & Oneal (2001: 143) calculate a dependency score for each member of the dyad by dividing the sum of its exports to and imports from its trading partner by its GDP. They assume that it is the effect of increased dependency on the least dependent country in the dyad that matters for peace. In other words relative dependency equals total trade between the two countries divided by the total GDP of the larger economy. Since conflict is considered likely to interrupt trade flows, the value of lost trade becomes an additional cost of conflict. Consequently, trade reduces the expected utility of conflict, making states more likely to prefer a peaceful solution. Relative dependence assumes that the constraint is less binding for the state which is least dependent (Polachek, 1980; Gasiorowski & Polachek, 1982; Gasiorowski, 1986; Polachek, Chang & Robst, 1999).

Since military conflict tends to be extremely costly anyway, relative dependency arguably primarily affects the terms of the bargaining outcome, or how long it will take states to solve the conflict, but not

necessarily the initial decision between war and peace (Wittman, 1979; Wagner, 1988). Noting this weak spot in the argument, Morrow (1999) argues instead that trade matters because it enables states to signal resolve. The threatened or actual interruption of trade becomes part of a war-of-attrition allowing states to ascertain their relative ability to hurt and absorb pain. Such economic competition may help states to avoid escalation to a militarized conflict. Since ultimately ‘signaling’ still relies on the opportunity costs of trade, a comparison of the relative value of existing trade (i.e., relative vulnerability) is appropriate to test this argument.⁶

While relative dependency is not logically incompatible with the classical-liberal literature, it does not capture the same thing as mutual dependence. It seems plausible to relate mutual dependence to the total trade between a pair of countries, so the remaining issue is whether to divide by the size of the largest economy or not. From the classical-liberal perspective, the effect of trade on internal politics matter particularly for peace. Suppose *A* has the larger economy, so it is the least dependent in relative terms. Then the relative-dependency view can be interpreted in classical-liberal terms as assuming that the constituency in *A* for trade and against war is weaker than in *B*. Here, weakness is a function of lack of motive or power, or both. Unless we have specific information to the contrary, the peace ‘lobbies’ in both countries should be assumed have an equal motive, based on mutual benefit from the same trade total. It now becomes clear that relative dependence thus actually assumes that the power of all other lobbies is used to promote war. Moreover, the power of the ‘pro-war’ lobby can be proxied by the proportion of *A*’s economy that does not depend on dyadic trade. In fact, the latter assumptions are highly implausible; the elements of *A*’s economy that do not depend on dyadic trade are equally likely to be ‘neutral’ or may even ‘pro-peace’ because of interests in trade with countries other than *B*.

To summarize, we argue that trade should indeed be important for peace, but that mutual instead of relative dependency should matter most.

HYPOTHESIS 1: The more two countries are mutually dependent on their trade, the less likely that they will engage in a militarized conflict.

Indirect Links via the Trade Network The relative-dependency view is also highly implausible from a liberal perspective for another reason. If a country increases its trade but simultaneously diversifies its trading partners, according to the relative dependency view, if anything, it should become more likely to be involved in dyadic conflict. Classical liberals would have considered such an effect of diversification difficult to deal with, because the country has attained greater mutual dependence and a stronger network of ties. It is thus important to look beyond bilateral links to links through third parties and longer chains of intermediaries. In doing so we can also examine classical-liberal arguments about the way trade generates personal ties between people, allows ideas and information to flow, and even creates a sense of shared identity.

While it is unsurprising that Ricardo as the author of the theory of comparative advantage claimed that all trading nations are linked by the economic benefits of trade, he also emphasized the ways in which it creates social ties: “while increasing the general mass of productions, [free trade] diffuses general benefits, and binds together by one common tie of interest and intercourse, the universal society of nations throughout the civilized world” (Ricardo, 1951: 133–34). Clearly, the classical liberals were aware that the importance of trade reaches beyond direct links. Ricardo’s ‘common tie of interest and intercourse’ is, in modern terms, a network of links between countries which also includes indirect

trade connections. To properly examine the liberal proposition on trade and peace, we need to look beyond bilateral ties and examine the way that states are indirectly linked through intermediaries.

The classical liberals viewed mediation and arbitration as the preferred alternatives to intervention by states in others' conflicts (Bramsted and Melhuish 1978). We can usefully focus on Cobden's views, although they are not entirely representative (Cain, 1979; Hammarlund, 2004). While many liberals favored an international organization or court to mediate conflict, backed by a code of international law and access to armed force of its own, Cobden remained "suspicious of all kinds of government, even world government" (Read 1967: 113).

Whatever may be the future state of the world, I am quite convinced that at present it would be to the last degree inexpedient to bring the representatives of the different nations together for the purpose of inducing them to *agree to anything*. They would be far more likely to sow the seeds of war than to plant the olive tree throughout Europe. (Cobden, quoted in Read, 1967: 113, italics in original)

Cobden ([1849] 1978: 374–8) instead favored arbitration by a panel of mutually acceptable individuals from the countries concerned, with possible recourse to an 'umpire' if the panel could not agree. He says little about who the 'umpire' might be. But it is consistent with his view that trade builds bridges between nations that it should be an individual from another nation with which both the parties to the conflict have strong trade ties, for such an individual would be in a better position to see both sides of the case. Yet Cobden also seems to have a preference for individuals from countries directly involved in conflict; in other words, individuals engaged by way of indirect links are considered imperfect substitutes (see also Dorussen & Ward, 2007). In particular, information exchange may become

compromised if more intermediaries are involved. We formulate the two hypotheses to test for the importance of third-party links, the first drawing on mechanisms like third-party mediation⁷ and the second expressing the way indirect links may come more into play when direct links are weak:

HYPOTHESIS 2: The greater the number of indirect trade links via a third party between states in a dyad, the less likely that they will experience a conflict.

HYPOTHESIS 3: An increasing number of indirect links between states in a dyad has a stronger effect if there are no or limited direct links in the dyad.

'Embeddedness' in the Trade Network Once it is accepted that indirect links matter, there seems no obvious reason from a network perspective to stop at those through one intermediary. After all, goods and services have always passed through chains of intermediaries in different countries, from the Silk Road linking China to medieval Europe through electronic goods designed in the USA, manufactured in China and packaged and distributed in Europe. If goods flow along such chains, so does information, albeit with a higher degree of attenuation the longer the chain of intermediaries. J.S. Mill (1909: 14) viewed the contacts created by and cultural effects of trade as more important than any narrow economic benefits:

It is hardly possible to overrate the value, in the present low state of human improvement, of placing human being in contact with people dissimilar to themselves, and with modes of thought and action unlike those with whom they are familiar.

A further classical-liberal argument is that the involvement of citizens in this global community affects the domestic 'balance of power' in favor of a more peaceful foreign policy. For Cobden protectionism

and war-proneness were two sides of the same coin, because the politics of both ran along the same political and class cleavage. On the one hand there were the large landowners who favored agricultural protection under the Corn Laws; on the other there were the commercial interests, manufacturers and their workers who favored cheaper food and consequently better living conditions in the cities. The cleavage coincided with the one between those who had a continued interest in Britain's military strength, intervention in the affairs of other countries and colonial expansion, on the one hand, and those whose interest lay in peace. There were longstanding historical links between the feudal landed aristocracy, the military, and parts of the British state that favored war—inextricably tied to high tax rates that drained industry. Free trade supported the commercial revolution and together they would reduce the power of the old, superseded, feudal order.

In his *Imperialism and Social Classes*, Schumpeter (1951) develops these ideas theoretically in his claim that imperialism is atavistic in character; “it is an element that stem from the living conditions, not of the present, but of the past—or, put in terms of the economic interpretation of history, from past rather than present relations of production” (1951: 84). Capitalism has created or promoted social classes, like the bourgeoisie, working class, and the ‘new middle class’, that are “all inevitably democratized, individualized, and rationalized” (Schumpeter, 1951: 88–9) and “likely to be essentially of an unwarlike disposition” (90).⁸ Schumpeter also considers the conditions under which some of them may nevertheless expect to gain from war, like entrepreneurs in the armaments industry. Crucially, these conditions are either very limited (e.g., labor shortage as a result from war) or related to restrictions of capitalism—“It may be stated as being beyond controversy that where free trade prevails *no* class has an interest in forcible expansion as such.” (Schumpeter, 1951: 99, italics in original). In contrast, “protectionist policy (...) does facilitate the formation of cartels and trusts” (104). Here, Schumpeter locates a potential economic interest in an aggressive foreign policy and war,

but the emergence of such economic interests does not follow from the ‘inner logic’ of capitalism and actual imperialism further requires an alliance with pre-capitalist “feudal” classes.⁹

[Figure 1 about here]

One way we might proxy the power of the domestic lobby for peace is the trade openness of a country’s economy – its total trade to GDP ratio (Russett & Oneal, 2001; Gartzke & Li, 2003). Typically, dyadic analyses use the openness of the least open country, i.e., with the smallest amount of total trade relative to its gross domestic product. By construction the openness variable of a particular dyad does not depend on its bilateral trade. It is even—at least theoretically—possible for two open economies to have very limited indirect trade relations. The condition would be for both countries to trade extensively within trade blocs between which there is limited economic exchange. Network variables are useful to measure the ‘embeddedness’ of any pair of countries into the global trade system. A relevant network measure of the total connectedness is the maximum flow of influence that can occur between the members of a dyad, taking into account both direct and indirect connections. Here, trade is considered the mechanism linking countries. Importantly, indirect connections need not involve just one other country, but it also include multiple intermediaries: *A* is connected to *D*, because of *A*’s trade with *B*, *B*’s trade with *C*, and eventually *C*’s trade with *D*. Consequently, the maximum flow of influence is primarily determined by ‘bottlenecks’ in the trade system (Ford & Fulkerson, 1956; Dorussen & Ward, 2007)). In Figure 1, we draw two hypothetical trade network to illustrate the difference between maximum trade flows and minimum openness. If the trade system is dense—i.e., most countries have a relatively large number of trading partners—bottlenecks are most likely because of one of the countries in a particular dyad, and maximum trade flow will be very similar to minimum openness. In Figure 1, pattern A illustrates this situation. However, restrictions on trade between trade

blocs may also pose a bottleneck, in which case maximum flow and minimum openness will be clearly distinct. Pattern B, in Figure 1, depicts the latter possibility. For the period of our study (1948 – 2000), we expect the trade network to have become denser, and the total connectivity to become more important. The final two hypotheses summarize our expectations.

HYPOTHESIS 4: The greater the channels of communication, of any length, between states in a dyad (‘embeddedness’), the less likely that they will experience a conflict.

HYPOTHESIS 5: As the global trade system becomes denser, ‘embeddedness’ becomes more important for dyadic peace.

Conceptualizing and Measuring International Trade Networks

This section presents our conceptualization and measurement of direct and indirect connectedness by means of trade. Using Gleditsch’s (2002) trade data, we created a valued, undirected graph of trade connections, measure in real terms, for each year from 1948 to 2000.¹⁰ We averaged the directed total trade flows, where directed trade equals imports plus exports. Although the sum of country *A*’s exports to and imports from *B* ought to equal the sum of country *B*’s exports to and imports from *A*, in practice the base trade data Gleditsch used does not always satisfy this condition (2002: 715), so rendering the trade data symmetric by averaging is appropriate here.¹¹ In an undirected graph, every edge of the graph links a pair of states with bilateral trade and the value of the edge gives the average trade flow, $v(i, j)$ for countries *i* and *j*. In practice these graphs have many missing edges (there is no bilateral trade between the pair of countries) and there is enormous variance in the values of edges that do exist. Our first trade measure (*ln_dyadic trade*) is the natural log of the value on the edge plus one, taking on the value zero if there is no such edge. In our theoretical framework this can be seen as measuring the opportunities for direct communication, or mutual dependency. Moreover, *dyadic trade* captures any

‘feedback’ costs because of co-ownership and direct foreign investment between the international sectors of two economies—i.e., the effects of war on another country’s economy may indirectly harm one’s own economic interests through stakes in the other economy, and vice-versa.

By way of further illustration, Figure 2 gives a hypothetical example of a trade graph. Each edge of the graph is considered to have a capacity equal to its value, which amounts to the assumption that the communication possibilities are directly proportional to the total trade flow. An information flow between i and j is a function such that the flow along any edge is less than or equal to its capacity, and the flow entering a node along the edges is equal to the flow leaving it along all other edges incident on it. The maximum flow between i and j , $maxflow(i,j)$, is the largest flow that satisfies these conditions and in addition that the flow leaving i is the flow entering j (Ford & Fulkerson, 1956). For instance in Figure 1, $maxflow(1, 2)$ equals 9. We use the maxflow-statistic (here the variable is called: *systemic trade*) to test the hypothesis that conflict is less likely between i and j if there are greater possibilities of direct and indirect communication between them. We calculated *systemic trade* on the trade network using UCINET, a standard network package.¹² This variable captures ‘embeddedness’ of both countries. The maximum flow of information in a network between two nodes is primarily determined by ‘bottlenecks’ (Ford & Fulkerson, 1956; Dorussen & Ward, 2007)); and because there are multiple channels of intermediate communication in the trade network, the bottlenecks mostly occur at the point the countries in the dyad link to the remainder of the network. In other words, a measure of the relevant bottlenecks is how open to trade the economy of the country least open to trade is. In our case, the maximum flow network measure is both conceptually and empirically distinct from openness as used in the literature.

[Figure 2 about here]

Since agents can misperceive messages, flows of information involving only a few intermediaries might be less prone to accidental distortion. Also such short paths are plausibly implicated in mediation: i asks k to use its influence on j to prevent a war between i and j , or i uses the diplomatic ‘good offices’ of k to pass on a message to j . In this case, a stronger link between (say) i and k may partially substitute for a weaker link between k and j , or vice-versa. A multiplicative (information) production function allows for substitution while requiring both that i is linked to k and k to j . The third-party linkage statistic evaluates linkage by means of all possible third parties, or

$$\ln_triadic_trade_links_{i,j} = \ln\left(1 + \sum_{k \neq i,j} v(i,k) \cdot v(k,j)\right),$$

where the rationale for taking the natural log is that there are likely to be decreasing returns with respect to reducing conflict between i and j arising from scaling up third-party links. The third-party link statistic can be calculated using simple matrix methods, and this procedure was carried out annually on the trade-network.

Further Research Design and Data Issues

We follow the by now standard research design of existing empirical studies of the Kantian peace, using pooled cross-sectional time-series data on state dyad-years. We have restricted the temporal domain to 1948-2000 for two reasons. First of all, the Gleditsch (2002) trade data do not extend before 1948. Secondly, the characteristics and norms of the network of international interactions need not be constant over time. The current international system established after WW II under US hegemony embodies relatively strong norms on the use of force only as a last resort and respect for state

sovereignty, and at the same time encourages third-party mediation. We use a peace-years variable and cubic-splines to correct for temporal dependency (Beck, Katz & Tucker, 1998; Tucker 1999).

Dependent Variable Militarized interstate disputes (*MID*) are conflicts in which the use of force is threatened or actually implemented. The source of the data is the Correlates of War project, using the Maoz correction for the pre-1992 period. We include information on new as well as ongoing military disputes. The variable *mid* takes on the value “1” for each year in which there is an ongoing MID between members of a dyad and “0” otherwise. The dependent variable is actually *mid_y1*, which takes on the value of *mid* in the following year to the one in question. This helps with the problem of establishing causality as the analysis is equivalent to lagging all the variables one year.

Independent Variables We have discussed the trade-network measures above. The complete model includes both ‘realist’ and ‘liberal’ controls. ‘Realist’ constraints include contiguity and distance, power ratios, and alliance structures. All these variables measure the opportunities and willingness to use force. Countries that share a common border have both more potential for conflict and they are less burdened by the logistics of using force. The ability to project force beyond land under direct control is reserved to only a small group of countries; mainly states that have a major-power status. The models presented here thus include the standard ‘realist’ geographic constraints. *Contiguity* is a dummy variable indicating all country dyads whose borders are separated by less than 150 miles of water. *Distance* is the natural log of the shortest direct distance between the capitals of the countries in the dyad. *Minor powers* is a dummy variable indicating that both countries have minor power status. For the period of our study, the USA, USSR/Russia, China, Great Britain, and France had major power status. Following Gartzke (2007: 156 fn46), we include a Middle-East dummy, coded “1” if both countries are located in this region.

Capability ratio is a composite index of relative (military) capabilities developed by the COW-project to measure the balance of power. The index contains information on population (total as well as urban), energy consumption, iron and steel production, military manpower, and military expenditures. These six elements are weighted equally, and the power ratio is the natural log of the ratio of the stronger country's capability index to that of the weaker country. (Singer, Bremer & Stuckey, 1972; Russett & Oneal, 2001: 103). The COW-project further includes information on allies. *Allies* measures the existence of mutual defense treaty, a neutrality pact, or an entente between the members of a dyad in a particular year.

Hegre (2003) and Gartzke (2007) argue that the Kantian model should include a control for economic development. We include the natural log of total GDP of both the largest and smallest economy (*GDP total (high)* and *GDP total (low)*) as controls for major power status as well as economic development. Gartzke (2007: 175) further argues that "a decline in the value of conquest will manifest itself in relations with neighbors, where territorial claims are most common and aggression most practical." To allow for this possibility, we include an interaction term between GDP and contiguity.¹³

The models include the 'liberal' variables on democracy and trade. The information on democracy is from Polity IV (Jagers & Gurr, 1995), and makes use of the full 21 point scale from full autocracy (-10) to full democracy (+10). The models follow Russett & Oneal (2001: 99) in assuming that in a dyad the level of democracy of the least democratic country matters in particular, measured with variable *Democracy (Low)*. If the less democratic country is more democratic, both countries are more constrained in using force. To allow for the possible importance of differences in levels of democracy in the dyad, we also control for the level of democracy of the most democratic country (*Democracy*

(*High*)). The actual implementation of all variables mentioned so far for country dyads was done using EUGene (Bennett & Stam, 2003).

We calculate the dyadic trade-to-GDP ratio using trade aggregates based on information compiled by Gleditsch (2002). Once more following Russett & Oneal (2001), we analyze the trade-to-GDP ratio for the country with the lower dependence score (*Dependency (Low)*), which is equivalent to the country with the highest GDP in the dyad. As with democracy, the inclusion of the lower dependence score implies a weakest-link assumption, since the country with the lower dependency score should be less constrained by economic arguments against using force (Russett & Oneal, 2001: 143). Finally, the models include a measure for IGO co-membership. *Intergovernmental Organizations* measures the number of IGOs of which both countries are member (Russett & Oneal, 2001). Table 1 provides the correlations between the various network variables. Clearly, the variables are sufficiently distinct so as to avoid any suspicion of measuring an identical phenomenon. At the same time, the correlations suggest that we need to be careful when introducing the various variables in the same model.

[Table 1 about here]

Results

The four models in Table 2 introduce the three network variables sequentially. Model 1 is the baseline replicating work by Russett and Oneal, in particular as it has been reinterpreted by Gartzke (2007). With regard to the control variables, the results in Table 2 are largely consistent across the models and for the most part confirm earlier studies. The ‘realist’ capability variables seem to matter, in that minor powers are less likely to engage in conflict. Opportunity is also important as shown by the highly significant impact of contiguity and distance. Finally, the models confirm the complex interaction between economic development and contiguity as suggested by Gartzke (2007: 175); territorial

conflicts are less likely between more highly developed and powerful neighbors. The Middle East emerges as a particularly conflict-prone region across the various models. In contrast, the alliance variable is generally insignificant. The models further confirm the relevance of the major ‘liberal’ controls. Democracy is consistently significant across the models. If the least democratic country in the dyad becomes more democratic, conflict becomes less likely. Further, if the distance between the most and least democratic country in the dyad increases, conflict becomes more likely. The models thus support a strictly dyadic interpretation of the democratic peace (Gleditsch and Hegre, 1997). Contrary to liberal expectations, IGO co-membership appears to lead to more (instead of the expected less) conflict (however, see Boehmer, Gartzke, & Nordstrom, 2004; Dorussen & Ward, 2007).

[Table 2 about here]

Table 2 further demonstrates that the trade network variables have a significant pacifying effect which is separate from any effect of trade dependency. In fact, trade dependence is only significant in Model 1 which excludes any of the trade network variables. Direct (dyadic trade) and indirect trade linkages by way of a third country (triadic trade) both reduce the likelihood of the conflict, but the effect of direct links appears to be more robust. Model 4 shows that the ‘embeddedness’ of both countries in the network of world trade also significantly reduces the chance of conflict. These results clearly support hypotheses 1 and 4, while we judge the support for hypothesis 2 less conclusive.

To get a better sense of the substantive impact of the trade network variables, we have used simulations using Clarify (Tomz, Wittenberg, & King, 2003).¹⁴ The substantive impact of dyadic trade is approximately 30% on the baseline probability, which is similar to the pacifying effect of democracy (32%). The impact of direct links in the trade network is comparable to dependency, but the 95%

confidence interval of the latter is much larger and includes dependence having no impact at all. The findings for the indirect network effects are more mixed. Contrary to our expectation, third-country trade links (*triadic trade links*) only have a relatively modest impact of 23%. However, the general connectedness of a country to the international trade system (*systemic trade links*) clearly matters by reducing the probability of conflict by nearly 50%.

[Table 3 about here]

The models in Table 3 endeavor to test the expectation of hypothesis 3 that indirect trade links are partial substitutes for direct links. The first three models compare the effect of third-country indirect links and systemic trade links assuming low (model 5), above average (model 6) and high (model 7) direct trade links. Clearly, the differences between the coefficients are not statistically significant across the models. Moreover, the effect of third-country links is less significant if direct trade links are below average. In contrast, the effect of systemic links is somewhat stronger in this case. The substantive impact of third-country trade links is to reduce the probability of conflict by about 30% if there are below-average direct trade links, and by about 20% if direct trade links are above average. The substantive impact of systemic trade links is approximately 40% (below-average direct links) and 28% (above average) respectively. However, given the much higher baseline probability of conflict given below-average direct trade links, even maximum levels of indirect trade links can only partially compensate for the relative lack of direct trade links.

Model 8 (Table 3) tests the third hypothesis somewhat differently. In this case, we dichotomized direct and indirect (triadic) trade links, and use below-average trade linkage along both dimensions as the baseline category. In this case, the simulated baseline probability is approximately .57.¹⁵ Simply

assuming high indirect trade links (but keeping direct links below average) does not significantly alter the baseline probability of conflict. However, above-average direct links—while keeping the indirect links below average—does significantly reduce the propensity for conflict. The substantive impact is however a modest 5%. Finally, above-average direct and indirect links have a cumulative impact; in this case, the substantive impact is to reduce the probability of conflict by nearly 17%. To summarize, we find some limited support for our second hypothesis. Even though indirect links have a pacifying effect even if countries have limited direct trade links, direct links are clearly more important than indirect ones.

The international trade system has seen some dramatic changes since the end of the Second World War. The period started with the end of the colonialism and ended with the breakdown of trade barriers in East-West trade. A further break is between the periods before and after 1970, possibly coinciding with the Bretton Woods period and after, or prior/post the first oil price shock. It is therefore interesting to assess whether the trade-network effects are robust for the whole period. In hypothesis 5 we formulated our expectation that system trade links should have become more important over time as the trade system denser. Figure 3 gives a visual impression of the way the trade network changed from 1960 to 1990.¹⁶ Names of countries are indicated by standard abbreviations. To improve clarity all edges of the graphs valued below \$250m 1948 dollars were deleted. Thus any country whose name does not appear might informally be regarded as peripheral. Thickness of the lines gives some indication of the strength of ties. All four networks are highly centralized; and network centralization even increased over this period.¹⁷ Taken on its own this might suggest the growing relative importance of third-country links via central states. However, the density of the network increased considerably as well, especially between 1970 and 1980, and this increased the density of links between middle-range countries away from the center. Figure 4 clearly illustrates these developments. Here, all edges valued

below \$100m 1948 US dollars have been deleted, and ties with former colonial powers and the largest economies have also been suppressed.¹⁸ As can be seen there were few direct ties between medium sized economies in 1960 and even in 1970, but by 1980 far greater numbers of such ties existed.

[Figures 3 and 4 about here]

Figure 4 evaluates whether systemic trade links have begun to matter more accordingly. Figure 4 plots the coefficients (and their 95% confidence intervals) of trade network links for 15 year rolling intervals; in other words, the first coefficients are for the regression using data from 1948 until 1963, the second from 1949 until 1964, etc, up to the regression using data between 1985–2000. The midyear is given on the bottom axis; thus, 1960 gives the coefficients for the 1953–68 interval. The first graph traces the coefficients for third-country (triadic) trade links, and shows that they are significant up to the mid 1970s (intervals ending around 1982). The only exceptions are the early intervals which are marked by very large standard errors. In contrast, the coefficients for systemic trade links (the ‘maxflow’ coefficient) have become increasingly significant up to the early 1980s. Interestingly, the standard errors for the systemic trade coefficient appear to be highly affected by the end of the Cold War. Finally, the bilateral (direct) trade links have a significant pacifying effect for nearly the whole period. Judged by their statistical significance, the ‘embeddedness’ of countries appears to have indeed become more important as the trade system has become denser. To assess the substantive impact, we have split our data in pre- and post-1973 periods. In our simulations, the baseline probability for conflict is about .4 in both periods. Direct trade links reduce the baseline probability by about 25% in both periods. Similarly, systemic trade links reduce the baseline probability by about 35% in both periods. However, the substantive impact of short indirect links (triadic trade links) is reduced from 44% using data from 1948–73 to 13% using data from 1974–2000. Moreover, the effect is not

statistically different from zero in the latter period. To summarize, the support for hypothesis 5 remains somewhat mixed. As the international trade system has become denser, systemic trade links (or the general ‘embeddedness’) seem to have become statistically more significant, but the substantive impact of the variable has remained largely constant. In contrast, the statistical and substantive impact of triadic-trade links appears to have declined. In our opinion, the best explanation for these results is that the impact of former colonial ties has weakened over time.

[Figure 5 about here]

Conclusions

In our opinion, Doyle as well Russett and Oneal rightly sought to place the democratic peace thesis in a broader liberal framework in which trade and international institutions are seen as interrelated.

However, possibly because of the central place given to Kant’s *Perpetual Peace*, the impact of trade has remained relatively poorly theorized. The 19th century classical liberals did provide an extensive set of arguments about the pacifying effects of trade, which can even be traced to the classical and early Christian ‘universal economy’ doctrine. In both these traditions, the central role of merchants for international communication is central. In the classical-liberal tradition, moreover, trade interests are generally seen as undermining pre-capitalist/feudal interests in expansion and war. The productive sectors of society are seen as promoting international understanding and as being capable of making their services available for mediation. In the words of Cobden, trade leads to “as little intercourse as possible betwixt the *Governments*, as much connections as possible between the *nations* of the world!” (quoted in Read 1967: 110).

Revisiting classical-liberal ideas on trade and peace also leads one to measure the pacifying effects of trade differently. If trade is about communication and connections, the emphasis on dependency (inherently a realist concept) is partly misplaced. Moreover, a dyadic perspective on trade is likely to be too limiting. Communication can take place directly, but also by way of indirect channels. Such indirect channels may provide motivation and opportunities for third parties to intervene. Finally, the general connectedness of a country to the international (trade) system may well determine the relative power of productive versus exploitative sectors of society. Classical liberals strongly believed that a decisive shift in favor of the former would constitute a fruitful basis for peaceful international relations. We have argued that network measures applied to trade flows are better suited to measure such effects of trade.

Empirically, we include several variables to capture direct and indirect links in the trade network into the general model of the Kantian peace, and find that these variables consistently have a significant negative effect on the likelihood of conflict. Substantively, and in contrast to Gartzke (2007), we find the effect of trade comparable to that of democracy. Contrary to our initial expectations, we find general engagement with the international trade network to matter more than trade links with particular third parties. There is even some evidence that indirect trade ties have become increasingly important during the post WW II period. We argue that these findings are in line with general changes in the system of international trade during this period. Moreover, they suggest that in relation to trade and peace communication effects may well be more important than mediation effects. While modern liberals who defend a reformed version of globalization sometimes make passing reference to classical liberal's cosmopolitan arguments about trade and peace (Bhagwati, 2004: 30), in the light of the empirical evidence these arguments still seem significant today.

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Table 1: Pairwise Correlation of Trade Network Variables

	Dyadic trade (ln)	Triadic trade (ln)	Systemic trade (/100)
Triadic trade (ln)	.783 (.000)		
Systemic trade (/100)	.476 (.000)	.347 (.000)	
Dependence (Low)	.426 (.000)	.354 (.000)	.213 (.000)

Pairwise deletion of missing case; significance in parentheses

Table 2: Trade Network Characteristics and Militarized Interstate Dispute, 1948 – 2000, Logistic Regression

	<i>mid_y1</i>	(1)	(2)	(3)	(4)
Dependency (Low)		-58.5258 (19.9437)**	-23.9704 (14.0323)	-22.3521 (13.9362)	-16.4128 (12.5964)
Dyadic trade (ln)			-0.1795 (0.0234)**	-0.1551 (0.0253)**	-0.1322 (0.0245)**
Triadic trade (ln)				-0.1304 (0.0533)*	-0.1434 (0.0537)**
Systemic trade (/100)					-2.0087 (0.2459)**
Democracy (Low)		-0.0769 (0.0070)**	-0.0752 (0.0072)**	-0.0749 (0.0072)**	-0.0721 (0.0072)**
Democracy (High)		0.0252 (0.0054)**	0.0278 (0.0054)**	0.0272 (0.0054)**	0.0272 (0.0055)**
Intergovernmental Organizations		0.0141 (0.0031)**	0.0207 (0.0032)**	0.0230 (0.0033)**	0.0207 (0.0033)**
Total GDP (ln) (Low)		0.0836 (0.0441)	0.1288 (0.0456)**	0.1217 (0.0455)**	0.2615 (0.0487)**
Total GDP (ln) (Low) x Contiguity		-0.2659 (0.0488)**	-0.3063 (0.0498)**	-0.3049 (0.0497)**	-0.2820 (0.0502)**
Total GDP (ln) (High)		0.7320 (0.0507)**	0.8174 (0.0525)**	0.8265 (0.0526)**	0.8277 (0.0528)**
Total GDP (ln) (High) x Contiguity		-0.4294 (0.0482)**	-0.4029 (0.0490)**	-0.3972 (0.0490)**	-0.4118 (0.0487)**
Contiguity		8.3294 (0.4109)**	8.4414 (0.4271)**	8.3704 (0.4285)**	8.2835 (0.4359)**
Distance (ln)		-0.4032 (0.0392)**	-0.4225 (0.0394)**	-0.4150 (0.0395)**	-0.4557 (0.0399)**
Minor powers		-1.0998 (0.0935)**	-1.1437 (0.0963)**	-1.2041 (0.0974)**	-1.1505 (0.0980)**
Allies		-0.1606 (0.0941)	-0.1161 (0.0956)	-0.1621 (0.0965)	-0.1115 (0.0972)
Capability Ratio (ln)		-0.4350 (0.0395)**	-0.4692 (0.0402)**	-0.4861 (0.0405)**	-0.4556 (0.0411)**
Middle East		0.3769 (0.1042)**	0.2888 (0.1087)**	0.3066 (0.1090)**	0.3934 (0.1086)**
Peace years		-0.6058 (0.0234)**	-0.5992 (0.0237)**	-0.6002 (0.0237)**	-0.5833 (0.0237)**
Constant		-6.7266 (0.5057)**	-7.5149 (0.5303)**	-7.5484 (0.5304)**	-7.8254 (0.5292)**
Observations		411490	406849	406849	406849
Wald χ^2		8432.43**	8253.29**	8322.03**	8197.80**
Pseudo R ²		.48	.48	.48	.49

Estimates for temporal spline variables suppressed. Robust standard errors in parentheses;
* significant at 5%; ** significant at 1%

Table 3: Robustness of Trade Network Characteristic for Militarized Interstate Disputes, 1948 – 2000, Logistic Regression

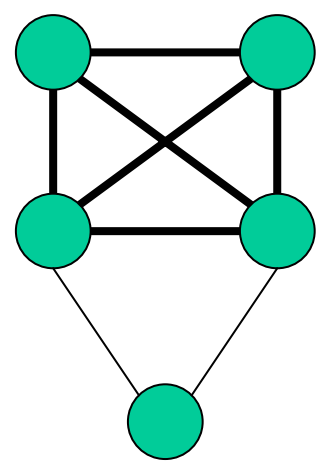
<i>mid_y1</i>	(5)	(6)	(7)	(8)
	Dyadic Trade (ln)			
	Below Average	Above Average	Above Av. + 1 Std. Dev.	
Triadic trade (ln)	-0.3364 (0.1532)*	-0.2317 (0.0541)**	-0.1920 (0.0563)**	
Systemic trade (/100)	-2.1761 (0.3833)**	-1.5718 (0.3186)**	-1.7881 (0.3936)**	-2.2189 (0.2421)**
Trade: Dyadic (Low) & Triadic (High)				-0.1216 (0.1656)
Trade: Dyadic (High) & Triadic (Low)				-0.2222 (0.0829)**
Trade: Dyadic (High) & Triadic (High)				-0.7014 (0.1019)**
Democracy (Low)	-0.0747 (0.0128)**	-0.0843 (0.0089)**	-0.0746 (0.0097)**	-0.0778 (0.0072)**
Democracy (High)	0.0274 (0.0079)**	0.0242 (0.0078)**	0.0262 (0.0100)**	0.0266 (0.0055)**
Intergovernmental Organizations	0.0115 (0.0056)*	0.0276 (0.0042)**	0.0222 (0.0047)**	0.0172 (0.0031)**
Total GDP (ln) (Low)	0.4743 (0.0712)**	0.1189 (0.0660)	0.0523 (0.0846)	0.2680 (0.0484)**
Total GDP (ln) (Low) x Contiguity	-0.5843 (0.0865)**	-0.1743 (0.0634)**	-0.1596 (0.0780)*	-0.3015 (0.0488)**
Total GDP (ln) (High)	0.8878 (0.0766)**	0.5716 (0.0844)**	0.7329 (0.1022)**	0.8196 (0.0535)**
Total GDP (ln) (High) x Contiguity	-0.4117 (0.0727)**	-0.2988 (0.0724)**	-0.3422 (0.0897)**	-0.4249 (0.0479)**
Contiguity	10.1301 (0.6848)**	6.4190 (0.7180)**	6.8502 (0.9163)**	8.5167 (0.4280)**
Distance (ln)	-0.5865 (0.0610)**	-0.1948 (0.0545)**	-0.1349 (0.0688)*	-0.4277 (0.0388)**
Minor powers	-1.3141 (0.1906)**	-1.1362 (0.1174)**	-0.8973 (0.1310)**	-1.0435 (0.0975)**
Allies	-0.2666 (0.1832)	-0.1107 (0.1158)	0.0026 (0.1322)	-0.1630 (0.0962)
Capability Ratio (ln)	-0.5372 (0.0608)**	-0.3603 (0.0588)**	-0.3812 (0.0749)**	-0.4375 (0.0412)**
Middle East	0.7390 (0.1714)**	0.1715 (0.1586)	0.0928 (0.2084)	0.4921 (0.1084)**
Peace years	-0.6577 (0.0405)**	-0.5284 (0.0293)**	-0.4730 (0.0336)**	-0.5864 (0.0237)**
Constant	-8.2886	-7.0620	-8.6888	-8.0617

	(0.8138)**	(0.8251)**	(0.9811)**	(0.5233)**
Observations	272040	134809	71123	406849
Wald χ^2	3952.94**	36.44.37**	2192.18**	8101.54**
Pseudo R ²	.58	.39	.37	.48

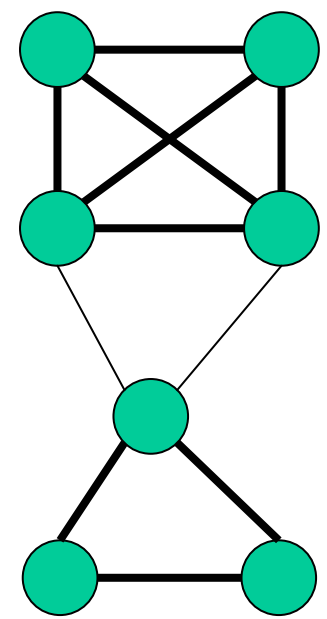
Estimates for temporal spline variables suppressed. Robust standard errors in parentheses; * significant at 5%; ** significant at 1%.

Figure 1: An Example of Trade Networks with Different Implications for Maximum Flow and Minimum Openness Statistics

Pattern A



Pattern B



Note: Thicker lines indicate more extensive trade flows between countries (circles).

Figure 2: An Example of a Valued, Non-Directed Graph

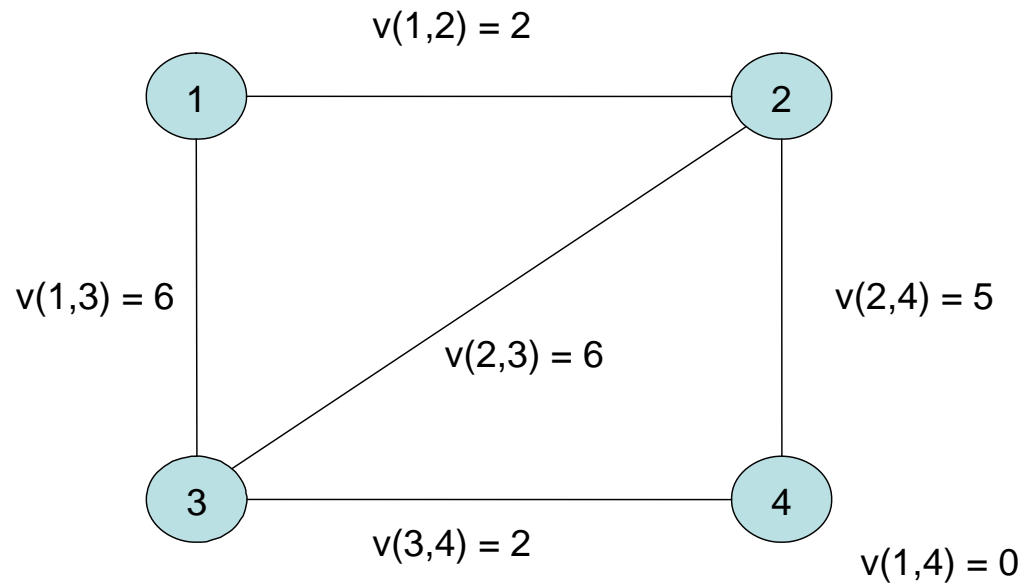
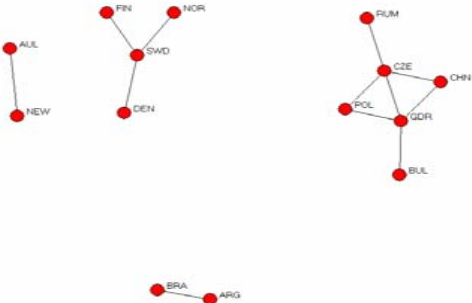
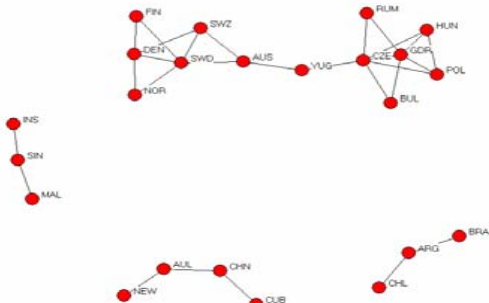


Figure 4: Growth in direct interconnections between medium-sized economies, 1960 - 1990

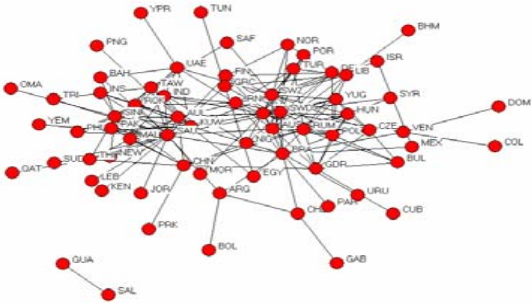
1960



1970



1980



1990

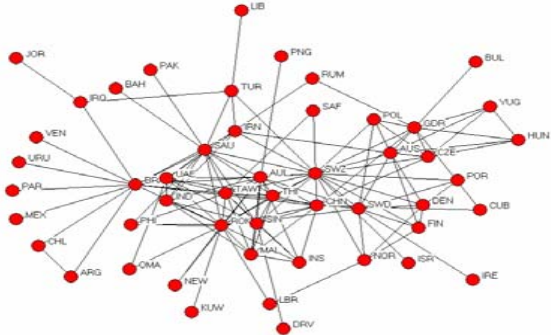
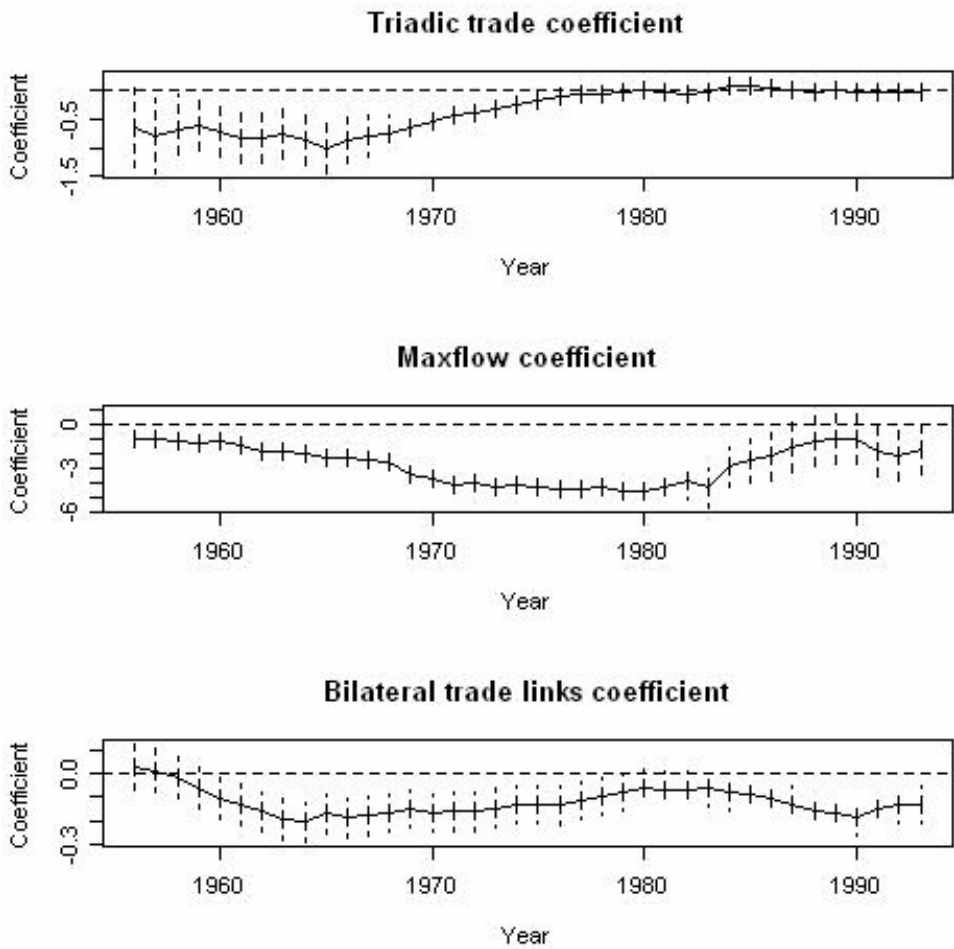


Figure 5: Tracing the Significance of Trade Network Variables over Time



Note: Coefficients plus 95% Confidence Intervals from Logistic Regression of full model on 15 year intervals. Special thanks to Kristian Gleditsch for helping us with programming / plotting in R.

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¹ Ingram, Robinson and Busch (2006) find that joint IGO membership increases the amount of dyadic trade, not just in the case of specifically trade related IGOs but also in the case of socio-cultural IGOs; see also, Mansfield and Pevehouse (2001) on the effect of preferential trade agreement and trade flows and interstate conflict.

² Whereas Maoz et al interpret structural equivalence in rational-choice terms, it is also possible to interpret it sociologically as indication of membership of an ‘in group’ as Hafner-Burton and Montgomery (2006) do, deriving clusters of nations from the IGO network.

³ Hafner-Burton and Montgomery (2006) take degree centrality in the IGO network as a measure of a country’s power or prestige. They find that countries with similar centrality scores are less likely to go to war, extending arguments about power similarity and conflict to power derived from network position.

⁴ The same passage is also quoted in Irwin (1996: 16). The doctrine of the ‘universal economy’ was not unequivocally accepted in the Christian tradition, neither did it provide a unambiguous defense of international trade, let alone establish a link between commerce and peace, Viner ([1959] 1991: 49 – 50) and Irwin (1996: 30).

⁵ Most famous is Cobden’s opposition to British involvement in the Crimean war (1853 – 1856), but also in the Don Pacifico debate (intervention against Greece) in 1850 or the ‘China War’ in 1859. More ambiguous is the position of John Stuart Mill who finds a justification for intervention and transitory colonialism to advance the spread of ‘international morality’: “But there assuredly are cases in which it is allowable to go to war, without having been ourselves attacked, or threatened with attacks” ([1859], 1978: 366) and “nations which are still barbarous have not got beyond the period during which it is likely to be for their benefit that they should be conquered and held in subjection by foreigners” ([1859] 1978: 367).

⁶ As noted by Gartzke & Li (2003: 556) dependence evaluates the importance of dyadic trade (between countries *A and B*) either relative to total trade (of *A or B*) (Barbieri, 1996) or relative to total GDP (of *A or B*) (Russett and Oneal 2001).

⁷ Here, we do not test directly whether trade links promote mediation. In this article, our concern is to present and test a reduced network-theoretic model on trade and conflict. A (network-theoretic) model on mediation would obviously have to consider different factors, and we leave this task to future research.

⁸ “In a purely capitalist world, what was once energy for war becomes simply energy for labor of every kind. Wars of conquest and adventurism in foreign affairs in general are bound to be regarded as troublesome distractions, destructive of life’s meaning, a diversion from the accustomed and therefore “true” task” (Schumpeter 1951: 90).

⁹ MacDonald (2004), drawing on the work of Cobden and Schumpeter, thus rightly concludes that it is *free* trade should matter in particular for peace. He finds that his openness measures are not highly correlated with the trade dependency variable but significantly reduce the likelihood of a particular dyad experiencing conflict. Unfortunately, we are unable to distinguish between trade and free trade in our measures of trade networks.

¹⁰ Gleditsch (2002) gives trade current dollars, which we recalculated in terms of 1948 dollar value using US Bureau of Labor Statistics data on US prices (McCusker, 2003)

¹¹ Taking the sum total of trade between *A* and *B* rather than the average is merely to rescale all our derived network measures.

¹² Borgatti, Everett, & Freeman (2002). Because of computational restrictions when calculating maximum flow in UCINET6, we re-scaled the symmetric trade matrix by multiplying every entry by 0.001. We would like to thank Steven Borgatti for explaining to us why this was necessary.

¹³ Gartzke (2007: 175) uses “the lower of the two monadic population weighted gross domestic product statistics” thus, presumably, GDP per capita. However, we were unable to replicate his results in our model using this variable. Further tests revealed that population needed to be included either separately or as total GDP. Moreover, log-transformation for both GDP and population was appropriate given the highly skewed distribution of these variables with a small number of outliers. We report models with total GDP. Logfile with models including GDP per capita and population available from *JPR* website.

¹⁴ The baseline values were defined as means except for allies (0), contiguity (1), minorpowers (1), and Middle East (0), which gives a high baseline probability for conflict of .47 in Model 4 (Table 2). The impact is evaluated by varying the independent variable from its minimum to maximum value.

¹⁵ In the dataset, militarized conflict is rare, but in the simulations the parameters are set so as to maximize the risks of conflict. Further, the results are robust for rare-event logit (see log-file).

¹⁶ Here a spring embedding of the graph is shown. This tends to put sets of nodes with large number of ties between them at the center of the representation of the network. On trade data the effect is to place the largest trading nations at the center.

¹⁷ Kim and Shin (2002) carry out a network analysis on directed graph representing trade data for 1959, 1975 and 1996. They argue that the degree of network centralization (the extent to which the network approximates a star configuration) has fallen. However, their analysis relies on dichotomizing the trade data, thus throwing away information about the volume of trade. Freeman’s measure of network centralization for valued graphs, based on the normed summed differences between the degree centrality of the most central and other nations, and the skewness of the distribution of degree centrality go up over this period. Their argument that there have been growing trade ties between middle-range economies is consistent with what we found, but the growth in trade between the EU, North America and Southeast Asia makes the network as a whole more centralized.

¹⁸ The list of formal colonial powers is Belgium, Canada, France, the German Federal Republic, Italy, Japan, the Netherlands, Portugal, Russia, Spain, the UK and the USA.