“The Politics of Prominence in the Globalized Network of Trade Agreements”

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ABSTRACT: As WTO negotiations sputter to an unremarkable death, it looks increasingly likely that future liberalization in global trade will occur through the deepening and expansion of preferential trade agreements (PTAs). Recognizing this fact, we build on an emerging literature that considers the jumble of some 250+ PTAs as an evolving network, one that is providing the institutional structure for global trade. In this paper, we consider what drivers are determining the ties of this network, particularly as we move into the “post-WTO” era of trade negotiations. Drawing on descriptive statistics of this globalized PTA network, we find that several curious actors have high degrees of importance. In explaining the prominence of these actors, we argue that it is geographic and political ambiguity that positions in key positions in the global trade network, and test these contentions using inferential network analysis (NA) tools. We find that countries and institutions that can bridge ideological and physical space are the most important for creating the institutional linkages of trade in the evolving 21st century multi-polar world.


NOTE: This paper is very much a work in progress. In particular, the empirical operationalizations and findings of the inferential model are VERY preliminary and subject to change. Please do not cite without the authors’ permission.
Introduction

Much has been made of the decline of the multilateral trade order and the rise of preferential trade agreements (PTAs) across the globe since the end of the Cold War (Heydon and Woolcock 2009). As of April 2015, the WTO records 449 total PTA notifications with 262 in force.¹ Many of these recent agreements are concentrated geographically, constituting what has been called the “new” regionalism (Ethier 1998). The proliferation of bilateral and regional agreements has led to a vast interconnection of trade ties, coined by Bhagwati as the “Spaghetti Bowl” (Bhagwati 1995). While a considerable literature has examined the domestic and dyadic drivers of PTA formation (e.g., Frankel, Stein et al. 1997, Freund 2000, Chen and Joshi 2010), consideration of the network dynamics behind PTAs is still in its infancy (for exceptions see (Furusawa and Konishi 2007, Manger, Pickup et al. 2012, Lee and Bai 2013, Manger and Pickup 2016 )).

As WTO negotiations lose steam, it looks increasingly likely that the contemporary global trade order could be dominated by the network of PTAs, including “mega-PTAs” such as the Transatlantic Trade and Investment Partnership (TTIP) the Trans-Pacific Partnership (TPP) or the Regional Comprehensive Economic Partnership (RCEP), that often go beyond WTO commitments in terms of scope and depth (Hartman 2013, Lamy 2014), leaving the WTO to perhaps act as no more than an adjudicator in PTA disputes (Gao and Lim 2008, Marceau and Wyatt 2010). However, formal work by both Furusawa and Konishi (Furusawa and Konishi 2007) and Lake (2015) suggests that it is unlikely that a stable, global, “PTA network” will form in the presence of asymmetric countries. This result suggests that the PTA network will be sub-optimal vis-à-vis the multilateral regime for actors that are not adequately connected. If the WTO is to be supplanted by a PTA network with asymmetric welfare consequences, then studying the structure of that network is crucial in understanding what actors are and are not important in the current global trade regime.

In this paper, we add to the emerging literature on PTA networks by bringing both new techniques and insights to the understanding of PTA network formation. Crucially, we are concerned with identifying and explaining those actors that are fundamental to the PTA network and, by extension, those who are marginalized by it. Our argument is twofold. First, geographically and politically ambiguous states are important, but often over-looked, in a global trade regime characterized by increased interdependence, contestation of ideas, and a proliferation of actors. In such a system power is wielded by those able to traverse both physical and normative boundaries. Thus, some of the crucial actors in the PTA network are not the poles of a multi-polar world, but instead, the states that can bridge the geographic and ideational space between those centers. Second, that the PTA network does not develop

¹ https://www.wto.org/english/tratop_e/region_e/region_e.htm Accessed 14-04-2015. We use “PTA” as a catch-all term for trade agreements that also include the so-called “Free Trade Agreements” (FTAs) or “Regional Trade Agreements” (RTAs).
according to instrumental logics alone, but also contains powerful endogenous processes that reward those who occupy key positions within the broader structure.

Accordingly, the first task in the paper is to model the existing PTA network, using diagnostic tools to identify key measures of network prominence. These diagnostics identify several non-intuitive important actors in the network, presenting a puzzle that prompts us to develop expectations about the types of state characteristics that lead to prominence. We consider two strands of determinants for network prominence: institutional and economic-geographic. We then use inferential network techniques to evaluate these hypotheses, finding XXX before concluding with thoughts on the implications of prominence and directions for further research.

**What we know about PTA Formation, Proliferation, and Networks**

There is a substantial literature examining the formation and proliferation of PTAs. Economists have long focused on “gravity” explanations of geographic proximity and on issues of trade openness related to Viner’s (Viner 2014) classic analysis of trade “diversion” and trade “creation” (for examples see: Frankel, Stein et al. 1995, Bhagwati, Krishna et al. 1999, Krueger 1999, Magee 2003). Concurrently, political scientists brought attention to the formation of PTAs in consideration of hegemonic decline and geostrategic interests (Mansfield 1998, Powers 2004) or “political” trade dependence (Manger and Shadlen 2014), in the context of intra-democratic trade promotion (Mansfield, Milner et al. 2002), or as a process driven in conjunction with success and failure in the multilateral order (Mansfield and Reinhardt 2003). These papers have brought valuable insights into the determinants of PTAs, but most have focused on dyadic relationships between pairs of actors, rather than on the structure and dynamics of the PTA network.

While there is a long history of both formal and informal analysis of networks in global trade (De Benedictis and Tajoli 2011) attention has only recently turned to network analysis (NA) of PTAs despite the fact that some countries, such as China, explicitly view their PTA agreements as a holistic network.² Recent work by Piccardi and Tajoli (2015) uses NA tools to conduct a community analysis of trade diversion, based on both de jure and de facto identifications of preferential groupings. The authors find no significant trade diversion as a result of these groupings. With respect to PTA formation, Baldwin and Jaimovich (Baldwin and Jaimovich 2012) examine the “spread” of PTAs finding support for contagion where “political” PTAs instigate a response of “defensive” third party PTAs. However, while this work examines the spread of PTAs, it does so using spatial econometrics with a panel of data, rather than explicitly focusing on the network features using NA. Longitudinal network analysis is also brought to bear on the question of PTA formation by Manger et al (Manger, Pickup et al. 2012) who focus on the formation of the PTA network from 1994 to 2004. Similar to Baldwin and Jaimovich’s defensive

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PTAs, Manger et al focus on the mechanism of “triadic closure” to understand the proliferation of PTAs. In addition, they also focus on how relative levels of economic endowment determine PTA formation, finding a hierarchical network where high income countries are likely to form ties with each other, with middle-income countries and that middle-income countries form ties among themselves. They find little evidence of low-income countries forming PTAs with themselves or others. In a recent working paper, Pauwelyn and Alschner (Pauwelyn and Alschner 2014) present a toolkit of NA descriptive statistics regarding the PTA network including measures of prominence, clustering and depth. Their findings prompt much of the investigation in this paper, as they identify countries such Egypt, Chile, Korea, Ivory Coast, Turkey, and the Sudan as key actors in the PTA network. None of these countries are likely to strike the casual observer as crucial to the global trading system and none share immediately obvious characteristics that would explain their positions of high importance. Pauwelyn and Alschner go further in mapping the PTA network when weighted by “depth” and the network of “double” PTAs, where in multiple PTAs may cover the same dyad pair of countries (Pauwelyn and Alschner 2014).

While these papers provide a valuable foundation in describing the formation and shape of the global PTA Network, they do not fully develop or exhaust explanations of why some actors are more central to the PTA network than others. Manger et al’s (Manger, Pickup et al. 2012) principal finding is that high-income and trade-dependent actors are more likely to form ties in the PTA network. Yet these explanations alone appear to be insufficient to explain the heterogeneity of prominence suggested in Pauwelyn and Alschner (2014) who identify a number of prominent actors who do not appear to meet these criteria, while simultaneously noting the low degree of prominence of several actors that fit the profile of high-income and trade dependent actors. Importantly, we think the period under study in Manger et al (2012), 1994-2004, provides incomplete insights for the determinants of the current global PTA network. While the prospect of continued WTO negotiation was still very much alive during the period in their study, it has become increasingly moribund since. As such, we think it plausible to assume that more recent driver of PTA network formation and, in particular, the formation of inter-regional ties, may be motivated by additional logics to those considered by Manger et al (2012). Thus, in the subsequent sections we first replicate Pauwelyn and Alschner’s (Pauwelyn and Alschner 2014) findings before developing a theoretical understanding for prominence in a globalized PTA network.

Describing the Network

Figure 1 shows the preferential trade network in 1990 and 2014. It is immediately evident that this system became substantially denser in a relatively short period of time. In 1990 there were relatively few PTAs and nearly ties are organized around regional associations such as the European Free Trade Area, which joined Iceland, Lichtenstein, Norway, and Switzerland. In the ensuing years other regional associations came into force – e.g., NAFTA and ASEAN – which led many to conclude that the world economy was becoming increasingly regionalized. But by 2014
the PTA system had become increasingly *globalized*: the density of the network increased substantially, and all regional clusters were linked by at least one pathway.\(^3\)

**FIGURE 1a:** The preferential trade agreement (PTA) network in 1990, plotted by the authors using the Fruchterman-Reingold algorithm included in the *igraph* package in the statistical software *R*. At the end of the Cold War the PTA system was dominated by highly regional and most PTAs involved regional associations such as the EFTA, CARICOM, and MERCOSUR. Note:

\(^3\) Figure 1b understates the amount of “globalization” of trade rules, since WTO membership also increased significantly during this period.
organizations with external links (e.g., EFTA) are included as nodes linked to by their constituent members; organizations without external links are not included as nodes. Source: World Trade Organization Regional Trade Agreements database.

FIGURE 1b: The preferential trade agreement (PTA) network in 2000, plotted by the authors using the Fruchterman-Reingold algorithm included in the igraph package in the statistical software R. Note: organizations with external links (e.g., EFTA) are included as nodes linked to by their constituent members; organizations without external links are not included as nodes. Source: World Trade Organization Regional Trade Agreements database
FIGURE 1c: The preferential trade agreement (PTA) network in 2014, plotted by the authors using the Fruchterman-Reingold algorithm included in the igraph package in the statistical software R. Over time, the PTA system became much denser and much less regionalized. Note: organizations with external links (e.g., EFTA) are included as nodes linked to by their constituent members; organizations without external links are not included as nodes. Source: World Trade Organization Regional Trade Agreements database.

It remains a system with the European Union and European Free Trade Association (Iceland, Liechtenstein, Norway, and Sweden), but significant clusters of integration exist in all regions, and the United States has become much more central within the PTA structure over time. As the network developed some previous patterns were reinforced, but some countries that were
not a major part of this system in 1990 became much more prominent by 2014. Many of these are small, open economies that are highly involved in trade; others are dependent upon the export of primary commodities for growth.

Figure 2 portrays the network in a slightly different way by plotting countries’ prominence as measured by degree (x-axis) and closeness (y-axis) prominence for the most recent period. Degree prominence is simply a count of the number of countries to which one is tied via a PTA (Freeman 1979; Wasserman and Faust 1994). Closeness prominence is a measure of the average “distance” – the average of the shortest paths between one trading entity $i$ and all other nodes $j$ in the network – and is calculated by $C_c(i) = [\sum_{j=1}^{n} d(i,j)]^{-1}$. In other words, degree prominence captures all of the direct connections a node has to the rest of the network while closeness prominence is one way of measuring the position of a node within the network by reference to the other nodes. Countries that are prominent in terms of closeness are “in the middle of things” even if they are not, themselves, strongly-tied. If a country is highly prominent on both measures then we can say that it possesses both direct (degree) and indirect (closeness) influence on the network.

From Figure 2 it clear that the relationship between the degree and closeness prominence is loosely linear in the PTA network: as countries gain more ties they also become closer to all other nodes. As expected, the EU and EFTA are clearly the most prominent, but the next tier of influential nodes is more diverse: along with large OECD economies such as the U.S. and Canada are Chile, Egypt, Jordan, Morocco, India, Peru, South Korea, Turkey, and Ukraine. It is also important to note which countries are not particularly prominent, chief among them China. China has the 12th most PTAs in the network, but its closeness score is not remarkable: it is “in the middle of things” to roughly the same extent as Bosnia and Costa Rica.

Some other interesting patterns emerge. For example, the U.S. has roughly double the overall connections as Malaysia but its average closeness is no higher, suggesting that many of the U.S.’s PTAs are with countries that are relatively isolated in the network, (including small regional neighbors such as Costa Rica). This also provides a context for why the U.S. would seek to become more attached to two of the most prominent clusters in the network – Europe (via the Transatlantic Trade and Investment Partnership) and East Asia (via the Trans-Pacific Partnership). While most policy discussion has focused on the direct economic gains that will come from these deals, there is a secondary consideration: the U.S. will move into a much more prominent position within the structure of global trade institutions if TTIP and TPP are completed successfully. Thus, even if the first-order economic impact of these deals is relatively small as some economists expect (Petri & Plummer 2016; Raza et al. 2016), the second-order consequence – the U.S. will move into a more influential position within the “regime complex” (Keohane & Victor 2011) of global trade agreements – may be much more important.
Other measures of network prominence reveal different patterns. Figure 3 plots eigenvector prominence (x-axis) against countries’ betweenness scores (y-axis). A node’s eigenvector prominence scores is the sum of the prominence of the other nodes one is connected to, normalized to vary in between zero and one; that is, a high eigenvector value indicates that a unit is not only strongly tied but is strongly tied to other well-tied units. A node $i$ that provides a pathway connecting otherwise un-tied $j$ and $k$ is prominent in terms of its betweenness score,
calculated as $C_B(i) = \sum_{j<k} g_{jk}(i)/g_{jk}$. Nodes with high betweenness prominence can be thought of as important brokers, or gatekeepers.

In the PTA network, the European Union is connected to every other important unit and provides more pathways to other countries in the system than anyone else. The EFTA remains influential by these measures as well. But following those are some countries whose prominence could be more surprising: Chile’s eigenvector prominence is quite high, while India and Ukraine serve as important brokers despite being only moderately well-tied to other important nodes. Perhaps surprisingly, by all of these metrics other than simple degree prominence India is the most influential of the so-called BRICS (Brazil, Russia, India, China, South Africa) economies. Several OECD economies outside of the traditional G10 core are also quite important within the global PTA structure, including Chile, Egypt, Mexico, South Korea, and Turkey.

**Theorizing Prominence in the PTA Network**

The descriptive portrait above offers an interesting puzzle – why are some actors more central to the global PTA network than others? Why are some countries important according to some measures but not others? Some positions are not surprising, including the overwhelming dominance of the EU in the network. Evolving from an institution focused on trade liberalization, the institution now has nearly 30 internal members and over 40 external agreements. As a liberal “soft-power” actor, the EU has been a popular choice to replace the US as the spearhead of the international trade system, despite the fact that internal squabbles have caused observers like Elgstrom (Elgström 2007) to brand the group a “restricted leader”. Indeed, the EU’s rise and fall within the WTO may have both been managed prior to the new millennium through its overplaying of the “Singapore Issues” (Young 2011) and recent and ongoing financial cum political crisis have presumably only further undermined this leadership potential. However, despite these challenges, the group has done well at positioning itself as the major actor within the PTA network, a feat unmatched by its economic counterweights to the West or East. Indeed, a conscious effort of “competitive interdependence” (Sbragia 2010) or “competitive liberalization” (Aggarwal 2009) has been attributed with promoting the EU’s PTA efforts.

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4 Where $g_{jk}$ is the number of geodesics connecting $jk$ and $g_{id}(i)$ is the number of geodesics that include $i$. 
However, apart from the EU, it is somewhat surprising that the usual suspect powerhouses are not as prominent in the global PTA network as their economic dominance would suggest. The relative non-prominence of the US, in particular, stands out. Perhaps this seeming unimportance is unsurprising as much has been made of the challenges facing the global trade regime since the advent of the WTO in 1994. As early as 1992, Preeg (Preeg 1992) noted that the US-led system would face challenges from regional agreements and a changing geo-political
landscape. Indeed, an increasing disconnect in the visions for the multilateral order has recently been cited as a long-term force driving discord in the multilateral order (Muzaka and Bishop 2015). Numerous authors have attributed this stagnation to declining US hegemony and leadership which are unable to sustain the multilateral effort initiated with the Bretton Woods regime (Goldstein and Gowa 2002, Ikenberry 2003, Aggarwal 2009), although others, notably Keohane (Keohane 2012) argue this case is overstated. Yet although the US has taken a well-documented bi-lateral and regional turn (Bhagwati & Panagariya; Gathii 2011), they do not occupy the position of prominence in the PTA network. If the US is not at the center of the PTA network, and not driving the multilateral initiative, there is little clarity as to who or what replaces the US as the anchor of the international trade system, both materially and ideationally (Ikenberry 2011).

Likewise, the major emerging economies are not as uniformly important as one might suspect. While there has been a flurry of speculation that the BASIC (Brazil, South Africa, India, China) powers could take the reins of the WTO (Narlikar 2010), there is little to suggest that these states have assumed that mantle (Efstathopoulos 2012), and that, instead, they might be adding to the increased contention and gridlock of the institution (Hurrell and Narlikar 2006, Wilkinson 2015), albeit to greater or lesser degrees (Hopewell 2015). India and, to a lesser extent, South Africa, come closest to occupying positions in the PTA network commensurate with their economic and political importance, but even they fall short of being as “central” as they might be. While the reasons for this comparative disengagement no doubt vary with the heterogeneity of these emerging states states, each follows domestic and international economic approaches that are at some variance with the existing norms of the trade order. Indeed, some go so far as to classify these powers as “illiberal” trading states (Stephen and Parízek).

Instead of these obvious candidates, “second” or even “third” economic and political tier countries such as Chile, Jordan, Egypt, Turkey and the Ukraine punch above their weight in terms of network prominence. This presents the most puzzling finding of our analysis. What characteristics, if any, do these countries share that leads to their positioning in the global PTA network? Our theoretical explanation builds on the notion introduced by (Fontaine and Kliman 2013) of global “swing states”, whose “mixed political orientation gives them greater impact than their population or economic impact might warrant” (p. 93). However, whereas (Fontaine and Kliman 2013) use the concept to identify states with whom the US can engage to extend their (unipolar) global order, we instead take the logic in a direction to theorize about states that can serve to bridge the poles in a multi-polar world. Here again, the “mixed” orientation matters. While perhaps not as stark as the three “worlds” of the cold war, the coming global order has distinct ideational poles in terms of norms and values. The US, EU, China, Russia and their respective spheres of influences in the countries of Europe, Africa, South America, and the Middle East, all have ideational variants of the global economic order (Nolke 2011). Indeed, as (Hale, Held et al. 2013) argue, this multi-polarity is one of the driving factors behind multilateral gridlock. As physical and ideational polarity has increased, the states that straddle these divisions should become key to any global network. The ambiguity, or centrality, of these swing-states allows them to engage with the differentiated poles, providing linkages where
they might not otherwise exist. This turns these states into powerful actors in the global trade network – with outsized influence due to not their material capacity but to their geo-economic and ideational positioning.

In theorizing on the determinants of prominence in the global PTA network we invoke the primary logic of trade - distance. Based on the classical gravity model (Tinbergen 1962), proximity as a causal mechanism has driven decades’ worth of theoretical and empirical trade research. Indeed, this proximity logic drives the expectations and findings of Manger et al. 2012, who find that countries that are near each other economically or politically are more likely to form ties in the PTA network. This logic was useful for the network under their period of study, 1994-2004, where, as shown in figures 1a and 1b, most ties in the network were intra-regional, with few linkages between the clusters. However, as the network becomes globalized in figure 1c, the key actors shift to those that provide the inter-regional linkages. Using a proximity logic, these actors need to be proximate to both regions which are being linked. When these regions are geographically, institutionally economically or geo-strategically disparate, the key linkage nodes are likely to be those actors that fill the middle ground along one or more of those dimensions. This is what we mean by ambiguous actors, actors that bridge the geographic boundaries, straddle levels of economic development, or span institutional or ideational diversity between two or more disparate nodes. Thus, our first hypothesis focuses on distance.

H1: Distance: Actors that are nearer the median of geographical, institutional, economic and geo-strategic measures will have more centrality in the globalized PTA network.

This hypothesis has several observable implications along different dimensions. From an economic geography standpoint, the gravity model has consistently informed studies into the formation of PTAs (Magee 2003) and flows of trade (Disdier and Head 2008), with Ward et al. (2013) bringing NA to bear on the latter. Based on simple logic of “melting iceberg” trade costs the model posits that geographic distance will be inversely related to the volume or presence of trade ties. The gravity logic has most often been employed through the examination of dyadic links, either through use of a simple distance measure or a trade-weighted measure of distance. The latter is useful when considering the formation or expansion of linkages between systematically important trade actors. While Fagiolo (2010) uses a trade-weighted gravity logic in a network analysis of trade flows, we are unaware of any work that has used a trade-weighted gravity logic to investigate prominence in the PTA network. In particular we would expect trade-weighted distance to matter particularly for measures of betweenness and eigenvector prominence. Actors that are geographically central to the density of global trade flows are likely to be hubs of PTA formation. Indeed, countries like Egypt, Turkey and the Ukraine are situated at the crossroads of continents. The advantages of favorable geographic trade are most evident in the centuries-long importance of South-East Asia stretching from

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5 While Manger et al. (2012) do include a measure of great-circle distance in their analysis of the PTA network formation they do not investigate the role of trade-weighted distance in explaining prominence.
early Malaysia (Jacq-Hergoualc'h 2002) to modern day Singapore (Huff 1997). Yet other countries that serve as important inter-regional or inter-continental geographic bridges between other hubs of economic importance may also be central to the global PTA network – linking East to West (Turkey, Ukraine), North to South (Mexico) or both (Israel).

_Hypothesis 1a: Countries with lower trade-weighted distances in the global trade network will have a higher degree of prominence in the globalized PTA network._

However, the hubs at the centre of the global PTA network do more than link geographically disparate areas of the globe – they also may serve to bridge culturally or institutionally diverse actors. While there is strong evidence that democracies are more likely to form PTAs (Mansfield, Milner et al. 2002, especially with each other (Manger, Pickup et al. 2012), and especially when the PTA is “deep” and the number of veto players is small (Mansfield, Milner et al. 2008). Yet, there are numerous significant non-democratic actors in the global trade system. Indeed, Hankla and Kuthy (Hankla and Kuthy 2013) find that institutionalized, party-based and temporally stable, authoritarian regimes often adopt open trade policies. However, despite the presence of “liberal autocracies” there is little evidence to suggest that highly democratic states form PTAs with highly non-democratic states (Manger, Pickup et al. 2012).

Given this lack of interaction we would not expect democratic states to be central to the PTA network. Nor would we expect autocracies to feature prominently as key hubs in the system. Instead, we expect that politically ambiguous actors – illiberal, semi, or quasi-democracies (Zakaria 1997), “anocracies” (Gurr 1974) or “hybrid regimes” (Diamond 2002)– to have high degrees of _betweeness_ prominence due to compatibility with either democratic or authoritarian alters. Indeed, Egypt, Jordan, Turkey and the Ukraine all fulfill the Polity IV criteria of “closed” (in the case of Egypt and Jordan) or “open” (for Turkey and the Ukraine) anocracies. Democratic states can justify engaging with these states based on supporting an emerging democracy, while the quasi-democracies will have fewer qualms engaging with authoritarian regimes as they need be less responsive to their own domestic constituencies.

_Hypothesis 1b: Actors with more ambiguous political regimes will have a higher degree of prominence in the globalized PTA network._

Finally, there is a long literature that understands the formation of trade ties (Mansfield and Bronson 1997; Powers 2004). This literature has recently been updated by Haim (2016) who considers the relationship between alliances and trade flows in the network context of shared alliances and alliance communities. However, in a globalized PTA network once again it is going to be the actors that cross geo-strategic communities that will display high degrees of centrality. Actors that have historically straddled different security communities, like Egypt, may be able to access the economic communities of each faction (Barnett & Levy 1991, Brownlee 2012). Likewise, countries, like Mexico or the Ukraine, that do or have recently practiced _de facto or de jure_ neutrality can serve as bridges between economic communities (Friedman & Long 2015, Yost 2015).
Hypothesis 1c: Actors with ambiguous geo-strategic ties will have a higher degree of prominence in the globalized PTA network.

Our second hypothesis regarding the formation of the globalized PTA network rests on network characteristics and dynamics. WILL EXPLAIN HERE. (or is this just controlling for endogeneity in the network)?

H2: Network dynamics: “Memory”, Hierarchical degree distribution, shared partners distribution

**Empirical Strategy**

Most existing political economy scholarship has examined the system of PTAs at the level of the dyad, often using logistic regression or some other binary response model. While this generation of work has led to numerous knowledge gains there are reasons to think that a new approach could move our understanding of PTA formation forward.⁶ We believe that analyzing the system of of PTAs as a network has two key benefits: first, governments appear to view their own PTA portfolios holistically, at least in some cases; second, analyzing dyadic data as a network allows us to consider whether dyads in the system are independent or whether, say, the probability that the United States pursues a PTA with Japan is in part related to Japan’s existing PTA portfolio (and vice versa). These structural considerations may be especially important in cases where the direct economic gains from PTAs are not enormous but the cost to political leaders is non-trivial, a situation that appears to exist in many advanced economies at present.

To examine these hypotheses we present what we believe to be the first examination of the network of preferential trade agreements using temporal exponential random graph models (TERGM). Unlike the linear and logistic regression models that are commonly used to model the PTA system, TERGMs are highly flexible models that allow for the testing of hypotheses without the assumption – required of regression models – that observations are identically-distributed and independent from one another (Cranmer & Desmarais 2016). Given a specified model, which can include exogenous covariates (monadic or dyadic) as well as parameters that capture endogenous structural processes, TERGMs estimate the probability of observing the network that we have observed over all of the possible networks we could have observed. These parameters are unbiasedly estimated via maximum pseudolikelihood (MPLE), and potential inconsistency in standard errors is corrected via a non-parametric bootstrapping re-sampling algorithm developed by Desmarais and Cranmer (2012).⁷

This method is most appropriate for analyzing the global system of preferential trade agreements, as these agreements, taken together, constitute a dynamic network that has

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⁶ See CRANMER + DESMARAIS ISQ for a more general discussion of the limits of dyadic research design
⁷ All models were estimate using the xergm package in statistical software R. Post-estimation procedures used the texreg package. The bootstrapped errors were replicated 5,000 times.
developed over time. It is even more important to employ a method capable of incorporate endogenous network dynamics given our theory above, in which new PTAs are formed partially according to their direct instrumental value relative to the cost of adjustment, but also partially according to their indirect benefit: the ability of countries with structural prominence to possess influence over the broader institutional structures that govern trade. Arguably this latter factor has become even more relevant over time as progress in the Doha round of WTO negotiations has stalled and much of the “low-hanging” fruit has been collected in previous trade deals. It is this motive that is likely to provoke what we called the “struggle for position” within the PTA network.

TERGMs allow for examination of “complex” processes that may contribute to network formation. In this paper we focus on two: endogenous processes that influence tie formation at the level of the node, and those that influence tie formation at the level of the k-ad. In particular we are interested in answer two questions. First, are new ties distributed relatively randomly, or do nodes with high structural prominence ex ante reinforce their positions ex post? Second, is the likelihood that ties form between any two nodes distributed relatively randomly, or are new ties more likely to form ex post between nodes that have common partners ex ante. The answers to these questions may help us understand why the increased density in the PTA network has not eroded the position of some key entities – such as the European Union – within that structure. It can also help us understand some ways in which high-betweenness nodes might influence future tie formation among its partners.

We restrict our analysis to the period from 1990-2012 as the bulk of the PTA network has formed since the end of the Cold War. This nevertheless represents a substantially longer time frame than what was analyzed in the only other inferential network analysis of the PTA system of which we are aware, as Manger et al (2012) used SIENA models to examine the 1994-2004 period. The addition of years 2005-2012 represents a significant increase in the number of PTAs in the network, which provides a good opportunity to re-evaluate these earlier findings. The dependent variable – the entire network of PTAs in a given year – was taken from the World Trade Organization’s Database on Regional Trade Agreements, which contains information on all reciprocal PTAs agreed between WTO members.

IVs: (basically inspired by prev lit, Manger et al (2012), plus some theory above)

GW terms: Rephrase this: “term is analogous to more traditional k-star statistics (Hunter and Handcock 2006), but are more parsimonious. Rather than specifying a model which includes a separate parameter for 2-star, 3-star, 4-star, etc., the GWID and GWOD terms captures the general effect, geometrically weighted by a decay parameter. As such, these terms reflect “anti-preferential attachment” mechanisms that operate within the network.80 A positive coe cient indicates that the probability that an additional tie will attract future ties decreases geometrically with node degree. As we can see, both GWID and GWOD are negative and statistically signi cant at all thresholds, which provides strong evidence that preferential attachment is driving part of both the in-degree and out-degree distributions within the network: countries that are strongly-tied to the rest of the network are more likely to attract
new connections than weakly-tied countries even after accounting for the state of the rest of the network.”

Results

The results shown in figure 4 provide mixed support for our hypotheses. Fulfilled most thoroughly are the expectations from network theory regarding endogenous structural processes being an important factor in the development and persistence of network of preferential trade agreements, but several of the proposed dyadic effects are also present.

Interpretation of estimated coefficients on TERGM models is not as straightforward as those from regression models. The coefficients themselves represent the conditional log odds of tie formation given the rest of the network. There are two types of ties in this model: dyad-independent ties, such as those comparing how the difference in GDP per capita between two nodes impacts tie formation; and dyad-dependent ties, such as those capturing the degree and shared-partners distributions. Dyad-independent variables averages the impact of a variable dyads on the probability of tie formation within dyads, irrespective of all of the other dyads in the network. Dyad-dependent variables capture the dependencies that exist across dyads. Because all of these are conditional on rest of the network there is no simple analogue to the kinds of predicted probabilities plots that are commonly found in interpretations of logistic regression models. Micro-level estimation is possible, but is beyond the scope of this analysis.

Several of the estimated coefficients associated with dyad-independent variables contain 95% confidence intervals that do not include zero. Difference in GDP per capita has a positive impact on tie formation, indicating that greater income disparities increase the probability of tie formation. This contradicts the finding from Manger et al (2012), perhaps because a greater proportion of PTAs enacted from 2005-2012 (and/or from 1990-1993) were between high- and low-income countries than those enacted from 1994-2004 (their sample years). There is no important statistical relationship between overall economic size, perhaps indicating that possession of different comparative advantages are more important for PTA tie formation than simple economic mass. The positive coefficient on log-transformed total trade within a dyad suggests that partners engage in substantial trade even before entering into a PTA arrangement.

Variables capturing institutional, geographic, and security closeness present a similarly mixed picture. Countries that have dissimilar levels of political freedom, at least as captured by Freedom House, are more likely to form PTAs. This may also capture a recent-year increase in PTAs among North-South dyads, and between democracies and mixed regimes such as Singapore. This model suggests that the PTA network is not becoming increasingly geographically regionalized, however, as distance between capitals is not a meaningful predictor of tie formation. Surprisingly, a defense pact between dyads negatively predicts tie formation, contrary to the finding of Manger et al (2012) and our expectation; once again this may indicate that the types of PTAs that entered into force since 2004 are qualitatively different from those created in the immediate aftermath of the Cold War: as the security
environment has changed, the institutional environment governing international economic exchange may have evolved with it.

The dyad-dependent network terms have a major – and more consistent – impact on the probability of tie formation. Previous iterations of the PTA network strongly predict future iterations of the PTA network, as they must (since PTAs almost never go out of force). This term functions similarly to a lagged dependent variable in regression analyses but may be even more critical in inferential network models in which the dependent variable is not an independent outcome but an interdependent network: just as people do not choose their friends every new day countries do not choose their partners for preferential trade access.
FIGURE 4: Results from a temporal exponential random graph model (TERGM) of the preferential trade agreement network from 1990-2012 estimated using the xergm package in the statistical software R. The TERGM was estimated via maximum pseudolikelihood and standard errors were corrected via 5,000 iterations of a bootstrapping resampling algorithm. The results strongly suggest that endogenous structural processes have a powerful impact on link formation. Some dyadic variables also influence link formation.

The geometrically-weighted (GW) terms are similarly important predictors of tie formation. The term capturing the GW degree distribution is negative and the 95% confidence interval is far away from zero. This indicates that new ties are not distributed randomly (taking into consideration the other covariates), but as a partial function of the prior distribution of ties: the negative coefficient indicates that the probability that an additional tie will attract future ties increases geometrically with node degree (Hunter 2007). This provides some indication that preferential attachment effects exist within this network, allowing tie-wealthy nodes (like the European Union) to attract new ties with more ease than a randomly-selected node. This should not be surprising; many real-world networks display properties such as these, including those found in IPE, and many of the most-prominent countries in the PTA network are presently pursuing deals.

Indirect connections condition the environment within which states pursue trade agreements. For example, if two states have a common PTA partner they may be more likely than average to become partners themselves. Similarly, if two countries are linked to each then they may have many other links in common, just as friends tend to have many friends in common.

The GWESP and GWDSP terms capture the impact of indirect ties on the probability of tie formation between two nodes, and are a more parsimonious analogue to the alternating k-triangles and alternating 2-paths statistics, respectively. When estimated together in the same model GWDSP represents the effect of having partners in common when there are no direct ties between two countries, while GWESP isolates the effect of shared partners on dyads that are directly connected.

The geometrically weighted edgewise shared partners (GWESP) statistic measures whether two economies that are tied together have more shared partners than would be expected by chance. For example, if the United States and Canada are linked to each other, GWESP captures the probability that they are both connected to the United Kingdom, Australia, New Zealand, and so on. Such groupings could occur among regional partners, for example, or among communities of nations with some other affinity (such as colonial legacy, common language, or shared culture).

The geometrically weighted dyadwise shared partners (GWDSP) statistic indicates whether economies that have partners in common tend to exist within the same network cluster irrespective of whether they themselves are connected. In other words, if the United States and Canada were not linked to each other but both were connected to the United Kingdom, GWDSP
would estimate the probability that they shared other partners as well (e.g., Australia, New Zealand, etc.).

Both of these statistics contain 95% confidence intervals that exclude zero: GWDSP is negative while GWESP is positive. Substantively, this means that tied economies have more shared partners than a random distribution would suggest, but economies that are not tied have fewer. This suggests that there is substantial clustering in the network, and observation that appears reasonable given the graph plotted in figure 1b.

The model’s goodness-of-fit diagnostic report shown in figure 5 is very encouraging. Despite a somewhat complex network structure – indicated by the multi-peaked degree distribution – the model predicts the network well. The receiver operating characteristics (ROC) and precision-recall (PR) curves indicate excellent model performance relative to a random graph with the same density of ties (i.e. a graph model containing only a term for edges, the analogue to an intercept term in regression). The covariates included in our model show substantial improvement in the prediction of ties; our model performs excellently by this criterion.

Overall, these results powerfully demonstrate the necessity of using a model that is capable of capturing patterns of interdependence in the system of preferential trade agreements. Non-network models, or network models that do not include statistics capture the previous state of the network, the degree distribution, and the shared partners distribution, are very likely to be misspecified.
FIGURE 5: Goodness-of-fit diagnostics for the model reported in figure 4, estimated using the ‘gof’ function in the xergm package in the statistical software R. The diagnostics show very good model fit.

Summary and conclusion

We have presented the first analysis of the global preferential trade agreement (PTA) network using an inferential temporal exponential random graph model (TERGM), and our sample is the largest ever analyzed using any inferential network model. Our results suggest that previous models of PTA creation may have over-estimated the importance of some monadic and dyadic attributes, particularly common economic status and political institutions, while under-
estimating the importance of endogenous structural processes embedded within the system of PTAs. In particular, the relationship between PTA formation and the dyadic levels of economic development and liberal political regimes – well-established in the literature on trade institutions – is different in a TERGM context than in prior models estimated via regression. They are also different from those reported in Manger et al (2012)’s SIENA inferential network model. In general, this model suggests that political and economic attributes are either less important than previous models have suggested.

While the diagnostic reports indicate that this model fits the data quite well, this analysis is not conclusive. Future work should examine the relative importance of other monadic and dyadic attributes in the prediction of PTA tie formation. Perhaps more importantly, out-of-sample prediction and micro-level estimation of the probability of tie formation can help us understand the likelihood of future ties that could be a critical importance to the international political economy of trade.

References


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