6 Degrees of Separation: The Topology of E-commerce Governance[*]

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Abstract

E-commerce and the digital economy are issue areas of geostrategic and economic importance to a wide range of countries. This paper employs tools drawn from network analysis to map the historical and future evolution of the topology of the global e-commerce regime. The study finds that the e-commerce governance architecture is complex, has become less fragmented over time, and is increasingly dominated by a series of network oligarchs. The structural contours of the e-commerce governance system have implications for governance outcomes within that system. Network effects could reinforce the structural positions of central states while increasing structural oligarchy could facilitate the promulgation of distinct models of e-commerce governance while simultaneously locking out developing countries.

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Introduction

Global e-commerce rules and regulations are governed by a maze of preferential trade agreements (PTAs). However, despite the economic and geo-strategic importance of e-commerce and the digital economy, very little is known about the structure of the global system of PTAs with e-commerce provisions or chapters. E-commerce provisions and chapters in PTA are a focus of this paper as e-commerce is likely to be a critical contributor to future international trade and global growth (Kathuria et al. 2020; UNCTAD 2018a; World Bank 2019). Furthermore, there are currently very real concerns about the prospect of e-commerce governance fragmentation and the development of incompatible e-commerce regimes (Fefer 2020; Segal 2018).

While policymakers, academics, and trade practitioners are becoming more interested in e-commerce and the digital economy, the literature remains relatively underdeveloped, largely ungeneralizable, and primarily policy-focused, in comparison to older trade policy issue areas such as trade in goods or investment.[1] In particular, the structural evolution of the e-commerce governance architecture, the position of countries within this architecture, and the impact of the architecture on governance outcomes and performance remains unexplored. Examining the topology of the e-commerce regime is vital as system architecture can influence outcomes for individual actors or enhance or impede the functioning of the entire system (Borgatti et al. 2009; Borgatti and Halgin 2011; Oatley et al. 2013). For example, Hollway, Morin, and Pauwelyn's (2020) innovative study demonstrates that “the relational structure of a governance system is important for understanding the appearance of legal novelties” (77).

This study addresses several key questions concerning the topology of the e-commerce governance network and, where possible, makes inferences about the impact of system’s structure on governance outcomes. What does the structure of e-commerce governance look like? Is it complex or complicated, polycentric or monocentric, fragmented or defragmented, or some combination of these three features? What are the implications of the structure for the functioning of the system with respect to regulatory coherence, system stability, and development outcomes? Where are various actors placed within the system’s architecture? How would proposed PTAs - such as Phase III of the African Continental Free Trade Agreement (ACFTA), EU trade agreements with ‘next generation’ e-commerce and data flow chapters, and the US (re)joining the Comprehensive and Progressive Agreement for Trans-Pacific Partnership (CPTPP) - influence the structure of the system?

This study provides the first systematic charting and analysis of the structural evolution of global e-commerce governance. More specifically, this study paper employs a conceptual framework drawn from the broader global governance literature (Kim 2020; Morin, Pauwelyn, and Hollway 2017; Ostrom 2010) and combines it with tools drawn from network science to map the contours of the e-commerce governance regime.

The proliferation of treaties, courts, and global rules has caused some scholars to argue that global governance, including trade and e-commerce governance, is fragmented (Bhagwati 2008; Biermann et al. 2009). This view of governance has generally regarded defragmentation as a barrier to effective and equitable governance (Capling and Ravenhill 2011; Drezner 2009). An alternative, and more recent, view of governance emphasizes the

[1] Azmeh, Foster, and Echavarri (2020) is a notable exception and is one of the few papers that explores the politics of the digital trade regime.

ways in which decentralized or polycentric systems can outperform centralized or monocentric systems by facilitating, for example, regulatory innovation and diffusion (Jordan et al. 2015; Ostrom 2010). There is a third line of argument which, while growing in acceptance, remains marginal in much of international law and international political economy and international relations discourse. This line conceptualization views governance structures as complex systems with unique properties including self-organization, emergence, and adaption (Morin et al. 2017; Oatley 2019; Orsini et al. 2020; Pauwelyn 2014b). This conceptualization of governance views complex social systems as being more analogous to organic systems, like beehives or gardens, than complicated systems, which operate according to linear and predictable rubrics, such as jet engines or clocks.

Drawing from Kim (2020), I apply these three different, but not mutually exclusive, conceptualizations of global governance to the e-commerce system. These conceptualizations are operationalized by longitudinally applying a series of network measures including average path length, clustering coefficient, and centralization metrics to the e-commerce regime. In addition to providing methodological tools for unpacking the topology of the e-commerce system, network science also provides a theoretical framework for understanding how and why certain structural features emerge and persist (Hafner-Burton, Kahler, and Montgomery 2009; Hafner-Burton and Montgomery 2009).

This study finds that the structure of the e-commerce regime is complex in nature, is dominated by a handful of network oligarchs, and has become less fragmented over time. However, if the proposed PTAs come to fruition, and additional agreements are not signed to comprehensively integrate African economies into the e-commerce network, then the trends towards defragmentation and structural oligarchy could reverse and three distinct structural clusters centered on Asia-Pacific, African, and Europe could emerge. While it is beyond the scope of this paper to tease out the causal relationship between the dynamics of the system and its structure, where possible, it identifies the ways in which certain structural properties, found in other real-world networks, could influence functional dynamics. For example, the position of central actors, including the United States, Australia, and the European Union, may be entrenched by network effects as countries seek to sign trade agreements with the most central actors in the system. Similarly, the complex structure system of the suggests that, regardless of what happens to e-commerce negotiations at the multilateral level, new e-commerce rules and norms will continue to emerge via PTAs.

This study contributes to the expanding complexity approach, still nascent in the social sciences (Bousquet and Curtis 2011; Morin et al. 2017; Pauwelyn 2014a) but widespread in the physical sciences (Barabási and Oltvai 2004; Holovatch, Kenna, and Thurner 2017; Iberall and Soodak 1987), by demonstrating how structural complexity can be empirically identified through the use of network methods. That the e-commerce system regime exhibits the properties of a complex system suggests that further study of this regime, the wider trade regime, and potentially other governance systems, could fruitfully employ a complexity-based framework. In turn, this suggests that policy measures and design decisions should be made with an eye to the structural features of the system and to the impact of these features on the effectiveness of the e-commerce system (Roberts and St John 2021).

The first section provides a brief overview of the state of play of the e-commerce regime, a ‘typology of topology, and a sketch of the way that network science can be useful in unpacking governance systems. In the second section, I touch on the methods and data employed. The third section is composed of three descriptive elements: a visual analysis of structure of the e-commerce regime, a static analysis of regime complexity, and a dynamic topographical analysis of e-commerce governance. The fourth section discusses the evolution of the system, system properties and the implications of those properties for e-commerce and digital economy governance.

1. The e-commerce regime and a typology of topology

This year marks two decades since the start of trade negotiations by the World Trade Organization's members over the Doha Development Agenda. What has become clear is that multilateral negotiations are deadlocked and that an overarching agreement may be unattainable. In partial response to the deadlock, preferential trade agreements (PTAs) have proliferated – 272 of the 302 agreements currently in force were adopted after 1995 (Baccini 2019). Increasingly, these types of agreements address issues such as e-commerce, services, investment, competition, and intellectual property rights and go well beyond traditional goods-centric issue areas such as tariffs and quotas. Kim and Manger (2017), note that "PTAs are now the principal venue to negotiate regulatory changes 'behind the border'" (467).

The OECD (2020, 5) defines the digital economy as "all economic activity reliant on, or significantly enhanced by the use of digital inputs, including digital technologies, digital infrastructure, digital services and data". The WTO defines e-commerce as "the production, distribution, marketing, sale or delivery of goods and services by electronic means". E-commerce has experienced tremendous growth over the last several years as firms and consumers have taken to buying and selling goods and services online. UNCTAD (2018) estimates that global e-commerce sales reached $25.6 trillion in 2018, an increase of 7% from 2017. The COVID-19 pandemic has accelerated the increasingly important role that e-commerce and the digital economy plays in the lives of people and businesses. During the pandemic, consumers increased their use of teleconferencing services, social media and internet shopping for, among other things, medical supplies, foodstuffs, and entertainment services while firms experienced an increase in both business-to-business (B2B) and business-to-consumer (B2C) sales (WTO 2020). Furthermore, e-commerce and the rise of the digital economy are a relatively recent phenomenon in comparison to trade in goods, which suggests that there is significant economic upside for international cooperation and the easing of digital and physical barriers.

The governance of the digital economy and e-commerce falls under a number of existing WTO agreements. These agreements include the General Agreement on Trade in Services (GATS), the General Agreement on Tariffs and Trade (GATT), the Trade Facilitation Agreement (TFA), the Information Technology Agreement (ITA), the Agreement on Technical Barriers to Trade (TBT), and Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS) (Gonzalez and Frencz 2018; Wu 2017). Of these agreements, the GATS has the most bearing on digital trade as "most of the content subject to e-commerce transactions falls within the scope of the GATS" (Fefer 2020). The GATS establishes a broad framework of rules that govern e-commerce and digital trade and applies to all members. Most favored nation treatment and national treatment apply to all WTO members regardless of the manner in which a good or service is delivered or consumed while services schedules regulate market access and national treatment.[2]

While e-commerce includes trade in digital products, such as computer programs, movies, music, and news services, it simultaneously covers trade in physical goods that are procured online. Given that physical products are still required to cross national borders, the GATT and associated agreements such as the TFA, which requires WTO members to enhance their import and export procedures, apply. Broadly, the TBT agreement and the ITA regulate the infrastructural components of the digital economy. The TBT agreement governs some aspects of WTO members' information and communications infrastructure (ICT), such as rules on encryption, while the ITA regulates trade in ICT goods, such as semi-conductors and GPS equipment, including those of an infrastructural nature (Gonzalez and Frencz 2018).

Intellectual property rights have a strong bearing on e-commerce and the digital economy as an increasing share of the value of goods and services is derived from their intellectual property inputs. The value of certain digital products is almost entirely accounted for by embedded intellectual property. Intellectual property rights protection is a central pillar of many advanced countries' international economic strategies (Sell and Prakash 2004). The TRIPS agreement establishes a basic level of protection for technologies that facilitate e-commerce, such as routers and switches, as well as for digital products, such as e-books.

However, these rules were not written with today's digital economy in mind and digital trade-specific rules have been slow to evolve at the multilateral level. The GATT was originally written on a typewriter while the GATS was most likely typed up using the original Pentium processor. To date, there is not a comprehensive agreement on e-commerce at the multilateral level and deep agreements at the regional and bilateral levels remain rare. The WTO's Work Programme on Electronic Commerce was established in 1998 and, until recently, has been characterized by little action over the last 22 years. Members agreed to a temporary moratorium on customs duties for electronic transmissions in 1998 which has been rolled over at succeeding Ministerial Conferences. Members agreed to review the Work Programme periodically at the Ministerial Conference in Nairobi in 2015 – to date the most notable output of the Work Programme. The International Centre for Trade and Sustainable Development (2017) noted that "for years, detailed discussions on e-commerce were completely absent from some meetings of WTO bodies."

In 2017, 71 WTO Members issued the Joint Statement on Electronic Commerce in which they agreed to engage in exploratory work on e-commerce in future WTO negotiations (WTO 2017). This was followed up by the second Joint Statement in 2019 which was signed by 76 members. The second Joint Statement confirmed the intention of members to engage in WTO negotiations (WTO 2019). Given the glacial pace of negotiations over e-commerce, it is perhaps unsurprising that PTAs have become the preferred venue to negotiate e-commerce rules.[3] Should substantive multilateral action on e-commerce be forthcoming, the provisions present in PTAs may become an important starting point.

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[2] For example, Mode 1 of the GATS covers the cross-border supply of services from one member to another and includes services that are supplied digitally over the internet. Mark Wu (2017) argues that if "venturing onto the internet to procure a service is considered 'consumption abroad', then Mode 2 commitments are also of relevance". Mode 1 is often the focus for trade negotiators as this is the area that WTO members have made the fewest commitments.

[3] In December 2020, a draft Consolidated text was circulated to WTO members. The hope is that this draft will pave the way for more substantive action on e-commerce at the next WTO Ministerial in 2021.

Trade economists have been anxious about the fragmentation of the international trading regime since PTAs first started to proliferate in the 1990s (Baldwin 2016; Bhagwati 2008; Hoekman and Sabel 2019). The disparate agreements were famously likened to a "spaghetti bowl" so intertangled as to render global trading rules / architecture chaotic. Some economists feared that PTAs would be trade diverting, economically inefficient and, ultimately, undermine the global trade project – the WTO – while others have viewed PTAs as 'stepping stones' towards enhanced multilateral cooperation (Cottier, Siber-Gasser, and Wermelinger 2015).

The debate among economists as to the impacts of PTAs on trade governance is similar to arguments that have characterized international relations and international legal scholarship on regimes over the last several decades. A number of scholars argue that the global governance architecture is fragmented (Benvenisti and Downs 2007; Biermann et al. 2009; Zürn and Faude 2013). Some argue that fragmentation serves the interests of powerful states at the expense of weaker states due to the technical and legal expertise that is required to navigate the 'spaghetti bowl' (Drezner 2009) as well as the ability to 'forum shop' (Drahos 2007; Rüland 2012; Sell 1998).

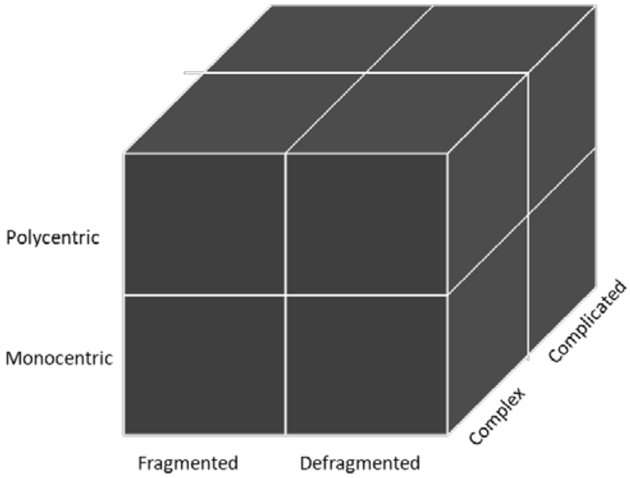
Other scholars suggest that a central authority is not necessary for governance systems to mutually adjust and facilitate cooperation (Faude 2020; Ostrom 2010). In contrast to the fragmentation conceptualization of global governance which has tended to view a regime centered around a single institution as necessary, the polycentric view of global governance emphasizes the way in which decentralized systems can be more adaptable, innovative, resilient and flexible than their monocentric counterparts (Jordan et al. 2018; Keohane and Victor 2011; Oberthür et al. 2006). Put another way, fragmentation does not, per se, generate noncooperation at the international level (Galaz et al. 2012).

According to a third line of argument, global governance systems should be conceived of as complex and adaptive (Bousquet and Curtis 2011; Mitchell 2009) . Complex systems, as opposed to complicated systems, can be defined as systems that are composed of deeply intertwined elements that interact with one and other at different levels. In addition to these characteristics, complex systems tend to possess the following three properties: self-organization or the ability to organize in the absence of a central authority, emergence or unanticipated outcomes generated via interactions between elements in a system, and the capacity of elements to interact and evolve with, or adapt to, their external environment (Oatley 2019; Orsini et al. 2020). Complicated systems, such as a car's gearbox, do not possess adaptive and interactive capabilities and, as a result, can be studied by decomposing their component parts. Complex system, because of higher order dependencies, are far less amenable to decomposition (Poli 2013).

Critically, these descriptions, and their associated policy implications, are not mutually exclusive. Kim (2020, 906) , argues that these three structural features (fragmentation/(de)fragmentation, polycentricism/monocentricsm, and complicatedness/complexity) are "found simultaneously in different systems of international institutions". These three structural features may each be present to a different degree in a governance regime. These three ways to characterize regime structures can be usefully intersected to create a three-by-three typology of regime topology (Figure 1). Network analysis tools can be used to operationalize this typology and produce robust measurements of the degree to which networks exhibit these three structures. As will be further explored below, this approach provides a basis to analyse the landscape of e-commerce and digital trade governance.

Figure 1: Typology of topology

Adapted from Kim (2020)



2. Methods and data

We live in an age of networks. The internet is the largest network ever created, social networks are the most popular sites on the internet (Campus et al. 2007) global production networks have come to dominate economic international trade (Backer and Miroudot 2013), while the international financial system operates as a network of indirect and direct creditor-debtor relationships (Oatley et al. 2013). Miles Kahler (2009) observes that "networks have become the intellectual centerpiece of our era. If the contest between markets and state hierarchies was an organizing feature of the 1980s, networks have emerged as the dominant social and economic metaphor in subsequent decades" (2).

Network science provides a helpful interdisciplinary approach for examining and understanding the governance structure of the digital economy and e-commerce. The primary difference between network approaches and traditional methods of explaining behavior is that network approaches analyse the relations that exist between actors rather than an exclusive focus on the traits or attributes of actors (Wasserman and Faust 1994). Network analysis is concerned with the associations – links, ties, or edges in network speak – between actors (nodes). More specifically, network analysis is centered on three guiding principles: i) rather than being independent, actors shape one another's behavior; ii) network structures determine the nature of resource flows between actors; and iii) the overarching network structure, which is a function of the relationships between actors, can constrain or facilitate the actions of individual actors (Marin and Wellman 2014; Wasserman and Faust 1994).

Network science has its origins in mathematics – it draws extensively from graph theory and topology – the physical sciences, including physics, as well as in the social sciences such as sociology and anthropology (Barabási 2009; Scott 2000; Wasserman and Faust 1994). Networks in international relations are not a new phenomenon. Keck and Sikkink's (1998) analysis of transnational advocacy networks extends to the 19^{th} century. However, the application of network approaches to the study of international relations and international political economy has been irregular at best (Bousquet and Curtis 2011; Oatley 2019). A limited but growing number of studies have examined intergovernmental economic networks using a variety of network tools (Dorussen and Ward 2010; Hafner-Burton et al. 2006; Kim and Manger 2017; Manger and Pickup 2016; Milewicz et al. 2018).

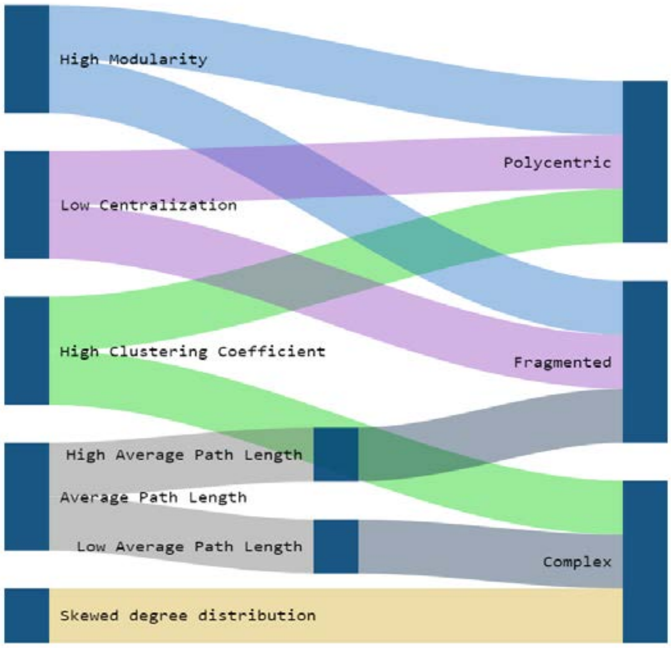
Network science includes a comprehensive arsenal of tools, based on graphs and matrices, that allow researchers to analyse the properties of networks, ties, and nodes. These include visualizations of networks, measurement and description of network properties and details about individual ties and nodes, and statistical models of network evolution (Luke 2015). A network approach allows analysts to: i) identify which nodes are central to a given system; ii) describe the characteristics of that system – for example, whether a system is characterized by density, hierarchy, fragmentation, or whether there are identifiable subgroupings of actors present; and iii) evaluate the strength or weakness of a system to exogenous or endogenous shocks. Joost Pauwelyn and Wolfgang Alschner (2015) note that "network analysis can thus reveal novel insights into the current structure and historical evolution of a given system".

More specifically, the typology of topology introduced in the previous section can be operationalized using network measures (Kim 2020). Five such measures are applied to the e-commerce and digital trade governance network: the clustering coefficient, modularity, centralization, average path length, and the skewedness of the distribution of connections (Figure 2). The clustering coefficient provides an indication of the level of 'cliquiness' or clustering of actors based on a count of tie triangles in a network. Modularity measures are a similar heuristic but measure the edge densities within cluster and, typically, compare them to the densities present in a random graph. Centralization measures, a number of which are commonly employed in network analysis, can be used to determine if a network is dominated by a single actor or if connections are more evenly distributed across the network. Similarly, the skewness of the degree distribution (i.e the number of connections that each actor possesses) indicates how connections within a network are distributed. Average path length measures the structural distance between actors in a network.

A fragmented system would typically be characterized by a high degree of modularity, a low degree of centralization, and a high average path length. A polycentric system, in general, would have a high clustering coefficient and modularity score and a low degree of centralization. Finally, a complex system would be characterized by a high degree of clustering, a skewed degree of distribution, and low average path length.

It is important to acknowledge that this type of analysis can only reveal part of the e-commerce regime's complexity. Network analysis, at its core, is a structural approach which can reveal much about the architecture of the e-commerce governance regime. This is a critical element in understanding how a complex system - such as the e-commerce governance regime, international investment regime, or climate change regime - constrains or enables the relationships between actors. However, as Barabási (2007, 37) notes "a thorough understanding of complex systems requires an understanding of network dynamics as well as network topology and architecture". Understanding the nature of specific dynamics within the e-commerce network, while important, is beyond the scope of this paper. Instead, I focus on unpacking the skeleton on which the dynamics of the e-commerce regime rests. Only where possible do I make making inferences as to the impact of structure on network function.

Figure 2: Network measures of e-commerce governance



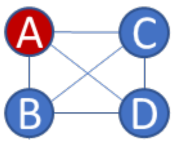
My analysis of the e-commerce and digital trade governance regime relies on the Trade Agreements Provisions on Electronic-Commerce and Data (TAPED) dataset (Burri and Polanco 2020) which is currently the most comprehensive dataset on e-commerce available. I included a number of recent agreements that were not originally in the dataset such as the Regional Comprehensive Economic Partnership Agreement (which includes the Association of Southeast Asian Nations (ASEAN) member states plus China, Japan, South Korea, Australia, and New Zealand, the Digital Economy Partnership Agreement (New Zealand, Singapore, Chile), or the Digital Economy Agreement (Australia and Singapore) and excluded agreements without substantive provisions including interim agreements (e.g. Cameroon-EU interim FTA) and framework agreements (e.g. ASEAN-China). This brought the total number of agreements with at least one specific e-commerce provision to 108. Agreements that have been superseded, such as the Trans-Pacific Strategic EPA and Australia's 2003 FTA with Singapore, were included in order to track network evolution over time.

The period under analysis was from 2000, the year of the first agreement in the dataset, to 2020. Additionally, agreements that have been proposed or are currently under negotiation were included in the analysis but were clearly differentiated. These include the ACFTA, the EU's proposed bilateral PTAs with Australia, New Zealand, and Tunisia, and the US (re)joining the CPTPP.

Bilateral trade agreements are straightforward to represent in network analysis as they can be represented dyadically. However, multiparty trade agreements present a more serious challenge and require modelling decisions to be made. Multiparty trade agreements can be divided into two types: those that govern e-commerce and data flows between existing members (e.g. the United States-Canada-Mexico Agreement) and those that govern relationships between the original members of a trade bloc and a third party, whether an individual country (EFTA-Singapore) or another trade bloc (e.g. EFTA-GCC agreement).

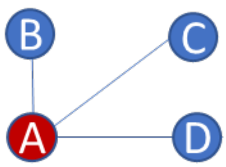
When countries negotiate a multiparty agreement, they engage in separate negotiations with each member of that agreement – the end result of which is a unified text but separate schedules of commitments for goods and services for every country within the grouping. In order to preserve this dynamic, I model agreements that include multiple members as part of a single trade bloc dyadically– i.e. when Canada joined the CPTPP, it gained ties with all of the CPTPP's member countries. Canada is represented by node A and the members of the CPTPP by nodes B, C, and D (Figure 3).

Figure 3: Multiparty model



Following Pauwelyn and Alschner (2015), this paper assumes that agreements in which a trading bloc negotiates as a single entity with another party - whether another country or another trading bloc - does not alter the relationship between the members of the trading bloc. That is, while the bloc members may technically be entering into a new legal relationship, they will not be making additional concessions in the new agreement that go beyond the existing commitments owed to one another as part of the trading bloc.[4] For example, Vietnam's agreement with the Eurasian Economic Union (EEAU) in 2015 did not change how e-commerce and data flows were governed between the EEAU member states but did alter the way in which e-commerce and data were governed between the EEAU and Vietnam. Vietnam is represented by node A and the members of the EEAU by nodes B, C, and D (Figure 4) .

Figure 4: Trading bloc model



Modelling these types of agreements in this manner helps to ensure that the number of connections between actors are not overestimated. If the alternative were followed, i.e. every

[4] An example of how a bloc seeks to preserve intra-bloc concessions is how, in relation to investment, European Union members have agreed to not enter into international obligations (e.g. by bilateral investment treaties, or BITs) that grant non-EU countries' investors greater protection than that granted to EU investors by national constitutions and EU law. This followed internal debate about implementing BITs consistently with intra-EU treaty obligations.

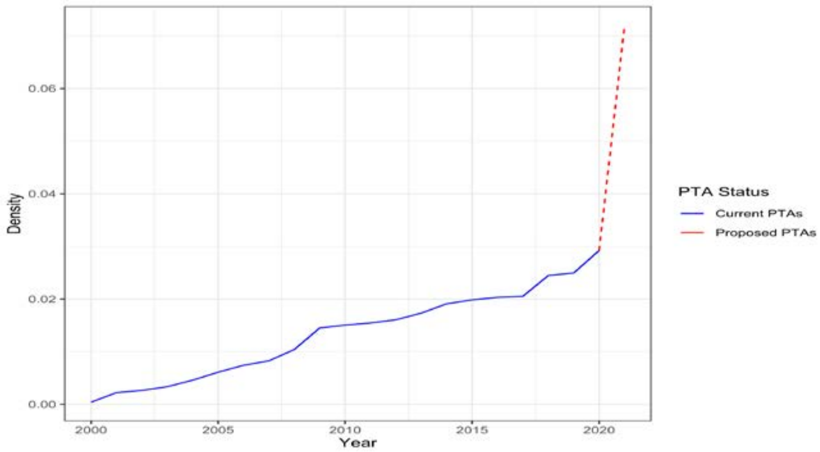
new agreement between a bloc and third party were treated as resulting in new ties between the bloc's members, not only would the true legal relations not be maintained, but the connections (degree in network speak) of all parties involved would be inflated.

Like Manger, Pickup, and Snijders (2012) I treat the EU as a single actor. The EU negotiates trade agreements on behalf of the entire EU membership – a role it has played since the 1950s. Treating the member states of the EU separately would not only fail to take into account the way in which their trade agreements are negotiated, i.e. as single market, but would overstate the number of PTAs with e-commerce chapters. For example, when the EU-Korea FTA was concluded in 2010, Korea obtained access to the markets of all EU member states even though the agreement had been negotiated bilaterally. Modelling the EU as a separate actor helps to minimize degree inflation.

The exact composition of the number of countries under analysis varies from year to year as some countries, almost entirely EU members, drop out of the network. For example, when Bulgaria and Romania joined the EU in 2007 they were treated as if they, and their ties to other countries, had disappeared from the network as it was assumed that their trade policy was subsumed by the EU. Treating the EU as a single actor meant that the maximum number of countries present in a given year was 185. At most, 17,020 ties between countries were possible for each year.

The density of a network can be a useful descriptive measure. Density captures the changes in composition of network or, put another way, changes in overall network activity. More specifically, network density is a function of the number of ties that exist at any point in time relative to the number that could potentially exist. Figure 5 suggests that density within the e-commerce governance trade network has been steadily increasing since 2000 – the year that the first PTA with e-commerce provisions was signed – although the network remains quite sparse (a large number of actors remain isolated within the network). The acceleration of PTA formation in 2009, driven, in part, by agreements between ASEAN and Australia and New Zealand and the EU's agreements with CARICOM, generated an increase in network density from 0.0104 in 2008 to 0.015 in 2009. Similarly, the signing of the CPTPP in 2018 and the RCEP in 2020 drove increases in density from 0.0205 in 2017 to 0.0245 in 2018 and from 0.2050 in 2019 to 0.0292 in 2020. Despite these increases, the overall density of the network remains quite low. For example, the density of the entire PTA network was more than 0.05 in 2004 (Manger et al. 2012). If one includes a number of PTAs that are on the policy horizon, the ACFTA, various EU agreements, and the US rejoining the CPTPP, as a maximally possible but not necessarily likely outcome - then network density increases dramatically from 0.0292 to 0.0720.

Figure 5: E-commerce network density



3. Evolution of the e-commerce governance architecture

A. Visualization

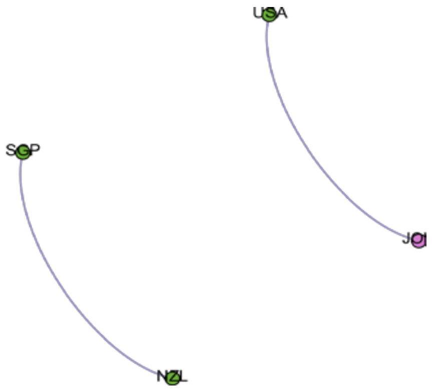
One of the primary allures of network analysis is that it allows one to visualize the structure of a given network. This section provides a brief visual analysis of the topographical shifts that have occurred in the e-commerce governance network between 2000 and 2020 before moving onto more quantitative analysis in the proceeding section. Potential PTAs are visualized as occurring in a single year although the agreements may take several additional years to conclude.

In the following visualizations, node size is a function of degree (i.e. how many connections a node/country has to other nodes/countries). This measure of centrality is the oldest and the most conceptually simple of the numerous measures of centrality such as eigenvector centrality, betweenness centrality, and Katz centrality.[5]

From a visual perspective, as the degree of a country/node increases, so does the size of the node relative to other nodes in the network. The colours of the nodes relate to the type of actor – green for high income countries (approximately 30% of the network), purple for upper-middle income countries (roughly 28% of the network), orange for lower-middle countries (around 27% of the network), and blue for low-income countries (almost 16% of the network). The colours of the edges/links/ties between the nodes/countries/actors is a function of the scope of e-commerce and data flow provisions in their PTAs. Agreements with more than 1500 words relating to e-commerce or data flow provisions are coded green, those with between 1000-1500 words are coded black, those with between 500-1000 are coded red, those with less than 500 words are coded purple and potential agreements coded blue.

[5] Eigenvector centrality is a measure of network centrality that measures the extent to which a node is connected to highly connected nodes. Like eigenvector centrality, Katz centrality captures whether a node is linked to other important nodes but is more robust in the face of real directed networks that are weakly connected. Betweenness centrality captures the number of shortest paths that do through a particular node – it is a measure of a node's linking power.

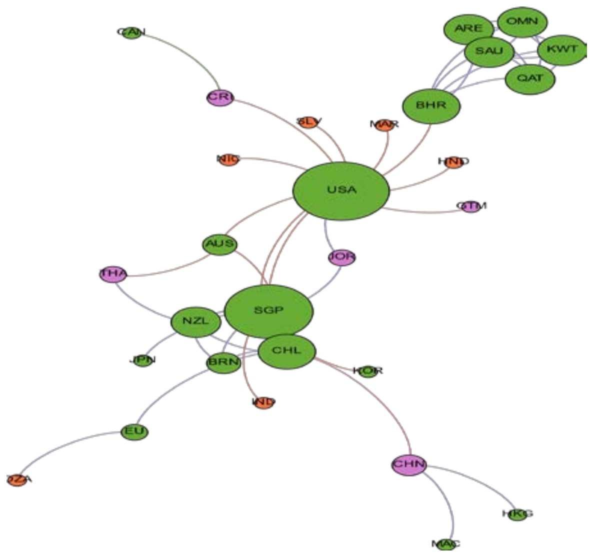
Figure 6: E-commerce network (2000)



A visual analysis of the network at the year 2000 is uninteresting as there are only four actors and two connections both of which are shallow in scope. The network in 2005 shows significant growth and a structure that is dominated by a handful of central nodes. The US and Singapore, by virtue of their multiple connections, are the most important nodes in the network and occupy central positions. The Gulf states, somewhat surprisingly, are also central actors. This is due to their connections to each other by virtue of the Gulf Cooperation Council agreement – it should be noted that this agreement is rather shallow and doesn't contain a dedicated e-commerce chapter. Chile is another actor with a central position due to its connections with the members of the Trans-Pacific Strategic Economic Partnership Agreement. The Central American economies are located in peripheral positions and as spokes in the US's hub as their e-commerce regimes are governed by their agreement with the US rather than their agreements with one another under the Central American FTA.

Interestingly, the EU is a peripheral actor within the e-commerce governance regime at this point – in contrast to its position within the wider PTA network – due to the limited number of agreements that it concluded that contained e-commerce and data-related provisions. A feature, and a continuing theme throughout the visualizations of the network, is the relative lack of participation of low-income economies in the e-commerce network.

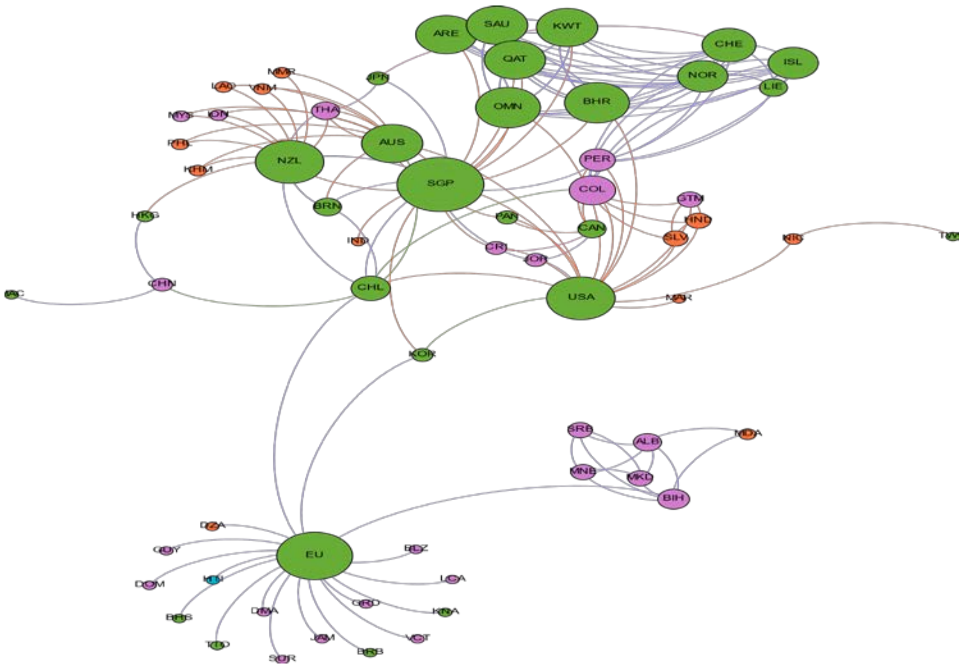
Figure 7: E-commerce network (2005)



In 2010 a series of starlike structure emerges with the network centered on three regions: Asia-Pacific, Europe and Central and South America (anchored by the United States). EU centrality increased by virtue of its agreement with the members of the Caribbean Forum (CARIFORUM). Australia and New Zealand emerged as more central actors due to their connections to the members of ASEAN with whom they signed a multiparty/plurilateral agreement in 2009. The United States remained an important actor within the network and concluded additional agreements with, among others, Korea, Panama, and Colombia.

The network continued to be dominated by developed economies with most other economies (upper-middle income, lower-middle income, and low-income) in peripheral positions or spokes in another country's hub. All of the most central actors during this period were high income economies while Haiti, due to its participation in the EU-CARICOM agreement, was the only low-income country in the network. Colombia was the most important non-high income economy by virtue of its ties with the members states of the European Free Trade Association (EFTA), the United States, Canada, Chile and the members of the Northern Triangle.

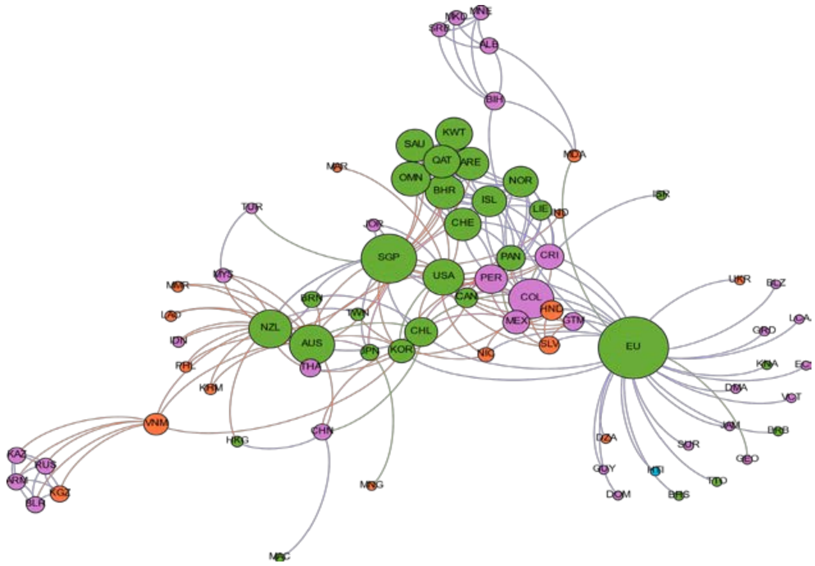
Figure 8: E-commerce network (2010)



By 2015, the network had undergone substantial change in terms of the most important actors. The United States relinquished its position as the third most central actor in the network after the EU and Singapore. As the same time, the EU became the most important actor in the network due to it signing a series of agreements with, among others, the members of the Central American FTA and association agreements with Eastern European countries.

Colombia remained the most important middle-income country in the network while Vietnam emerged as the most important lower-middle income country. The increase in Vietnam's position was driven by its agreements with Korea and with the members of the EAEU. It is important to note that, despite a burst of PTA formation, most countries (66%) did not participate in the network during this stage, with low-income economies being the most underrepresented group.

Figure 9: E-commerce network (2015)



By 2020, the visualization of the network closely resembles the infamous spaghetti bowl, although it is possible to distinguish two distinct clusters centered on Asia-Pacific (anchored by Singapore, Australia, New Zealand and the United States) and Europe (anchored by the EU). During this period, Singapore emerged as the most central node in the e-commerce governance network. Singapore's central position was driven by its membership in regional/megaregional trade agreements, specifically the RCEP and CPTPP, as well as a series of bilateral agreements with Turkey, Sri Lanka, and the EU. Australia and New Zealand were the second and third most connected actors for very similar reasons – membership in megaregional agreements. In contrast, the EU's position as a central actor declined despite signing agreements with a number of countries including Canada, Armenia, Mexico, Japan, Vietnam and the members states of the Southern Common Market (MERCOSUR). The US withdrawal from the Transpacific Partnership (TPP), the predecessor to the CPTPP, and a slow rate of trade agreement formation saw it occupy approximately the same structural position as Mexico and the Philippines. Least developed countries remain almost entirely excluded from the network and lower-middle income countries accounted for 17% of connected countries, despite accounting for roughly 27% of the all countries in the network.

Figure 10: E-commerce network (2020)

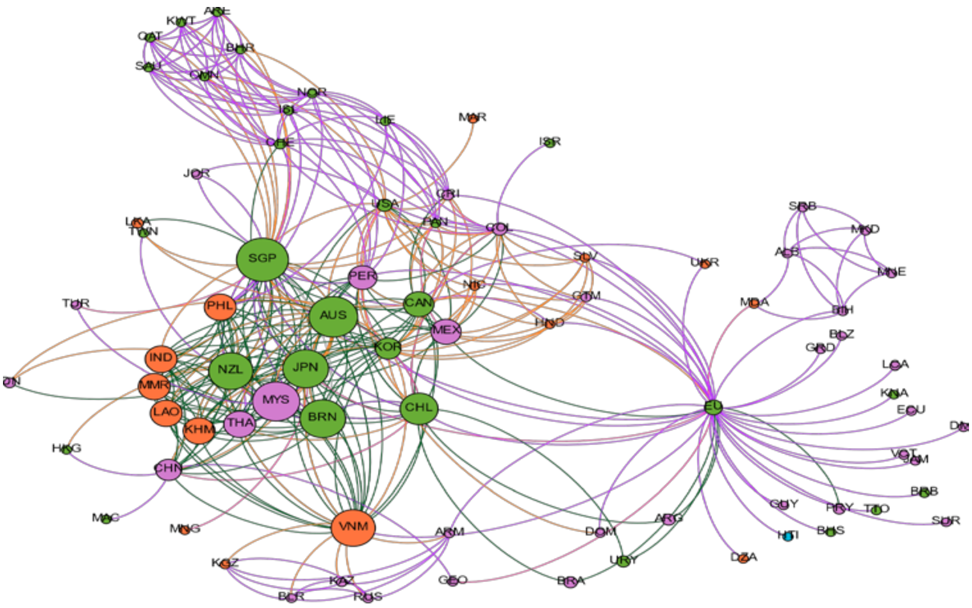
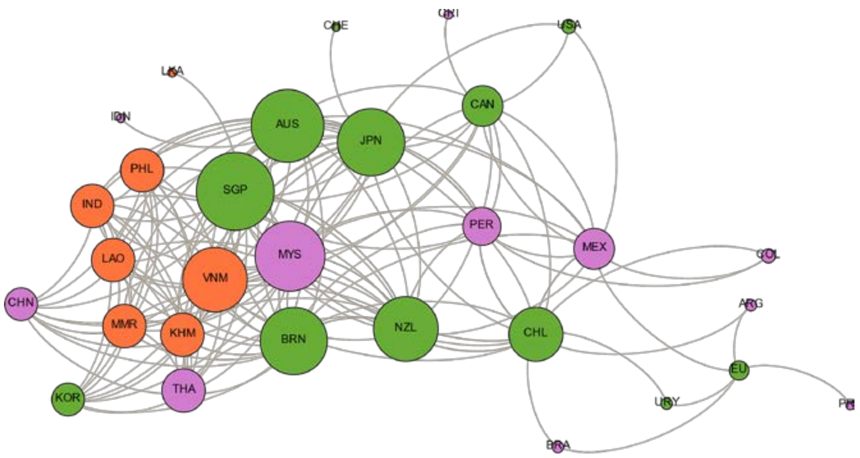


Figure 11: Deep agreements in the e-commerce network (2020)

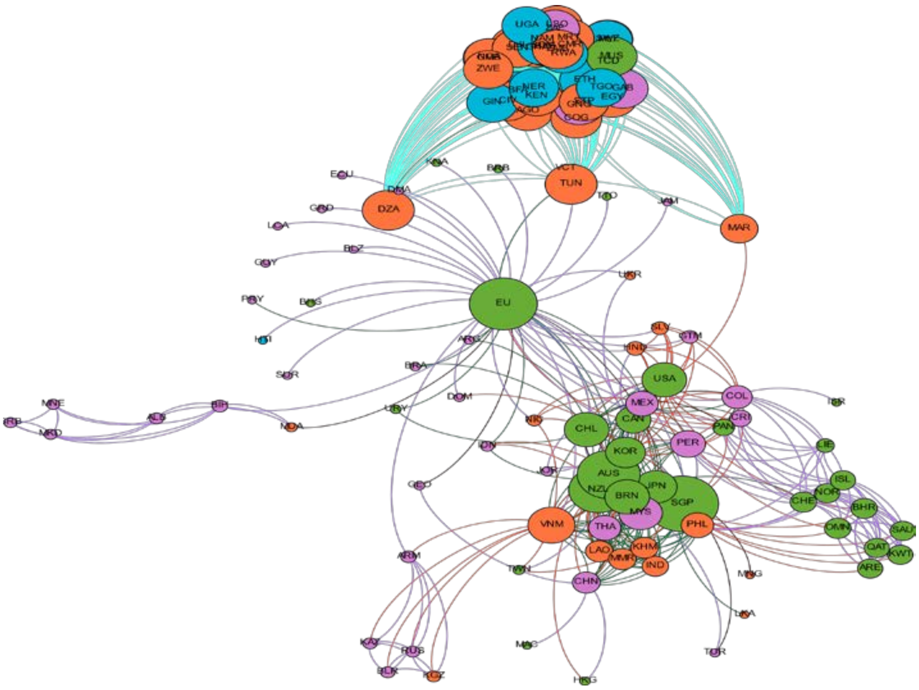


Focusing on agreements whose scope is classified as deep (i.e. those agreements whose e-commerce chapters contain more than 1500 words) reveals a number of interesting patterns. First, the deep scope network is even more heavily Asian-centric than the overall network. Second, the EU and the US occupy peripheral positions in the network. This is especially surprising given that they are two of the most important originators of e-commerce provisions (Elsig and Klotz 2018). Third, high income and high-middle income economies dominate the network. Low income countries do not feature and the only lower-middle income countries that make an appearance are those of Southeast Asia.

The inclusion of those PTAs that are on the policy horizon, such as the EU's agreements with Australia, New Zealand and Tunisia, the US (re)joining the CPTTP, and the conclusion of the ACFTA's Phase III negotiations, alters the structure of the e-commerce governance network significantly. The ACFTA would result in the formation of a distinct and largely disconnected network composed of African economies. This network is connected to the wider e-commerce governance network via the EU's current agreements with North African economies: Algeria, Morocco, and the proposed agreement with Tunisia. A particularly interesting question, and one that is beyond the scope of this paper to answer, is whether the ACFTA will follow the EU's e-commerce governance model (given the structural ties between ACFTA members and the EU), adopt one of the existing models (i.e. from China, the US or the EU), or develop an indigenous model of e-commerce governance.

Re-joining the CPTPP, an agreement that was negotiated while Joe Biden was Vice-President, would enhance the US's position within the network and move it from a relatively peripheral position to one of more structural importance. This is perhaps unsurprising, given that the TPP was intended to build a network of friendly states to counter-balance the growth of China (Hufbaur, Schott, and Lu 2020). Rejoining the CPTPP would enhance the structural position of the United States relative to China.

Figure 12: Potential e-commerce network



B. Testing for complexity

Before discussing the implications of systems complexity on function, it is important to first determine whether that system is actually complex (Allen et al. 2018). Morin and Gomez-Lera argue that the international trade system displays the four characteristics and three properties of a complex system (Orsini et al. 2020). As convincing as their argument is, it is still necessary to test it empirically. Fortunately, network science provides us with the tools to pick up on structural complexity. Kim (2020, 917) notes "network-based indicators can tell us whether a system of institutions is complex or merely complicated".

Complex networks generally have a structural form that sits between random or disorganized networks and regular or ordered networks (Newman, Barabási, and Watts 2006). Disordered systems look more like gas molecules which collide with one and other at random while ordered systems resemble those of magnets which operate with other magnets with well-behaved regularity (Barabási 2005).

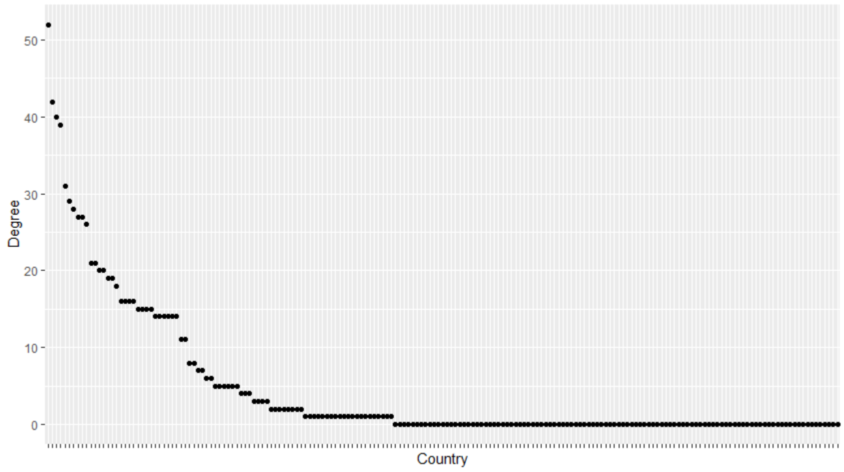
Complex systems are characterized by at least two important structural features, scale-free and small-world, which can be used as helpful, albeit imperfect, proxies for complexity (Kim 2013, 2020). Scale-free networks, i.e. networks in which the size of the network does not determine the underlying structure, are those in which the distribution of connections is highly skewed – i.e. they are non-random – and follow a “power law” curve (Barabási 2009). Two primary dynamics drive this structure. First, nodes with numerous connections are more likely to form connections than their less-well connected counterparts. This ‘preferential attachment’ captures the idea that the ‘rich get richer’ in degree/connection terms (Barabási and Bonabeau 2003). Second, nodes that have been in the system longer have a greater chance of accumulating connections relative to newer nodes (Barabási and Bonabeau 2003).

In addition to a scale-free structure, complex systems are also typified by small-world characteristics. Small-world networks are those that are characterized by clumping or clustering but with shorter distances between nodes (Borgatti, Everett, and Johnson 2013). In other words, nodes are grouped together but are not separated by a large number of degrees – i.e. the Kevin Bacon 6 degrees of separation phenomena. In network terms, small world networks are characterized by low average path length, a feature of random networks, and high clustering which is associated with regular networks (Watts and Strogatz 1998) .

The e-commerce governance network in 2020 could be characterized as scale-free. To test whether the e-commerce governance network possess a scale-free characteristic, I followed Clauset, Shalizi, and Newman's (2009) approach. Their method, which produces more robust and useful results than commonly employed methods such as least-squares fits, involves combining goodness-of-fit statistics, derived from the Kolmogorov-Smiranov (KS) statistic, with maximum likelihood fitting methods. The p-value of the value KS test was 0.98 and substantially larger than 0.05 which suggests that the degree distribution in the e-commerce governance network does follow a power-law distribution and supports the idea that the distribution of connections is far from random.

Furthermore, the degree distribution in the e-commerce and digital trade governance found in Figure 13 is heavily skewed to the left which lends further support to the claim that the e-commerce governance network is scale-free. The top 10% of countries account for approximately 59% percent of all ties. By way of contrast, Kim’s (2013) study found that the top 10% of environmental agreements (nodes) – a network which was also found to be scale-free – accounted for 65% of total cross-references (ties).

Figure 13: E-commerce degree distribution



Following Watts and Strogatz (1998), I tested whether the e-commerce governance network is a small-world network by comparing the clustering coefficient (i.e. the probability of adjacent nodes forming connections with one and other within the network) and the average path length of the network to that of a random network. The clustering coefficient (0.511) for the e-commerce governance network was well above that of the random network (0.02), while the average path length (2.4) (the number of steps that each country in the network is from all other countries in the network) was below that of the random network (3.5). The relatively high clustering coefficient and low average path length both suggest that the e-commerce governance network is a small-world network. As the network is both scale-free and small-world, it is reasonable to assume that it is also complex.

C. Dynamic network topology

In order to analyze the global structure of the e-commerce governance network and determine the nature of its fragmentation, polycentricity, and complexity, I operationalized the typology of topology presented previously. This subsection provides a summary of these results before proceeding to a more detailed discussion of them in the next section.

1. Modularity

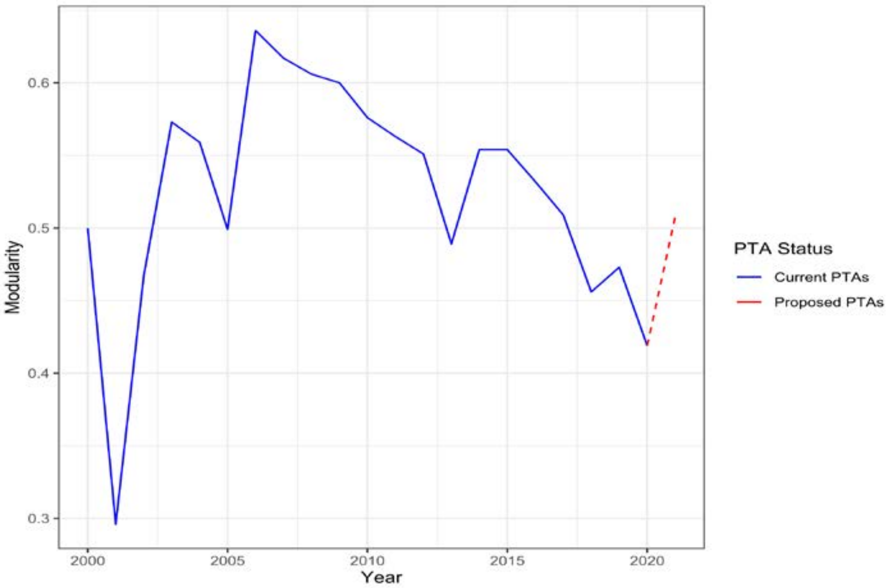
Clustering and cohesion has been an important component in theoretical and empirical network analysis for several decades (Freeman 1992). Empirical work suggests that nodes in real-world networks, particularly social networks, have a tendency to group together in tightly connected clusters (Holland and Leinhardt 1970; Opsahl and Panzarasa 2009). The notion of clustering, or cohesion, has been used widely in the social sciences as an explanatory variable for ideological homogeneity or ‘group-think’ (Wasserman and Faust 1994). Clustering is of particular importance in the e-commerce governance network because it can provide a sense of whether a positive or negative regulatory norm has the ability to diffuse through the system – clusters facilitate the dissemination of norms within them but can prevent the diffusion of norms outside them.

Measures of modularity are designed to detect the presence of, as the name suggests, modules or communities within a network (Girvan and Newman 2002). A high modularity statistic suggests that a network is characterized by dense connections between nodes in a module but limited connections between modules. In addition, high modularity scores indicate that a handful of nodes serve as links or bridges between modules. This is what is referred to in the network literature as ‘weak ties’ (Granovetter 1973). Weak ties play a critical role in maintaining the structure of the network. If important community-level nodes disappeared, the overarching structure of the network would persist. However, if these linking nodes were terminated, the overarching structure of the network would fragment as clusters/communities lost touch with one another. For example, Malaysia is tightly integrated within the Asian cluster but if Malaysia withdrew from the e-commerce governance network, that network would continue. However, if Singapore, a member of that same cluster, but, in contrast to Malaysia, possessing high linking/brokerage power, withdrew from the system, then the e-commerce landscape would be become much more fragmented.

However, modularity measures are not without their issues and need to be combined with other measures to detect fragmentation and polycentrism. Modularity measures are based on algorithms that follow an optimization function that attempts to divide a network into modules with the overall goal of maximizing connections within the module (Girvan and Newman 2002). Typically, modularity measures compare the connections within a module (i.e. the density of a subgraph) with the connections between the same module of nodes, and with the same degree distribution, in a random graph. Unfortunately, modularity measures suffer from a resolution problem: they have a propensity to combine modules when resolution is low and to split modules when resolution is high (Lancichinetti and Fortunato 2009, 2011). For this reason, modularity measures should be used as either an exploratory or auxiliary statistic.

Bearing this in mind, from 2000, modularity steadily increased before peaking in 2006. From 2006 to 2020 modularity declined as additional agreements, such as the EFTA-GCC agreement and ASEAN-Australia-New Zealand (AANZFTA), were signed which, on the whole, increased the connections between groups. Multiparty trade agreements, specifically the CPTPP, and RCEP, sharpened the rate of decline in 2018 and 2020. Looking ahead, if the ACFTA were signed, this would increase network modularity and bring it back to approximately the same place that it was in 2011 (0.5) with three clearly defined clusters centered on Africa, Asia-Pacific (including the United States), and Europe. If additional connections between African economies and the rest of the world were formed (i.e. new bilateral or multiparty agreements), this would reduce the overall modularity score of the network.

Figure 14: E-commerce network modularity



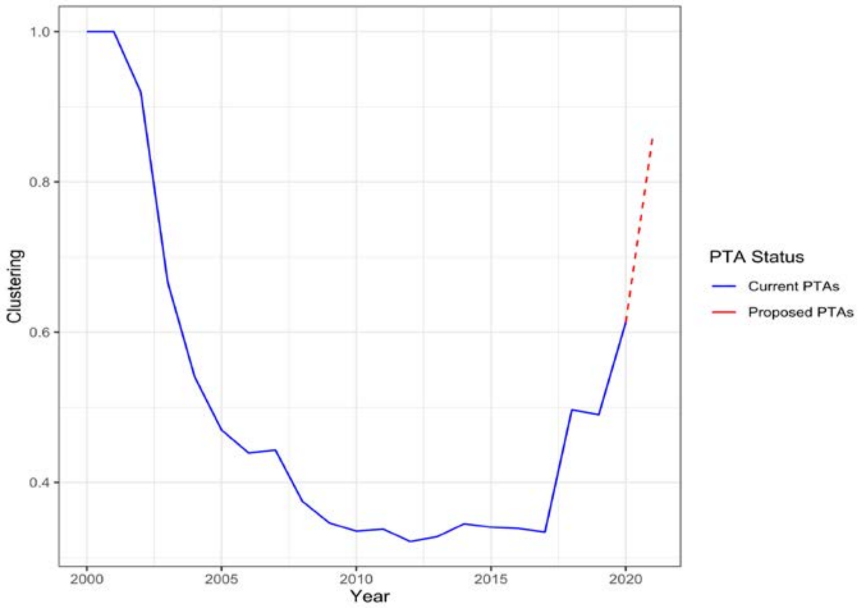
2. Clustering

The degree of clustering can also be measured by the number of triplets or triangles (also referred to as the clustering coefficient in the network literature) in contrast to modularity which measures the number of links with a module relative to a random graph with the same module. It is entirely possible that a network could be characterized by a low modularity score and a high clustering coefficient. For example, a series of star-shaped structures would have a high modularity score but a low clustering coefficient. The clustering coefficient is helpful in determining whether a network is polycentric or monocentric but is less useful in identifying if a network is fragmented or defragmented. On the other hand, the modularity metric can be used as supporting evidence of either polycentricity or fragmentation but, as noted above, it can suffer from resolution problems.

In its weak form, the clustering coefficient corresponds to $a \rightarrow b \rightarrow c \Longrightarrow a \rightarrow c$ or, in its strong form, to $a \rightarrow b \rightarrow c \Leftrightarrow a \rightarrow c$ (Holland and Leinhardt 1972; Wasserman and Faust 1994).
I assessed the clustering of the network using the weak form of the metric as it is the most commonly used and captures the notion of "a friend of a friend is a friend" (Butts 2008).

Figure 15 demonstrates how the measure has varied since 2000. The general downward trend implies that the e-commerce governance network became less clustered and cohesive until roughly 2016 when the CPTPP was signed. The CPTPP served to tie together a series of "friends of friends" across Asia and the Americas. In network terms, the mega-regional agreements served to create cliques or substructures in which every, or almost every, country was tied together (Borgatti et al. 2013). A similar dynamic played out with RCEP increasing the level of network clustering in 2018. If the proposed PTAs came to fruition, this would dramatically increase network clustering.

Figure 15: E-commerce network clustering



3. Centralization

Graph centralization measures are useful in determining whether a network is cohering around a single actor or fragmenting. For reasons of simplicity and in the interests of brevity, my analysis of centralization utilized degree centrality[6]. Degree centralization, for the entire network and not a particular actor, can be simply measured as the sum of the differences between the most central node in a network and all other nodes (Freeman 1979). This difference is then normalized by the maximum difference between the most central node and all other nodes. Formally, this is expressed as:

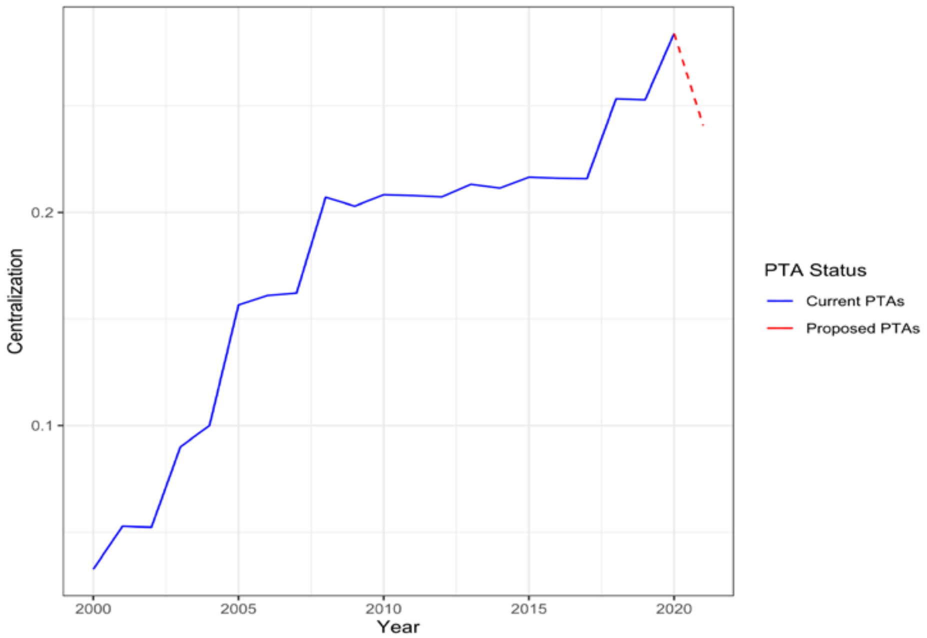
$$Centralization^{degree} = \frac{\sum(D(A^*) - D(Aa\ )}{\max\sum(D(A^*) - D(Aa)}$$

Where D(Aa) is the degree point centrality, D(A*) the largest value that D*(Aa) can take in the network and max∑(D(A*) - D(Aa) is the maximum taken over all possible graphs.

Figure 16 shows how the centralization of the e-commerce governance regime has, for the most part, been trending upward. The upward trend indicates that a limited number of countries came to dominate the system by attracting more partners than other countries in the network. This result suggests that these countries are most likely to diffuse e-commerce norms throughout the system. Including the proposed PTAs would result in a decrease in network centrality as competing central African actors emerge. This result, as in previous cases, is almost entirely driven by the ACFTA. However, it should be noted that the centrality score of African states is driven virtually completely by their ties to one another.

[6] Degree centrality was employed because it provides an intuitive measure of how many connections each actor has to every other actor in the network. This is particularly helpful in identifying which actors hold social power, which includes the ability to diffuse norms and set agendas, in a network (Hafner-Burton et al. 2009).

Figure 16: E-commerce network centralization

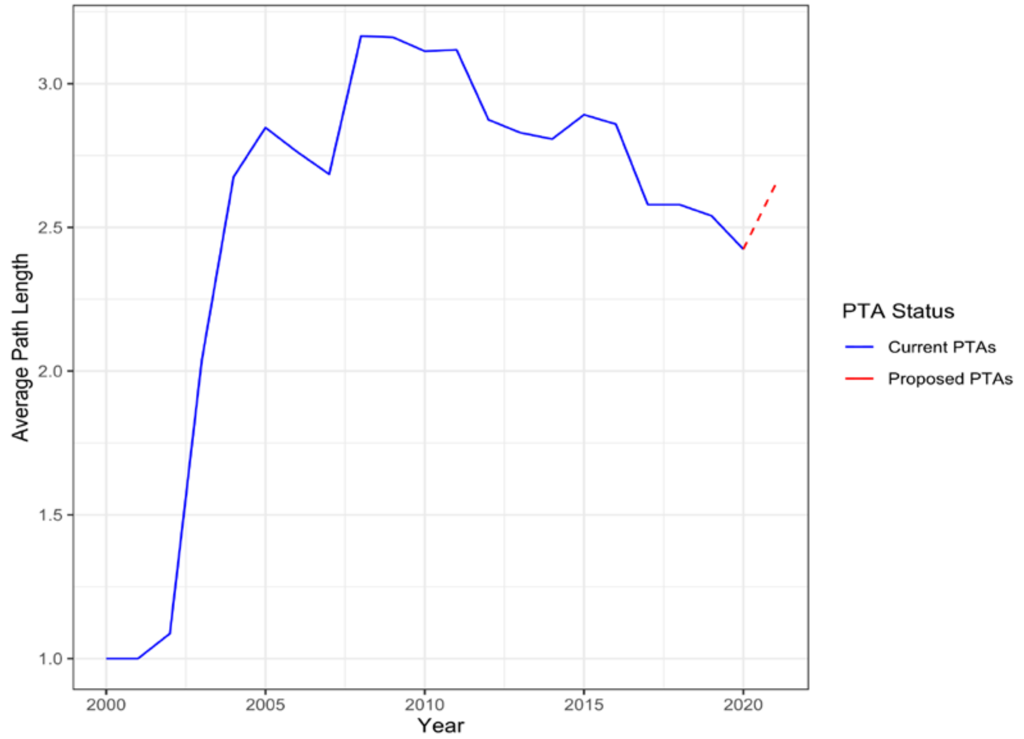


4. Path length

The concept of a path is one that is critical to network analysis and which supports the exploration of the structure of a network (Perez and Germon 2016). Average path length is defined as the average distance between any pair of nodes in a network (Albert and Barabási 2002). Average path length is particularly helpful because it allows one to measure how easily some kind of flow, e-commerce model diffusion for example, can move through a system. A network that is characterized by low average path is one in which two nodes are only a couple of steps away from one another. For example, a given Facebook user is only 4.7 'degrees of separation' from any other user on the network; a comparatively small number of steps given the size of the network (Backstrom et al. 2012).

Figure 17 tracks the evolution of path length within the e-commerce governance network and shows how, since 2008, average path length has declined. From 2000-2008, average path length underwent a dramatic increase as new, but separated, agreements were formed. From 2008 onwards, average path length declined, i.e. the distance between actors narrowed, as countries formed agreements that linked previously isolated countries together. This change in average path length suggests that it has become easier to diffuse regulatory models throughout the e-commerce governance network. If the proposed PTAs were concluded, this would increase the structural distance between actors in the network and would have the potential to make diffusion more difficult.

Figure 17: E-commerce average path length



4. Interpreting topological results

The preceding analysis has generated several insights pertaining to the evolution of the structure of the e-commerce governance system. The analysis reveals that the e-commerce governance regime is best characterized as complex, due to the presence of small-world and scale-free properties, rather than a complicated system. In addition, the e-commerce network has become less structurally fragmented over time and more monocentric. The presence of complexity along with a general trend towards defragmentation and monocentrism/structural oligarchy has implications for the overall functioning of the e-commerce governance system.

A. Identifying complexity, (de)fragmentation, and polycentricity in the e-commerce governance network

The identification of scale-free and small world properties can be used, albeit imperfectly, to identify complex networks (Kim 2013). This is because the simultaneous presence of both scale-free and small-world characteristics is suggestive of underlying complex non-random organizing principles. However not all complex networks possess scale-free characteristics (i.e. they are not characterized by a highly skewed degree distibutions). Some, including power grids, neural networks of worms, and actor colloboration networks, are clearly complex but follow an exponential distribution in one form or another (Albert and Barabási 2002). However, the point remains that if both scale-free and small-world characteristics can be detected, then it is reasonable to assume that the network in question is complex.

The static analysis of the topology of the e-commerce governance network indicates that the network is indeed complex rather than merely complicated. More specifically, in 2020, the network had a low average path length and high clustering coefficient (when compared to a random network) which is indicative of its possessing small-world properties (Watts 2004; Watts and Strogatz 1998). The degree distribution of the e-commerce network followed a power-law distribution – a signature of scale-free networks (Barabási 2009; Barabási and Bonabeau 2003).

Turning to the question of whether the e-commerce governance network is fragmenting or defragmenting, the declining modularity score, increasing centralization score, and declining average path length suggest that the network has become less fragmented over time. The e-commerce governance network was experiencing fragmentation at a structural level into the late 2000s before this trend reversed itself. Up until approximately 2008, average path and modularity were increasing, i.e. the distance between countries was growing and they were forming disconnected groups, while degree centralization was low: there were a large number of structurally important actors in the network. From roughly 2008 onwards, this trend inverted itself and the network moved towards defragmentation as modularity declined, centralization increased, and average path length fell. The inclusion of the proposed PTAs would, without additional agreements that would more comprehensively integrate African economies into the overarching network, have the potential to reverse the trend towards defragmentation, and splinter the architecture into three distinct clusters centered on the Asia-Pacific, Europe, and Africa.

The initial fragmentation of the e-commerce governance network and then subsequent contraction or defragmentation has generated an uneven topological structure composed of several interconnected hubs. Identifying the integrative nature of the network does not indicate one way or another as to whether the e-commerce governance system has a hierarchical structure. However, examining the level of polycentricity within the e-commerce governance network goes some way to providing an answer to that question.

The e-commerce governance network was, for large parts of the 2000s and 2010s, characterized by a declining clustering coefficient, increasing centralization, and declining modularity which is suggestive of a structure that hews towards a structure dominated by a handful of central actors. The current structure is generated by an oligarchy of countries, the EU, Australia, New Zealand, Singapore, and the United States, with similar degree distributions and structural positions. If included, the proposed PTAs would increase the clustering coefficient and modularity score, and decrease the centralization score - all of which is suggestive of a structural-level increase in the degree of polycentricism.

B. E-commerce network dynamics as a function of structure: complexity

The complex architecture, as is the case of other real-world complex systems, has implications for the functioning of the e-commerce system. For example, the declining average path length and an increasing level of clustering, driven by the emergence of megaregional trade agreements, suggest that the e-commerce network is a small world system. Dynamic systems with small world properties could be expected to display enhanced speed of information or norm diffusion and synchronization (Watts and Strogatz 1998).

To further understand the potential implications of a complex structure, it is helpful to revisit the properties of complex systems. First, complex systems possess the ability to self-organize (Orsini et al. 2020). While the WTO plays a role in regulating certain aspects of e-commerce and the digital economy, it is not a central regulatory authority. Even if an e-commerce agreement comes to fruition at the WTO, regardless of the substance of the agreement or its architecture (i.e. multilateral or plurilateral), it is likely that new rules governing the digital economy will still emerge through PTAs.

Complex systems are characterized by emergence - the unanticipated product of interactions between units in a system. The first generation of PTAs facilitated the rise of global value chains and the fragmentation of production (Laget et al. 2018; Orefice and Rocha 2014). Similarly, PTAs with deep e-commerce and digital trade provisions have the potential to either facilitate the next wave of globalization or to generate regulatory incompatibility within the system and hinder economic integration.

Complex systems are adaptive in nature. Changes in the nature of production and technology, facilitated, in part, an expansion of international trade and the diffusion of technology. In turn, this has created incentives for more comprehensive rules on the digital economy –a positive feedback loop. On the other hand, great power competition – for example between the US and China over the issue of cybersecurity or the US and the EU over the issue of privacy – manifested through trade disputes or trade restrictions, could drive the inclusion of more restrictive or incompatible digital trade rules within the e-commerce governance system and generate a negative feedback loop that fragments the system into competing and incompatible regulatory clusters.

Morin and Gomez-Mera in Orsini et al. (2020), make the point that complex systems produce endogenous dynamics which may generate positive or negative outcomes. For example, feedback loops can generate path dependency with a system. The 'moratorium on e-commerce duties' provides a clear illustration of how this can occur within the e-commerce governance network. Burri and Polanco (2020, 198) noting that "the ban on customs duties is one of the most common provisions found in PTAs with digital trade rules", show how WTO members, despite not making the ban on e-commerce duties permanent at the multilateral level, have made the ban a de facto feature of the system.

C. E-commerce network dynamics as a function of structure: defragmentation and polycentricity

The move towards defragmentation and structural oligarchy could have implications for the functioning of the e-commerce governance regime. As the e-commerce regime has become less structurally fragmented, it may become easier for norms to diffuse through the network as the structural distance between actors decreases. The rapid pace of technological change and evolution of the digital economy requires that e-commerce governance has a similar ability to rapidly adapt. This adaption could be facilitated by a decrease in the path lengths between actors in the e-commerce network as information, norms, and rules are able to flow more freely throughout the network.

There are at least three key implication associated with the oligarchical structure of the network. First, the network oligarchs are more likely to be able to diffuse distinct regulatory models throughout the system (Hafner-Burton et al. 2009). The network oligarchs, due to their central positions within the network, possess the ability to "to set agendas, frame debates, and promulgate policies that benefit them" (Beckfield 2003, 404 as quoted in Hafner-Burton, Kahler, and Montgomery 2009). The EU, United States, Australia, and Singapore have all have promulgated distinct e-commerce governance models (Elsig and Klotz 2018). Three of these actors currently possess dominant structural positions. Furthermore, when the United States become engaged in the TPP negotiations, it too held a central position with the network. I am not suggesting that network position is more important, or even as important, as material power, but simply that an actor's position within the network can reflect, constrain and enhance the ability of an actor to achieve their desired economic or political aims. China's relatively peripheral position would suggest that it will have a harder time diffusing its regulatory preferences than the United States or even Singapore or Australia.

Second, the tendency toward hierarchy may be disadvantaging low-middle income and low-income economies. The visual analysis of the network suggests that high-income economies are more likely to form connections with one and other while low-middle income and low-income economies are almost entirely excluded from the network. Manger et al.'s (2012) analysis indicates that the overall structure of the PTA network is driven by the tendency of high-income countries to sign agreements with one another as well as with middle-income countries but not with low-income countries. If e-commerce is to be harnessed to drive development outcomes, low-middle income and low-income economies need to be included in bilateral and plurilateral e-commerce negotiations. The passage of Phase III of the ACFTA would alter the topology of the regime, bring more low-income and lower-middle income countries into the frame, and help to ensure that the most vulnerable economies are not excluded from the e-commerce governance network.

Third, the e-commerce regime of the network is likely to continue to be dominated by a limited number of central advanced economies - network theory would suggest that these central actors, and the rules and norms associated with them, are more likely to attract additional connections relative to unconnected actors and further enhance their positions (Barabási and Albert 1999). This is because the marginal utility of forming an agreement with a central actor and adopting their norms increases as additional countries form agreements with, and adopt the norms of, that central actor (North 1990; Pierson 2000). Furthermore, those countries that have been involved in e-commerce governance longest, such as Singapore, are more likely to form connections as they have more opportunity to do so relative to “younger” actors (Barabási and Bonabeau 2003). In other words, it is likely that oligarchical governance will continue to characterize the system.

It is important to note that the network effects that are driving the structure of the e-commerce governance network may be following a parabolic path rather than a linear one – a dynamic that is not uncommon to complex networks (Kim 2020). This implies that there is a sweet spot in terms of network structure where there are sufficient or deep enough connections between actors and institutions in the network to link fragmented clusters and prevent conflict, but where connections are not so dense as to generate excessive homogeneity and inhibit regulatory innovation and experimentation. This type of polycentric arrangement, while not without flaws, may, as Ostrom (2010) argues in the context of climate change, possess a number of positive attributes. These include learning from the experience of other actors in the network and the use of local knowledge which enhances the adaptive capacity of the system.

This is not to say that network effects, and the resulting structure, will necessarily prevent regulatory conflict between the network oligarchs. Afterall, as Farrell and Newman (2010) point out, there is a high degree of variance between the preferences of countries with respect to ‘behind-the-border issues’ and e-commerce and digital economy regulation is not an exception. More specifically, a number of key actors including Australia, Singapore, China, the United States, and the European Union have diverse preferences with respect to a number of key digital economy issue areas including internet sovereignty and national security carveouts as well as legal flexibility, consumer protection, and regulatory cooperation (Dongxiao et al. 2019; WEF 2020, Elsig and Koltz, 2018).

However, a number of these oligarchs are already tied closely together, which bodes well for cooperation. Australia and Singapore are closely tied by the Digital Economy Agreement (signed in 2020), which is one of the most comprehensive and ambitious digital economy agreements currently in the network. Australia, Singapore and the United States are tied together through their bilateral agreements. In contrast to the agreement between Australia and Singapore, their respective agreements with the US are far shallower in scope. Similarly, China and Australia are tied by their 2015 agreement and Singapore and the EU by their 2018 agreement – both of which are even shallower in scope.

It is unlikely that these shallow scope agreements possess the necessary legal weight and depth to truly link these actors to such a degree as to prevent fragmentation and the establishment of conflicting regulatory principles. That said, if the proposed EU-Australia FTA is successfully negotiated and is sufficiently deep, it would enhance the overall cohesion of the network. In sum, there are network oligarchs who are well-connected and integrated with one another which suggests that fruitful cooperation is the most likely outcome. On the other hand, a number of oligarchs remain unconnected and with distinct regulatory preferences which does not auger well for the regulatory convergence or compatibility of the e-commerce governance system.

5. Conclusion

Digitalization is generating deep shifts in global production and consumption structures. Digitally enabled processes, including e-commerce, have experienced tremendous growth over the last several years as physical and digital products become more deeply intertwined. The digital trade agenda has emerged as one of the most critical issues areas of the international trade regime. The digital trade agenda, long moribund at the WTO, has been increasingly taken up in PTAs.

This study argued that the e-commerce governance regime is a complex rather than a complicated system. I demonstrated that the system possesses small-world and scale-free properties (indicators of complexity). The regime has also become less fragmented and has more monocentric, albeit dominated by a handful of central actors rather than a single governing actor, over time. In toto, the e-commerce governance regime can best be described as a complex oligarchical system that is not totally integrated nor totally fragmented. The introduction of proposed trade agreements has the potential to increase the level of fragmentation of the system while simultaneously increasing polycentricism.

The patterns identified in this study allow insights into the impact of the e-commerce governance topology on governance outcomes to be generated. The complex structure of the e-commerce regime suggests that the structural architecture of the system will continue to evolve and adapt, independent of action at the multilateral level. Even if e-commerce negotiations at the WTO prove to be successful, PTAs will likely continue to breed regulatory innovation in the e-commerce space, i.e. the self-organization of the system will likely continue. The unpredictable interaction of units in the e-commerce system could either drive the 4th Industrial Revolution or generate negative impacts that go well beyond the constituent parts of the e-commerce regime. E-commerce negotiations and design decisions should, ideally, reflect this emergent property. Similarly, the dynamic processes of the e-commerce regime, including feedback loops, necessitate design decisions that are, ultimately, flexible and do not lock in suboptimal policies.

Similarly, structural oligarchy and the level of fragmentation within the system could have implications for governance outcomes. Declining structural fragmentation could enhance the overall adaptability of the system. Increasing structural oligarchy suggests that distinct models of e-commerce governance may become the norm as network effects solidify the position of a handful of central actors. Of course, this move does not necessarily entail a move towards regulatory coherence or the avoidance of conflict. Key actors (the United States, Australia, and Singapore) are tied closely which, on balance, makes future cooperation more likely, while others (the European Union and China) are not – which does not bode well for regulatory compatibility in the system.

Future analysis of the topology of individual governance systems, as well as the structural relationship between these systems, could help to advance our understanding of the structure and evolution of global governance more broadly. Building from this line of enquiry, a new focus on structural architecture and its impact on the functioning of governance systems would be both possible and have theoretical and policy-relevant implications.

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