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An International Trade Disputes Analysis using Network Theory

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Abstract. *International trade is an important pillar of the modern economy. Beyond its benefits, the global market generates divergencies among trade partners that can be escalated into trade disputes. Notable interest has arisen in using network analysis to formally describe interactions with concepts derived from the graph theory. As we have noticed a less explored area on the graphical representation of trade dispute data, the purpose of this paper is to build, visualize, and analyze the trade disputes as a weighted network. We use data about trade disputes provided by the Word Trade Organization from 1995 to 31 January 2022 as this is a major regulatory body within the multilateral trading system. Our aim is to address the question on which countries are using the most the dispute settlement mechanism. Based on the association complainant – respondent, we map these interactions to obtain a weighted network that includes 75 countries, 247 unidirectional country pairs and 652 trade disputes. The results indicate the dominance of the United States as the main hub followed by the European Union and a core-periphery structure of the trade dispute network with less participation from smaller countries. Our study is a general assessment of trade disputes which contributes to identifying patterns on the positional changes of countries and their involvement as complainant and respondent respectively in international dispute settlement.*

Keywords: trade disputes, network analysis, weighted network, modularity, World Trade Organization.

Introduction

International trade is an important pillar of the modern economy that has widely developed in the context of globalization during most recent times. According to Krugman et al. (2010), international trade occurs because countries are endowed with different resources, and they can obtain mutual benefits by trading with each other, but also achieve economies of scale and specialize in the cost-effective production of goods and services.

Whereas the benefits of trade contribute to economic development, the global market is also affected by trade barriers across the supply chains. This may generate divergencies between trade partners that can be escalated into trade disputes and ultimately trigger trade wars. Close to that scenario have been the trade tensions between United Stated and China which have lately dominated the research topics in international trade. Moreover, unexpected events as the Suez

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Canal blockage in Egypt from 2021 or the containers shortage in the pandemic context led to disruptions in trade flows impacting international trade management.

The Word Trade Organization (WTO) has been one of the major regulatory organizations within the multilateral trading system since its establishment in 1995. For Bown (2004), a key difference between the WTO system and its predecessor, the General Agreement on Tariffs and Trade, is the formal existence of the trade dispute settlement mechanism to which member states can use for international dispute resolution. However, which countries are using most the WTO's dispute settlement mechanism?

The conceptualization of international relations through network analysis describes the interactions in a system by using tools derived from the graph theory to assess the structural characteristics and define the network power (Hafner-Burton et al, 2009). This provides valuable insights on topological characteristics by detecting and analyzing patterns and it can be applied to international trade by considering countries as nodes that are linked by the existence of a trade relation to observe the connectivity within the respective network (De Andrade and Rêgo, 2018).

We have noticed a less explored area on the visualization of trade dispute data. To address this issue, we aim to build a trade dispute network to assess its structure and identify the focal points. Using publicly available data retrieved from the WTO on international trade dispute between 1995 and 31 January 2022, we map the overall trade dispute system based on the association complainant – respondent and analyze the results.

Our study is close to Freitas et al. (2019) who investigated the configuration of member states in international arbitration at WTO by using network analysis with data for the year 2014. Whereas we have also employed specific centrality metrics and addressed the core-peripheral position of countries, our approach focuses on an extended analysis on the updated time span. We differentiate between complainants and respondents in the network and comparatively present the results. Our findings are consisted with the related literature.

The paper is structured as follows: in section 2, we make a literature review to identify the main approaches on trade disputes and to present different views on the trade areas from a network analysis perspective. Section 3 focuses on the research methodology by defining the theoretical concepts on centrality metrics and community detection approach to describe the process for building the trade dispute network. In section 4, we present the main findings through visual representations and descriptive statistics. The section 5 is reserved for conclusions.

Literature review

The study of international trade under the network modelling framework has gained notable interest in the trade related literature. Smith and White (1992) conducted a quantitative network analysis to examine trade relations and the findings confirmed the existence of asymmetrical trade patterns especially for raw materials and processed goods. This unbalanced exchange contributes to global inequality and country hierarchy. Blanton (1999) confirmed the hypothesis on the hierarchically structure of world economy based on the core-periphery positions of the countries.

Serrano et al. (2007) constructed a global weighted directed network using bilateral trade imbalances data between 1948 and 2000 and observed the trade flows were disproportionately distributed along trade partners and a presence of dominant backbones was identified in the form of sparse subnetworks that hold a major overall flux in the network. Following a similar pattern, Fagiolo et al. (2009) obtained a core-periphery structure of the trade relations between countries worldwide. Most countries displayed weak trade links. However, the highly connected countries which are more clustered through more intense trade links also trade with the less connected ones.

De Benedictis et al. (2014) successfully applied a network approach to international trade analysis. The world trade network was explored through data visualization, topological properties, network statistics and centrality measures applied to unweighted and unweighted networks. The outcome revealed different patterns. For the unweighted network, various Asian countries resulted of importance whereas the main players in the in weighted network were the United States and European countries, having United States as the main hub. China was found as important trade partner to most developed countries.

The primary data source on trade disputes mostly originates from the WTO whose dispute settlement system has been subject to both appraisal and criticism. As pointed out by Bagwell and Staiger (2004), this is the main instrument used by member states for trade liberalization in markets unjustifiably protected by trading partners, and it leads to effective mitigation of protectionism and better market access. According to Smith (2004), the WTO dispute settlement mechanism is controversial from an international legislative perspective due to direct implications on inequality between developed and developing countries. Criticism arises from the idea that reforms that have been proposed by developed countries which are allegedly the implicit beneficiaries of the resolutions even though international arbitration should generally favor smaller countries that are less economically powerful.

Chaudoin et al. (2016) argued that a dispute settlement under the WTO does not facilitate trade. Through a regression analysis in which trade disputes were included as a dichotomous exogenous variable, they showed that imports for the products under dispute do not increase for the respondent country. However, Shin and Ahn (2019) empirically showed that winning a trade dispute enhances multilateral trade liberalization. Thus, the trade gains are collectively shared among all WTO members that obtain better market access rather than benefitting only the parties involved directly in the trade dispute.

Among the reasons listed by Bown (2008) on why low-income countries rarely initiate trade disputes at WTO is that they do not obtain satisfactory economic welfare gains associated with their import activity. Subsequently, Davis and Blodgett Bermeo (2009) confirmed that high costs of initiating disputes can demotivate countries from using the WTO dispute settlement system, but that this cost decreases with experience. Their study shows that a country that has made the initial investment required to initiate a first dispute may further benefit from lower costs based on previous experience which has a significant influence on the extend developing countries initiate disputes. Moreover, their participation is important for the efficiency of the global trading system and the lack of experience is an important constraint on their ability to initiate disputes. The degree of participation in disputes has increased over time by accumulating experience. In the first five years of the WTO, high-income countries accounted on average for 71% of complainants each year and this percentage fell to around 50% between 2000 and 2007.

Lee (2012) used the number of trade disputes registered at the WTO with a biannual frequency between 1995 and 2008 as the exogenous variable to determine patterns of the complainants. The results showed that a high level of aggregate demand within OECD member countries as well as natural unemployment reduces the number of initiated trade disputes. The author showed that middle-income countries mostly initiate conflicts related to the agricultural sector, while low-income countries with a positive external balance of payments outcome tend not to initiate any trade conflicts.

Freitas et al. (2019) used social network analysis to study the configuration of the trade disputes in 2014. The results showed the United States followed by the European Union as main

players in a network which has a core-peripheral position of central and emerging countries with visible discrepancies in their participation in WTO's dispute settlement procedures.

To identify the factors that influence the participation of developing countries as complainant in trade disputes under the WTO, Wood and Wu (2020) set a binary dummy dependent variable for any country that initiated at least one trade dispute between 1995-2018 and then used the logistic regression to show that the key factors which determine developing countries to initiate a dispute against another country are related to export volumes, retaliation, economic strength and potential economic threat from the counterparty.

Methodology

International trade can be modelled as a network where countries are nodes and the trade relation between them are represented by edges (Liu et al., 2018). We employ general concepts derived from the graph's theory to define the methodological framework.

We consider the initial graph $G = (V, E)$ defined by a set of nodes $V = (v_1, v_2, \ldots, v_N)$ and the set of edges $E = (e_1, e_2, \ldots, e_M)$ having N and M as the total number of nodes and edges respectively. Let $e_{ij} = (v_i, v_j)$ be the link between node i and j, where $i, j \in (1,2, \ldots, N)$. The adjacency matrix is A = $\{ a_{ij}\}$. This includes binary information with $a_{ij} = 1$, if there is a link between node i and node j, and 0 otherwise.

Information on the edges is added by introducing the associated weight. The initial graph becomes weighted, and it can now be represented by a weighted adjacency matrix $W = \{w_{ij}\}$ where $w_{ij} > 0$, if node i and node j are connected, and 0 otherwise. If $w_{ij} \neq w_{ji}$, the graph is directed.

The differentiation between links is captured by the weight which is described by Granovetter (1973) as the frequency of the relation reflecting its strength. The insights provided by unweighted and weighted networks are different (Newman, 2010). The analysis should recur to metrics for both type of networks where applicable for more accuracy in the results (De Andrade and Rêgo, 2018; Schiavo et al., 2010). In our analysis, we use two main concepts of centrality measures and modularity as operational metrics.

According to Freeman (1978), identifying central nodes is essential in any network, and the centrality of a node is given by its degree. The degree centrality is a basic indicator that represents the number of adjacent nodes to node i determining its involvement in the respective network. The degree of a node k_i expressed as the numbers of direct relations for an unweighted network is:

$$k_i = \sum_{j=1}^{N} a_{ij} \quad (1)$$

For directed graphs, it is important to distinguish between indegree (k_i^{in}) which denotes the total number of edges incidents to node i, and outdegree (k_i^{out}) representing the total number of edges incident from node i. The total degree to display all links for node i is:

$$k_i^{total} = k_i^{in} + k_i^{out} \quad (2)$$

The average degree for the overall network can be calculated as:

$$k^{avg} = \frac{1}{N} \sum_{i=1}^{N} k_i^{total} = \frac{1}{N} \sum_{i=1}^{N} (k_i^{out} + k_i^{in}) \quad (3)$$

These centrality metrics can be easily extended to weighted network. Hence, we define weighted degree centrality or the strength centrality of a node i (s_i) as follows:

$$s_i = \sum_{j=1}^{N} w_{ij} \quad (4)$$

We apply the same reasoning for weighted indegree (s_i^{in}) and weighted outdegree (s_i^{out}) to obtain the total weighted degree for the overall network (s_i^{total}) and the average weighted degree (s^{avg}) respectively:

$$s_i^{total} = s_i^{in} + s_i^{out} \quad (5)$$

$$s^{avg} = \frac{1}{N} \sum_{i=1}^{N} s_i^{total} = \frac{1}{N} \sum_{i=1}^{N} (s_i^{out} + s_i^{in}) \quad (6)$$

The nodes with the highest centrality metrics are hubs (Newman, 2010). They can be perceived as focal points with great influence in the network. A combination of both centrality degree and strength centrality was also used by Opshal, Agneessens și Skvortez (2010) as indicators in network analysis.

To determine the optimal number of communities that a network can be divided into, the modularity (Q) extended to weighted networks is applied (Newman, 2004):

$$Q = \frac{1}{2W} \sum_{ij} (w_{ij} - \frac{s_i s_j}{2W}] \delta(c_i, c_j) \quad (7)$$

where:

- w_{ij} is the weight of the edge between node i and node i
- s_i is the strength of node i
- c_i is the community allocated to node i
- $\delta(c_i, c_j) = 1$ if node i and j respectively belong to the same community, and 0 otherwise
- Q is a scalar with $\max(Q) = 1$

Under this framework, we built a directed weighed network of trade disputes based on source – target pairs. We used the available data provided by the WTO on the trade disputes that have been filled from its establishment in 1995 to the end of January 2022. In collecting the data, we followed the reasoning of Torres (2012). In his statistical analysis of consultation requests in the WTO dispute settlement system, he emphasized that some of the requests that were filed had more than one country as complainant and it was considered that each of these countries filed an individual request. We applied the same reasoning for the countries listed as either collective complainant or responded and decomposed the trade disputes into single source – single target pairs. Thus, in our network, with participation in at least one trade dispute are the nodes and the edges illustrate the existence of the conflictual relation between countries. The weights account for the number of unidirectional trade disputes from the complainant to the respondent and make the transition from a binary analysis to a weighted analysis that captures the magnitude of the trade disputes.

The data was processed by using the open-source software Gephi 0.9.2. As visualization algorithm for our network, we use Force Atlas 2 software. Its efficiency was confirmed by Zhansultan et al. (2021) following their evaluation of the performance of multiple similar algorithms.

Results and discussions

We have obtained an overall trade dispute network that incorporates 75 countries, 247 distinctive complainant – respondent pairs and 652 trade disputes from 1995 to 2022 years, based on the WTO data. The centrality metrics are presented in Table 1. The degree accounts for the number of

countries that a particular country has established a trade dispute within the reference period. The intensity of this relation is addressed by using the weighted degree which represents the number of trade disputes between a country pair. On average, a country has approximately nine trade conflicts with three countries. The minimum value indicates that there are no isolated nodes in the network. All countries included in the analysis have been involved in at least one trade dispute. The centrality metrics are not normalized.

Table 1. Overall network centrality metrics

Indicator	Degree	Weighted degree
Minimum	1	1
Average	3.29	8.69
Maxim	60	300

Source: Authors' own calculation based on WTO data

To inspect the network structure, we first consider the overall involvement of the countries in trade disputes. The European Union (formerly European Communities) is reported as a trade block. By using the algorithm Force Atlas 2, we highlight the core versus peripheral positions in Figure 1. The nodes are labelled by the country's name and the node size is scaled based on the weighted degree which denotes the total number of trade disputes. Modularity was applied to partition the network and identify an optimum number of four communities which are highlighted differently.

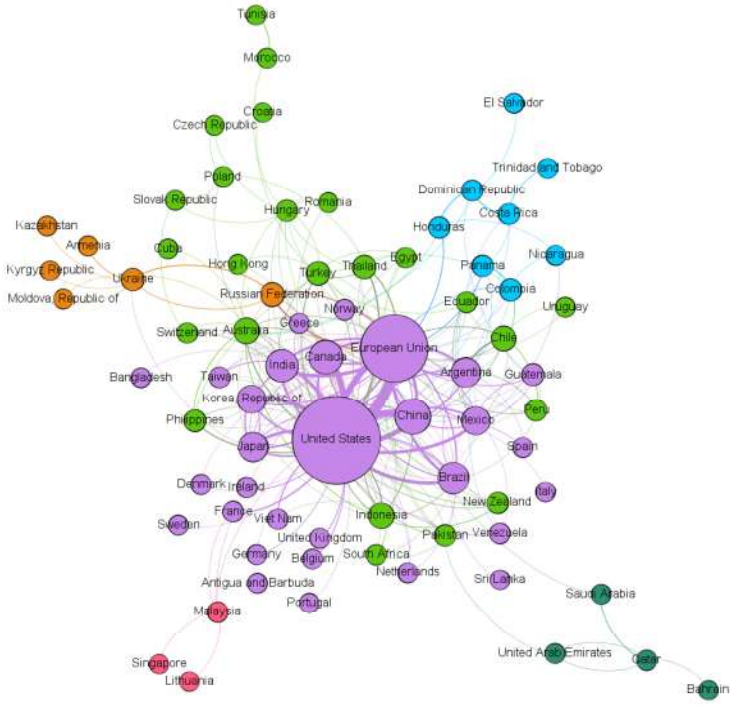


Figure 1. Overall trade dispute network

Source: Authors' representation based on WTO data.

We can observe (see Figure 1) that the United States is the main hub of the overall network which uses the WTO trade dispute settlement system the most as it has been involved in 300 trade disputes with 60 countries. This is followed by the European Union which is also part of the same community which connects the most significant influences in the network. These hubs are consistent with the findings of Freitas et al. (2019) for the year 2014.

The peripheral positions indicate a low involvement in the trade disputes where smaller countries are found in general. Most Central American countries are grouped into the same community. The overall trade disputes network follows a similar pattern to the characterization of Fagiolo et al. (2009) to the world trade web as it shows a most of the links between countries represent weak relations and connected countries are more grouped.

The next step in our analysis was to differentiate between the network of complainants and respondents with the aim of identifying any possible changes in the structure of the initial network. The node size is scaled based on weighted indegree and weighted out degree respectively with the magnitude of trade disputes also captured the node colors which vary from highly influential in red to minimal involvement in light grey. The peripheral nodes with no color associated did not have any involvement in the respective network. Both networks are presented in Figure 2.

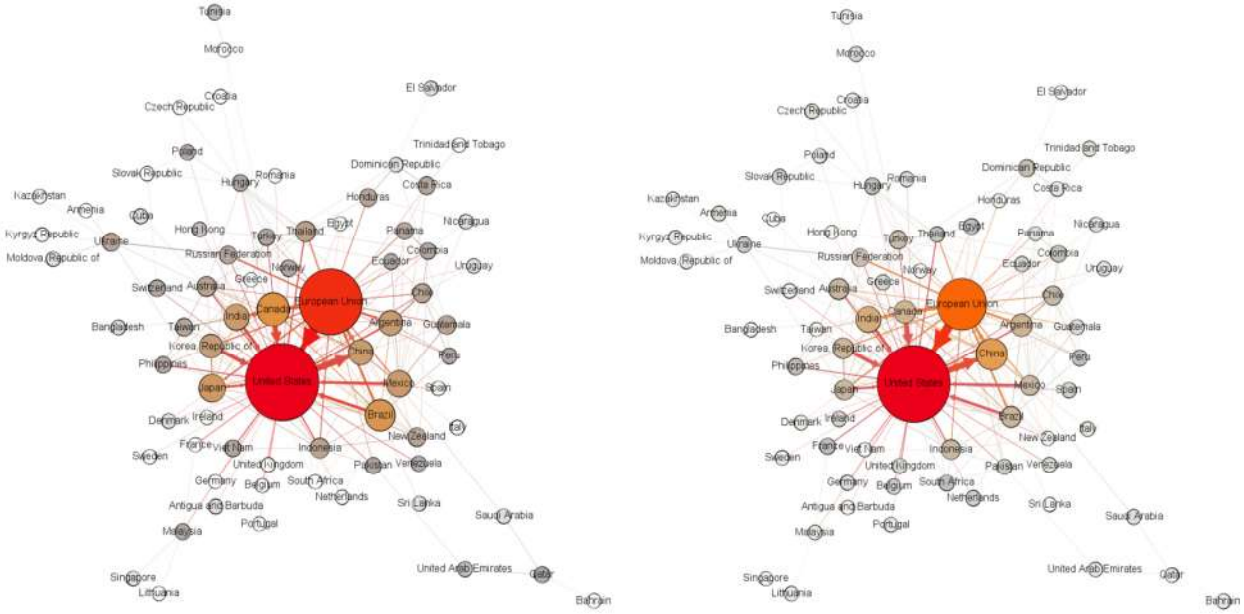


Figure 2. Complainant versus respondent trade dispute network

Source: Authors' representation based on WTO data.

The main hubs remain unchanged as the United States and the European Union. Positional changes indicate the tendency for most countries to be more actively a complainant. Trade disputes happen frequently between large economies (see Table 2). At a lower scale, countries aim to target their neighbors (Argentina – Chile, Ukraine – Russian Federation, Qatar – Saudi Arabia) or countries from the same region especially in Latin America (Panama – Colombia, Chile – Peru, Costa Rica – Dominican Republic). Similar patterns apply for peripheral countries that initiated singular disputes against countries that are territorially close (El Salvador – Dominican Republic, Singapore – Malaysia, Bangladesh –India) or larger economies (Antigua and Barbuda – United Stated, Sri Lanka – Brazil, Cuba – Australia).

Table 2. Top 10 key players in trade dispute networks

Rank	Complainant	Total disputes	Main target (%)	Respondent	Total disputes	Main source (%)
1	United States	132	China (17.42%)	United States	168	European Union (20.83%)
2	European Union	108	United States (32.41%)	European Union	101	United States (19.80%)
3	Canada	40	United States (50%)	China	48	United States (47.92%)
4	Brazil	35	United States (31.43%)	India	32	European Union (34.38%)
5	Japan	28	United States (28.58%)	Canada	23	United States (34.78%)
6	India	25	United States (44%)	Argentina	22	European Union (36.36%)
7	Mexico	25	United States (40%)	Korea, Republic of	19	United States (31.58%)
8	China	24	United States (66.67%)	Brazil	17	European Union (29.41%)
9	Argentina	22	European Union; Chile (27.27%)	Australia	17	United States (23.53%)
10	Korea, Republic of	21	United States (66.67%)	Japan	16	United States; European Union (37.50%)
Total	**-**	**652**	**-**	**-**	**-**	**652**

Source: Authors' own calculation based on WTO data.

The top ten economies in trade disputes are presented by frequency in Table 2. They are listed separately with their main connection for both networks and its share in the total disputes registered for the respective economy. The leading position pertains to the United States that was a complainant in 132 trade disputes with 17.42% initiated against China, and a respondent in 168 disputes out of which 20.83% were filed by the European Union. Apart from Mexico in the complainant network and Australia in the responded network, the same economies interchange their positions in the rankings.

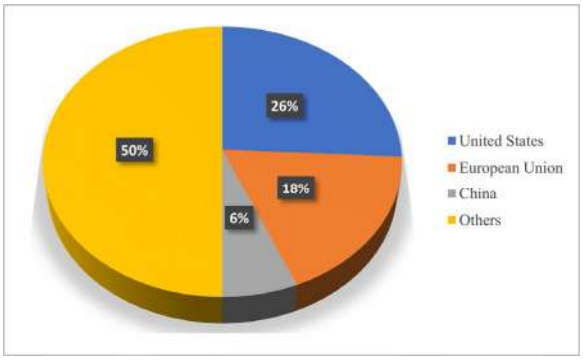


Figure 3. Ovrall involvement in trade disputes (%)

Source: Authors' own calculation based on WTO data.

In the overall trade dispute network, the top three economies account for a cumulative 50% with clearly separated positions (see Figure 3). The individual participation of the remaining 72 countries falls below 6 %. It was expected for China to have a greater involvement in trade disputes

due to the media exposure over the conflictual relations with the United States adopting protectionist trade policies that were also derived from alleged unfair trading practices and intellectual property rights. However, China continues to be a key participation in trade conflicts as the tariff increases with the United States affected the global economy.

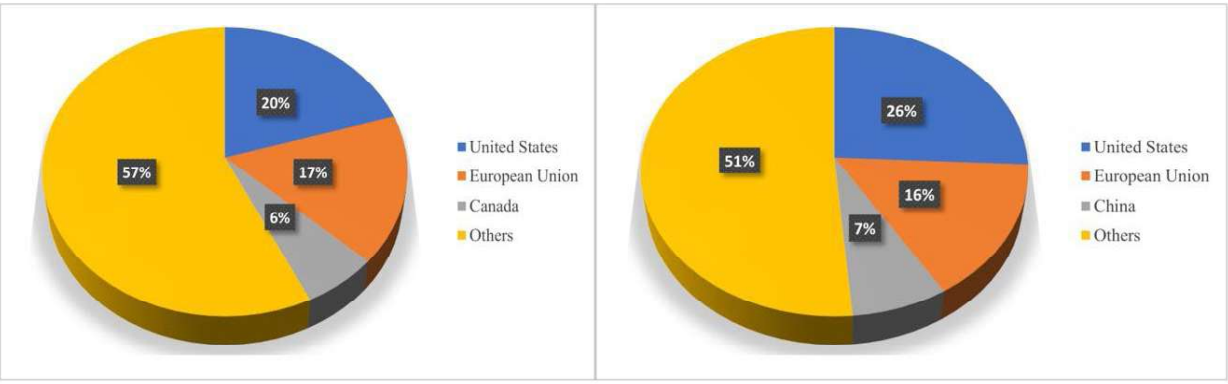


Figure 4. Involvement as complainant versus respondent in trade disputes
Source: Authors' own calculation based on WTO data.

The results are comparatively displayed in Figure 4. Canada from the complainant network is replaced by China in the responded network in which the top three countries have a higher cumulative involvement. The United States is a global trade partner especially for manufactured products. Thus, semi-peripheral and peripheral countries respectively initiated trade disputes against the United States and contributed to its 5% variation as a responded.

Conclusions

Most empirical studies used trade dispute data under an econometric modelling approach (Lee et al., 2012; Chaudoin et al., 2016; Wood and Wu, 2020) whereas network theory has been used for analyzing international trade flows (Smith and White, 1992; Serrano et al., 2007; Fagiolo et al., 2009; De Benedictis et al, 2014). There is less attention directed towards the descriptive analysis of the trade disputes.

In this paper, we studied international trade disputes from a network analysis perspective with the aim of identifying structural patterns and the most important economies engaged in this practice. Similar to Freitas et al. (2019), we started from the participation in trade disputes within the WTO's dispute settlement system. However, we have not limited the reference period to a year but conducted an extended analysis comprising all available data from the WTO's establishment in 1995 to 31 January 2022 to provide an overall perspective on the structure of the international trade disputes. We built a weighted network to capture the frequency of unidirectional trade dispute between complainant – respondent pairs and obtained a trade dispute network with 75 countries and 652 trade disputes.

Based on centrality measures, we determined the Unites States as the main hub of the network followed by the European Union reported by the WTO as a single trade block. To explore the data set, we partitioned the network and the countries with stronger links between them were grouped into four communities by using modularity. The network structure reveals the core-periphery alignment. Generally, smaller countries tend to participate less in trade disputes. These findings are consistent with the results Freitas et al. (2019) obtained for 2014, but also with other related studied on the participation to the WTO's dispute settlement system which may be

perceived as not easily accessible to less powerful countries (Smith, 2004; Davis and Blodgett Bermeo, 2009).

We also differentiated between complainants and respondents and build different networks to further study patterns. The main two hubs remained unchanged. From the ranking we computed for both networks, most active complainants are the United States (20%), the European Union (17%) and Canada (6%), whereas more requested responds are the United States (26%), the European Union (16%) and China (7%). The main target of the United States is China. With reference to their own participation in trade disputes, the United States is more engaged in the position of respondent whereas the European Union appears more active as complainant.

To conclude, we have explored the map of trade disputes and address separately the overall network, the complainants, and the respondents. Our analysis is general and centered on basic network metrics with relevance for this type of data. The weighted network approach accounts for quantifying the total number of trade disputes between two countries and incorporate this information to add more value to the analysis rather than simply accounting the presence of the conflictive relation. However, the outcome or the particularities of the trade dispute itself are not captured.

The visualization of a trade disputes network can represent a complimentary analysis for more elaborate studies and further directions of research may focus on either studying implication of trade disputes for the communities detected in this paper or determining if the number of trade disputes impacts any socio-economic patterns for the countries that belong to the most connected community.

References

Bagwell, K. & Staiger, R. W. (2004). Multilateral Trade Negotiations, Bilateral Opportunism and the Rules of GATT/ WTO. *Journal of International Economics*, 63(1), 1-29.

Blanton, R. G. (1999). Structure and Behavior in the World Trading System. *International Interactions*, 25(2), 119-144.

Bown, C. P. (2004). On the Economic Success of GATT/WTO Dispute Settlement. *Review of Economics and Statistics*, 86(3), 811-823.

Bown, C.P. (2008). Developing Countries and Enforcement of Trade Agreements: Why Dispute Settlement is Not Enough. *Journal of World Trade*, 42(1), 177-203.

Chaudoin, S., Kucik, J., & Pelc, K. (2016). Do WTO Disputes Actually Increase Trade? *International Studies Quarterly*, 60(2), 294-306.

Davis, C.L., Blodgett Bermeo, S. (2009). Who Files? Developing Country Participation in WTO Adjudication. *Journal of Politics*, 71(3), 1033-1049.

De Andrade, R. L., & Rêgo, L. C. (2018). The use of nodes attributes in social network analysis with an application to an international trade network. *Physica A: Statistical Mechanics and Its Applications*, 491, 249–270.

De Benedictis, L., Nenci, S., Santoni, G., Tajoli, L., & Vicarelli, C. (2014). Network Analysis of World Trade using the BACI-CEPII Dataset. *Global Economy Journal*, 14(3-4).

Fagiolo, G., Reyes, J., & Schiavo, S. (2009). The evolution of the world trade web: a weighted-network analysis. *Journal of Evolutionary Economics*, 20(4), 479-514.

Freeman, L. C. (1978). Centrality in social networks conceptual clarification. *Social Networks*, 1(3), 215–239.

Freitas, K. A. de, Vilela, B. de A., Ferreira, R. F. C., & Aprigio, A. E. R. de S. (2019). Forum Shopping Evidence in the World Trade Organization: A Social Network Analysis of Disputes between Member States. Contextus: Revista Contemporânea de Economia e Gestão, 17(1), 175-194.

Granovetter, M.S. (1973). The strength of weak ties, *American Journal of Sociology*, 78(6), 1360-1380

Hafner-Burton, Emilie M., Kahler, Miles, Montgomery, Alexander H. (2009). Network Analysis for International Relations. *International Organization*, 63(3), 559-592.

Krugman, R.P., Obstfeld, M., & Melitz, M. (2010). *International economics: Theory and policy* (10th ed.). London: Pearson Education.

Lee, J-E. (2012). Macroeconomic Determinants of the World Trade Disputes. *Applied Economics*, 44(33), 4301-4311.

Liu, Z., Wang, T., Sonn, J. W., & Chen, W. (2018). The structure and evolution of trade relations between countries along the Belt and Road. *Journal of Geographical Sciences*, 28(9), 1233-1248.

Newman, M. E. J. (2004). Analysis of weighted networks. *Physical Review E*, 70(5), 056131.

Newman, M.E.J. (2010). *Networks: An Introduction* (1st ed.). New York, Oxford University Press.

Opsahl, T., Agneessens, F., & Skvoretz, J. (2010). Node centrality in weighted networks: Generalizing degree and shortest paths. *Social Networks*, 32(3), 245-251.

Schiavo, S., Reyes, J., Fagiolo, G. (2010). International trade and financial integration: a weighted network analysis. *Quantitative Finance*, 10(4), 389-399.

Serrano, M. Á., Boguñá, M., & Vespignani, A. (2007). Patterns of dominant flows in the world trade web. Journal of Economic Interaction and Coordination, 2(2), 111-124.

Shin, W., & Ahn, D. (2018). Trade Gains from Legal Rulings in the WTO Dispute Settlement System. *World Trade Reviw*, 18(1), 1-31.

Smith, J. (2004). Inequality in international trade? Developing countries and institutional change in WTO dispute settlement. Review of International Political Economy, 11(3), 542-573.

Smith, D. A., & White, D. R. (1992). Structure and Dynamics of the Global Economy: Network Analysis of International Trade 1965-1980. *Social Forces*, 70(4), 857–893.

Torres, R.A. (2012). Use of the WTO Trade Dispute Settlement Mechanism by the Latin American Countries Dispelling Myths and Breaking Down Barriers. W*orking paper* nr. ERSD-2012-13, World Trade Organization, Geneva.

Wood, J., & Wu, J. (2020). The sustainability of the WTO dispute settlement system: does it work for developing countries? *Journal of World Trade*, 54(4), 531-566.

Zhansultan, A., Sanzhar, A. & Trigo, P. (2021). Parallel Implementation of Force Algorithms for Graph Visualization. Journal of Theoretical and Applied Information Technology, 99(2), 503-515.

World Trade Organization (2022). *Map of disputes between WTO Members*. Retrieved from https://www.wto.org/english/tratop_e/dispu_e/dispu_maps_e.htm (accessed on 22 February 2022).