Hertie School

Master of International Affairs

Global Politics

Assignment 3 – Research Paper

The Liberal International Order

A Network Approach to a Multipolar World

Julian Heiss – 213177

Word Count: 4746

December 27, 2021

1 Introduction

How robust is the Liberal International Order (LIO)? The state of the LIO remains a debated IR research topic (Lake et al., 2021; Copelovitch et al., 2020; Eilstrup-Sangiovanni & Hofmann, 2020). Variety in the definitions of underlying concepts prevents a clear consensus on whether and to what extent the LIO is being challenged and how it will evolve in the future. Current predictions are mostly vague, seem to be based on intuition, and are prone to a recency bias (Ikenberry, 2018; Mearsheimer, 2019; Eilstrup-Sangiovanni & Hofmann, 2020). One might argue that there is a gap between the aspirations of these predictions and their trustworthiness. Because of the multitude of aspects and mechanisms that shape a global order, a data-driven approach alone is unlikely to capture all aspects of the LIO and is no silver bullet in solving this problem (Mazarr, 2017, p. 13). However, following the credo that reliable quantitative measures should be employed where possible could help put future predictions on a more solid footing.

Can we test such past predictions from theories about the evolution of the LIO and gauge which theories provided the most value? Can we track aspects of the state of the LIO using quantitative measures in a reliable manner? Motivated by these overarching, abstract questions, I address in this study particularly the following leading question: Which effects does globalization have on the multipolarity of the international order?

The scholar Mearsheimer theorized a mechanism by which the hyperglobalization helped Russia and China to establish themselves as great powers, bringing an end to a unipolar LIO under American hegemony. He stated that such change will lead to competing bounded orders with a rivalry that has “both economic and military dimensions” (Mearsheimer, 2019, p. 49-50). This has far-reaching implications: if globalization, which can be understood as a normative goal of the LIO, is indeed causing increased multipolarity, then there is an inner tension in the concept of the LIO – an instability by design.

The emergence of economically competing bounded orders should have an effect on global trade relations. To be able to measure it, I draw on advice of European Commission President von der Leyen: ‘We want to create links and not dependencies!’, she said recently at the launch of “Global Gateway”, an answer to China’s Belt and Road Initiative. Taking this literally, I address the hypothesis that globalization is driving the global order towards multipolarity and bounded orders, by analyzing global trade relations in the framework of *network theory*.

Network theory evolved from the study of mathematical models, but is nowadays mostly used as a framework to investigate systems that are based on observational data. In this study, I propose a framework of network models based on the relative importance of trade relations as opposed to previous studies that used absolute quantities.

After this introduction, the remainder of this paper is organized into four additional sections. In the second section, I review the literature surrounding the state and future of the LIO and introduce shortly the field of network theory and its prior application in the field of international relations. The third section gives an overview of the network theoretical concepts, a newly proposed network model, and the data sets used in this study. The fourth section describes the results of the empirical analysis of the data and its implications for the aforementioned hypothesis and further analysis. Lastly, I summarize and discuss the findings in the broader context of the prior literature. The code for this analysis and further data checks can be found in a GitHub repository at `https://github.com/heissjl/gp-lio-network`.

2 Literature Review

2.1 The State of the Liberal International Order

The Liberal International Order (LIO) is seen as having undergone several forms, sometimes even dubbed with version numbers (e.g., Ikenberry, 2009), with the ends of World Wars I and II and also the Cold War each being an external shock that led to a change of the order. Differences between the forms are for example the reach of the order – from a formerly transatlantic to a now global reach (Ikenberry, 2009; Amadi, 2020; Lake et al., 2021). As long as the LIO existed it has been challenged. These challenges as well as changes of the LIO over time have always been a central part of IR literature (Lake et al., 2021).

The task of comparing insights surrounding the concept of the LIO is being hindered by the different notions of what this term entails: The different definitions of *liberal*, *order*, and *liberal order* fall on a spectrum, as scholars put different emphases on the underlying concepts. The scholar Ikenberry refers to a political order as "the governing arrangements among a group of states, including its basic rules, principles, and institutions" (Ikenberry, 2001, p. 45). His colleague Reus-Smit, however, argues that there are two more fundamental principles, namely "universalised state sovereignty" and "a framework of constitutional social norms" (Reus-Smit, 2013, p. 167). The concept of liberalism can be understood in a political, economic and institutional sense (Lake et al., 2021).

While in literature from the beginning of this century the American hegemony was seen as an integral factor in stabilizing the international order, since the American power was highly institutionalized (e.g., Ikenberry, 2001). This notion of the LIO has been critiqued in recent years, as several scholars argue that the concept of a post-hegemonic order can better explain current and coming interactions between states (Ikenberry, 2009, 2018; Amadi, 2020). Some even see arguments for a post-liberalism. The reason for this is the relative decline of American power, its subsequent decline of interest in liberal internationalism during the Trump administration and the economic rise of non-Western countries, such as Brazil, India and China (Amadi, 2020; Ikenberry, 2018, 2011; Mearsheimer, 2019). However, judgment on whether this power shift constitutes a crisis of the LIO or within the LIO hinges strongly on the author's notion of the liberal idea. It is argued that emerging powers like Brazil and China have come up through economic liberalism and thus have no intent on changing the order, but are looking for more influence within it (Ikenberry, 2011; Eilstrup-Sangiovanni & Hofmann, 2020). Yet, even when taking this perspective that the fate of the LIO is not dependent on the state of the American power, there is room for discussion left whether there is a crisis of the LIO or there are crises within it. The latter can be seen as a mechanism for change within the global order (Eilstrup-Sangiovanni & Hofmann, 2020).

In their approach to gauging the extent of such crises, Eilstrup-Sangiovanni and Hofmann (2020) separate political liberalism from economic liberalism. Only the latter is – together with the notions of "national sovereignty" and an "inclusive, rule based multilateralism" (Eilstrup-Sangiovanni & Hofmann, 2020, p. 1078) – taken as a foundational ordering principle. Copelovitch et al. (2020) follow this framework and in their mostly qualitative reasoning both these author teams argue that the current world order is indeed experiencing several crises, yet they see "ground for cautious optimism" (Copelovitch et al., 2020, p. 1123) that these are not leading to a collapse (Copelovitch et al., 2020; Eilstrup-Sangiovanni & Hofmann, 2020). The strongest threat is seen to come from the "erosion of the post-war 'permissive consensus'" (Eilstrup-Sangiovanni & Hofmann, 2020, p. 1085) by an increase in domestic national populism (Eilstrup-Sangiovanni & Hofmann, 2020; Hooghe, Lenz, & Marks, 2019). Building further on this framework, Kentikelenis and Voeten (2021) deliver a quantitative analysis of the legitimacy challenges of the LIO by using speeches at UN General Assembly as primary data. They find criticism of the LIO to be at an all time low, but shy away from using this evidence for a strong claim on the absence of a crisis. Instead, those scholars also point to contradicting qualitative evidence such as the critique of the order by Trump as well as the insufficient response of the LIO to the current pandemic. The question remains whether the methods employed in these quantitative analyses have sufficiently covered all aspects of the foundational principles and future research directions for improved operationalization and validity are suggested (Kentikelenis & Voeten, 2021, p. 748).

From the previous one can already see how current literature exhibits a dissent on the question of whether there can be a stable multipolar international order in the future. By decoupling American hegemony from the concept of the liberal order, some scholars expect the order to endure (Kentikelenis & Voeten, 2021; Eilstrup-Sangiovanni & Hofmann, 2020; Copelovitch et al., 2020), while e.g. Ikenberry proclaims that only an order led by liberal (and rather "social democratic and solidarist than neo-liberal" (Ikenberry, 2018, p. 23)) democracies can survive. He states that such a "bet on the future of the global liberal order is a little bit like a second marriage — a triumph of hope over experience" (Ikenberry, 2018, p. 22). An opposing and less romantic stance is taken by Mearsheimer who argues that "any ideological international order ... such as liberalism ... is destined to have a short life span" (Mearsheimer, 2019, p. 17) and expects the current order to collapse as a result of hyperglobalization and the power shift away from American hegemony. Instead, this scholar predicts a multipolar world with a realist international order and two competing bounded orders respectively led by the United States and China.

This notion leads to another debate in the literature, namely surrounding China's approach to and role within a new international order. Being a proponent of a western-led LIO, Ikenberry draws on similarities with the post-war United States. The scholar argues that China as a rising power has to practice restraint so not to create a backlash from its neighbours and will thus need to participate in international institutions and make itself "more predictable and approachable" (Ikenberry, 2011, p. 66). Weiss and Wallace (2021) deliver a more nuanced framework for China's behaviour in the international order. These scholars argue that domestic politics of authoritarian states will shape the extent of their international participation and follow that a "more minimalist version of then LIO" which allows for more "political and ideological diversity" (Weiss & Wallace, 2021, p. 659). At this point this debate feeds back into the previously discussed debate around the meaning of the word *Liberal* in Liberal International Order. In summary, there is no IR literature consensus on whether China will challenge the current LIO in a radical way (Lake et al., 2021, p. 242).

Although there is agreement that there are current challenges to the LIO, variety in the definition of the underlying concepts prevents a clear consensus whether this constitutes a crisis of the order itself or a crisis within the order driving another transformation. Even the extent of these challenges remains unclear. Qualitative analysis supported by mostly anecdotal empirical evidence (Eilstrup-Sangiovanni & Hofmann, 2020; Copelovitch et al., 2020) gives the scholars an impression of a threatened order such that the absence of evidence in a predominantly quantitative analysis is promptly relativized (Kentikelenis & Voeten, 2021, p. 747) by the authors themselves. Predictions about the future of the international order are varying as much as the employed approaches for such predictions: An approach based on historical analogies and hope (see quote above) suggests a resilient liberal order, while non-liberal alternative models seem to be ruled out simply because of the lack of precedence (Ikenberry, 2018). An examination of the status quo of leads some scholars to precautiously suggest the transformation towards a polycentric global order (Eilstrup-Sangiovanni & Hofmann, 2020; Copelovitch et al., 2020; Kentikelenis & Voeten, 2021). Lastly, unambiguous predictions about the future of the global order are made only by the proponent of offensive realism, Mearsheimer, who claims that we already live in an "emerging multipolar world" and expects "Chinese-led and U.S.-led bound orders" with a "rivalry that will have both economic and military dimensions" (Mearsheimer, 2019, p. 50).

2.2 Network Theory in International Relations

Network analysis is a mathematical approach to the mathematical modeling of complex systems. As such it has been employed in a broad spectrum of academic fields with international relations (IR) being no exception.

Recurring motifs in the use of network analysis in the field of IR studies are the measuring affiliation between countries and power of a country (Hafner-Burton et al., 2009). As opposed to using networks built on custom-made data such as membership in IGOs (Hafner-Burton et al., 2009, p. 563-566), trade data are a readily available source that are easily modeled as a network. Recent studies have investigated such data from different perspectives (Cepeda-López et al., 2019; Liu et al., 2020; Yan & Tang, 2021).

Trade flow data have a canonical way of mapping them onto networks, especially for the use of countries as nodes. However, there are variations in the modeling according to the respective study's thematic focus and employed methodology. While some scholars use aggregated flows (Cepeda-López et al., 2019; Bartesaghi et al., 2020), others built networks for a variety of trade sectors or groups of countries (Barigozzi et al., 2011; Yan & Tang, 2021).

Following the traditional network theoretical approach, some studies are focussed on network topology measures and try to connect their findings to real-world implications (Abbate et al., 2018; De Benedictis et al., 2014). Opposed to this, starting from a non-network theoretical concept, Yan and Tang (2021) analyze the correlation between a country's GDP and its centrality in the trade network. In an introductory article to a special edition of *Network Science* focussed on the analysis of globalization and multipolarity, De Lombaerde et al. (2018, p. 495-497) provide an overview of approaches to measure globalization, particularly in the context of network approaches.

Although the subject of community detection was not mentioned at all by (Hafner-Burton et al., 2009), since then there has evolved a second strain of literature relating to the international trade network concerned with the emergence of communities (Grassi et al., 2021; Bartesaghi et al., 2020; Zhu et al., 2014; Barigozzi et al., 2011).

3 Methodology

In this section, I first introduce basic network theoretical concepts relevant for this study, then describe the data sets and how they are processed and mapped onto a network model.

3.1 Network Analysis

Graph Model In its simplest form, a network (or graph) $G = (V, E)$ is a set of items, usually called *nodes* (or *vertices*) $v \in V$, with connections between them, called *links* (or *edges*) $e \in E$. Furthermore let $|V| = N$ and $|E| = L$. In the case of a simple graph, i.e. an unweighted, undirected network without self-loops or multiple connections between two nodes, the model can be described by the adjacency matrix

$A \in \{0,1\}^{N \times N}$ where $A_{ij} = 1$ if a link between node i and node j exists and $A_{ij} = 0$ otherwise. To account for weights in the network, e.g. the amount of trade volume between countries, and to differentiate between import and export, this model can be extended to a directed, weighted graph $G = (V, E, W)$. Such a graph has entries W_{ij} representing the weights of the links instead of the binary entries of A. Because it is directed W is not symmetric, i.e. $W_{ij} = W_{ji}$ does not hold in general.

Density One of the most basic network properties is the *network density* D: the ratio of edges that are present L to the maximum possible number of edges $\binom{N}{2}$ (Newman, 2010). It follows that

$$D = \frac{L}{\binom{N}{2}} = \frac{2L}{N(N-1)} \,. \tag{1}$$

Assortativity The *degree* k of a node is the number of links that it has to other nodes. One possibility to describe the *degree assortativity*, i.e. "the tendency for vertices in networks to be connected to other vertices that are like (or unlike) them in some way" (Newman, 2003), is to measure the covariance of the value pair (v_i, v_j), where v_i is the of node i, for all edges (i, j) in the network. The covariance will be positive if the degrees of both nodes of a link tend to be both large or both small and it will be negative when they tend to oppositional values. Normalizing by the maximum value of the covariance leads to the so-called *degree assortativity coefficient* (Newman, 2010)

$$r = \frac{\sum_{ij}(A_{ij} - v_i v_j / 2L) v_i v_j}{\sum_{ij}(v_i \delta_{ij} - v_i v_j / 2L) v_i v_j} \,. \tag{2}$$

I will use the symbol r because of its relation to the Pearson correlation coefficient. The degree assortativity coefficient is only dependent on the network structure and can be calculated solely from the knowledge of the adjacency matrix A. In this form it varies in value between a maximum of 1 for a perfectly assortative network and a minimum of -1 for a perfectly disassortative one; $r = 0$ indicates that the node degrees are uncorrelated. In this analysis, I will also use the weighted version *assortativity by strength* a_s (Newman, 2003; Cepeda-López et al., 2019).

Clustering The clustering coefficient is a measure of the probability that two neighbours of a vertex are linked themselves. A complete graph has perfect clustering and hence $c = 1$. I will also use the weighted version c_s as implemented in the package *NetworkX* (Hagberg et al., 2008).

Centrality The centrality is a measure for a single node in the network. In its simplest form, the *degree centrality* it is merely the number of connections of a node normalized over the number of nodes in the network (De Benedictis et al., 2014, p. 20). The *strength centrality* used in this analysis is an extension of the degree centrality by summing over the weights of all edges connected to the node instead of counting them. It follows that (De Benedictis et al., 2014)

$$C_s = \frac{\sum_{i \neq j}^{N} W_{ij}}{N - 1}\,. \tag{3}$$

Community Detection Another tool to discover and understand the structure of a network are community detection algorithms. Community detection is the search for groups of nodes that are naturally occurring in the network (Newman, 2010). It is an example of an unsupervised machine learning task as its goal is to classify unlabelled data by using structure in the data that we are initially unaware of. It is then the researcher's task to understand and determine the responsible features or processes for the observed partitioning. This is the promise of community detection: the potential to gain valuable insight into the central aspects that govern the function and evolution of the network by seeing its building blocks. Since community detection is unsupervised, there is no precise definition of what constitutes a community (Rosvall et al., 2019). Different community detection algorithms will therefore be reflecting different notions of what a community is.

Ultimately, this discussion of network structure is not an end in itself, but each pattern or anomaly on the level of networks should be understood as well in the language of the investigated system, in this case trade relations between states.

3.2 Data

As a globalization indicator, I am using the 'openness index', i.e. the world trade as a share of global GDP, as given in the Penn World Table (Feenstra, Inklaar, & Timmer, 2015). There are other possibilities to describe globalization, but I am focussing on this index as it is also derived from trade data and so in an accessible manner. Visualizing the Penn World Table data in figure 1 shows a steady rise in globalization in the second half of the past century and a stagnation for the last decade.

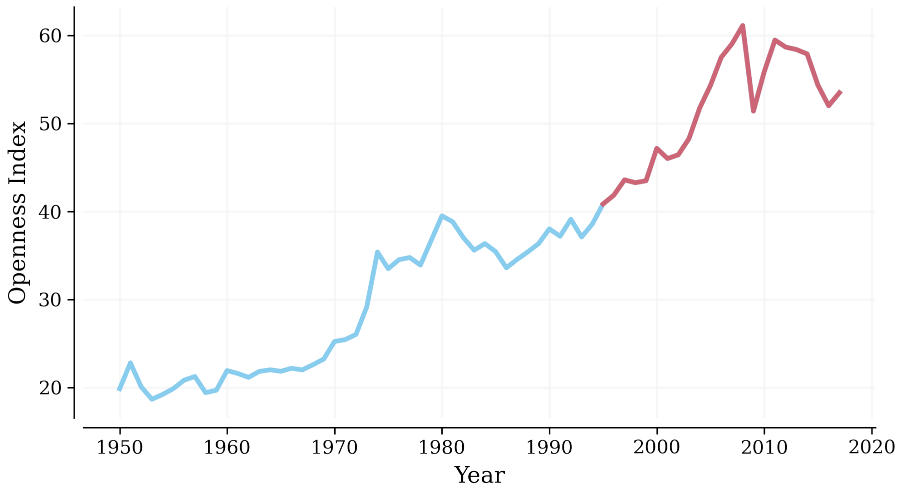

Figure 1: Globalization as measured by the Openness Index, i.e. world trade as a share of GDP. The blue section coincides with the time period for which the network data is available (1995-2017). The red section of the curve shows the prior development of this globalization index.

The primary data for the network model and the dependent variable comes from the United Nations ComTrade database[1]. However, since this database possesses missing values (De Benedictis et al., 2014), the study uses a curated version, the BACI[2] dataset (Gaulier & Zignago, 2010). This data includes the trade flows between countries by product category with the respective value of the trade flow (in thousands current USD) and its quantity (in metric tons) starting from 1995 up to 2017[3]. While it should be considered to collect data from prior years to better investigate the relationship between globalization and the trade network structure, the cost of collecting data of similar quality to this data set outweighs the added value for this preliminary analysis.

To get an indication for the adherence to a bounded order, the relative importance of the trade ties is more relevant than their absolute monetary values. I propose to use a directed network model where the nodes represent countries and an outgoing edge between two nodes represents the share of trade (export and import) relative

[1] `https://comtrade.un.org/`

[2] "Base pour l'Analyse du Commerce International": Database for International Trade Analysis.

[3] For a description of the raw data set see `http://www.cepii.fr/DATA_DOWNLOAD/baci/doc/DescriptionBACI.html`.

to the total share of the country's trade volume in which the edge originates. The temporal reference frame for the calculation of the trade volume are years, meaning that a network is created for every year in the data set. It is important to note that hence the direction of the edges does not coincide with a trade flow or economic dependency, as would be the case in conventional trade flow networks. Grassi et al. (2021) use a similar network model also based on the BACI data set, however, their edge weights "represent the amount of product trades between couple of countries expressed in US dollars" (Grassi et al., 2021, p. 719), i.e. in absolute value as opposed to the rescaled weights employed in this study. By choosing this representation the absolute value of trade volume will not affect the measure of multipolarity through bias in the edge weights. Likewise, to avoid systematic bias through the addition of nodes to the network, I will analyze only the subset of nodes that are present in every analyzed year, ignoring states that are newly added to or being dropped from the data set[4]. After this data processing, the sample contains 206 states. This number is artificially high since there are some 'edge cases', e.g. unincorporated territories American Samoa, that are shown as separate states. For subsequent analyses, further manual adjustments are needed to minimize the effects of such edge cases.

As some algorithms in open-source packages such as *NetworkX* are not readily implemented for the case of directed networks, further simplification of the model is needed at this first stage of the analysis. Thus, to use an undirected graph model, but still leverage the concept of relative importance, I will average over the directed edge weights between to create an undirected first order approximation of the initially proposed directed model.

4 Empirical Analysis

I first investigate the basic network structure of the proposed networks models, relying on standard structural measures. In the second subsection, I analyze the role of China and the USA in the networks in terms of centrality. Lastly, in the final subsection, I turn to community detection algorithms to introduce a way to measure multipolarity.

[4] The list of ignored states is given in the code for this analysis at `https://github.com/heissjl/gp-lio-network`.

4.1 Basic Network Properties of the WTN

The basic structural properties of the world trade network are summarized in table 1. The order of magnitude of the network density is consistent with prior literature with differences due to variation in preprocessing of the data (Cepeda-López et al., 2019). The clustering coefficient and the assortativity coefficient by strength cannot be compared to previous literature because the weights in this study are uniquely chosen. Noteworthy is the big difference in network density for the very last year, 2017. Since density has been steadily rising for the prior years this could hint at a data problem, but further investigation is needed to be certain. Until such, this data point is treated as an outlier.

Table 1: Summary of basic structural measures for the world trade network. The measures are number of edges L, density D, weighted clustering coefficient c_s, and assortativity by strength a_s. The network size is $N = 206$ for all years.

Year	L	D	c_s	r_s
1995	10328	0.48	0.0095	−0.10
1996	11059	0.52	0.0093	−0.097
1997	11748	0.55	0.0090	−0.092
1998	12047	0.57	0.0088	−0.083
1999	12285	0.58	0.0083	−0.080
2000	13324	0.63	0.0072	−0.068
2001	13642	0.64	0.0071	−0.070
2002	13848	0.65	0.0070	−0.070
2003	14159	0.67	0.0069	−0.063
2004	14406	0.68	0.0067	−0.065
2005	14523	0.68	0.0069	−0.067
2006	14735	0.69	0.0069	−0.064
2007	15000	0.71	0.0071	−0.067
2008	15042	0.71	0.0068	−0.073
2009	15043	0.71	0.0068	−0.066
2010	15292	0.72	0.0068	−0.063
2011	15353	0.72	0.0067	−0.062
2012	15438	0.73	0.0067	−0.064
2013	15501	0.73	0.0068	−0.064
2014	15367	0.72	0.0071	−0.065
2015	15439	0.73	0.0072	−0.064
2016	15327	0.72	0.0071	−0.065
2017	12483	0.59	0.0088	−0.11

In the WTN a disassortativy implies that trade hubs tend to be linked with countries which are less well-connected rather than to be linked with other hubs (Abbate et al., 2018). Thus, while not directly a measure of multipolarity, a high disassortativy would give an indication of non-cooperating hubs or poles.

In figure 2 one can see the assortativity by strength for this network model of the WTN. Although being negative, the absolute value of the assortativity coefficient is close to zero and over time and with higher levels of globalization approaching a plateau between $a_s = -0.06$ and $a_s = -0.07$. There is correlation with the globalization index, but no immediate explanation for the plateau effect. However, this could be an artifact due to the averaging over the edge weights. Before discarding this measure, one should investigate the assortativity by strength for the directed graph model, considering only incoming or outcoming edges respectively.

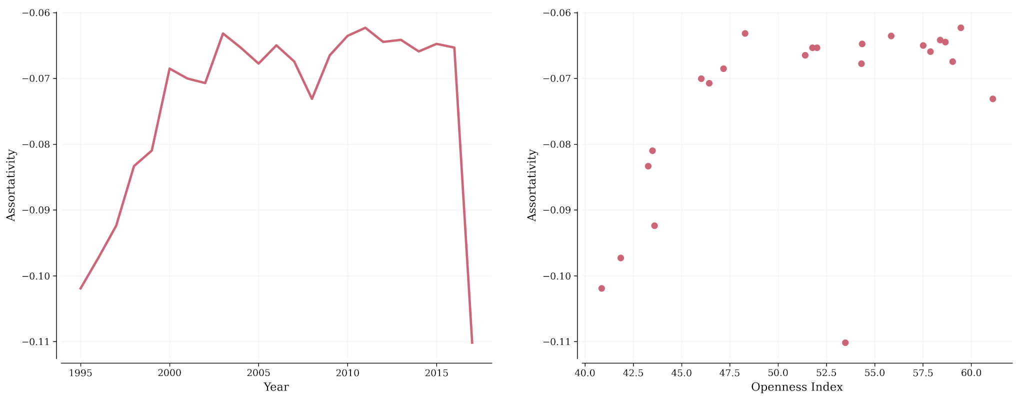

Figure 2: Assortativity by strength for the WTN. The left panel shows the evolution of the assortativity over time. The right panel shows the correlation between assortativity and the Openness Index.

The analysis of the clustering coefficient paints a similar picture, as can be seen in figure 3. While the unweighted clustering coefficient is strongly related to the density and increases in a linear manner up to 2016 (see table 1, the values for the weighted coefficient converge to a plateau. In fact, measures c_s and r_s are heavily correlated for this data with a Pearson correlation coefficient of $r_P = -0.86$.

Globalization drives the size and density of the network by introducing more links. The structural measures are heavily correlated to this change in the unweighted case. Controlling for the relative importance of the trade ties by introducing edge weights alters the results significantly. Although still correlated with globalization, the weighted measures no longer exhibit a linear relationship. Obviously more data and more investigation is needed, but it seems that controlling for weights dampens the influence of globalization on the structure of the model. Such a scaling in size at similar properties hints at an underlying building principle of the network, e.g. according to the model of preferential attachment[5]. Further analysis needs to compare the empirical results to theoretical models.

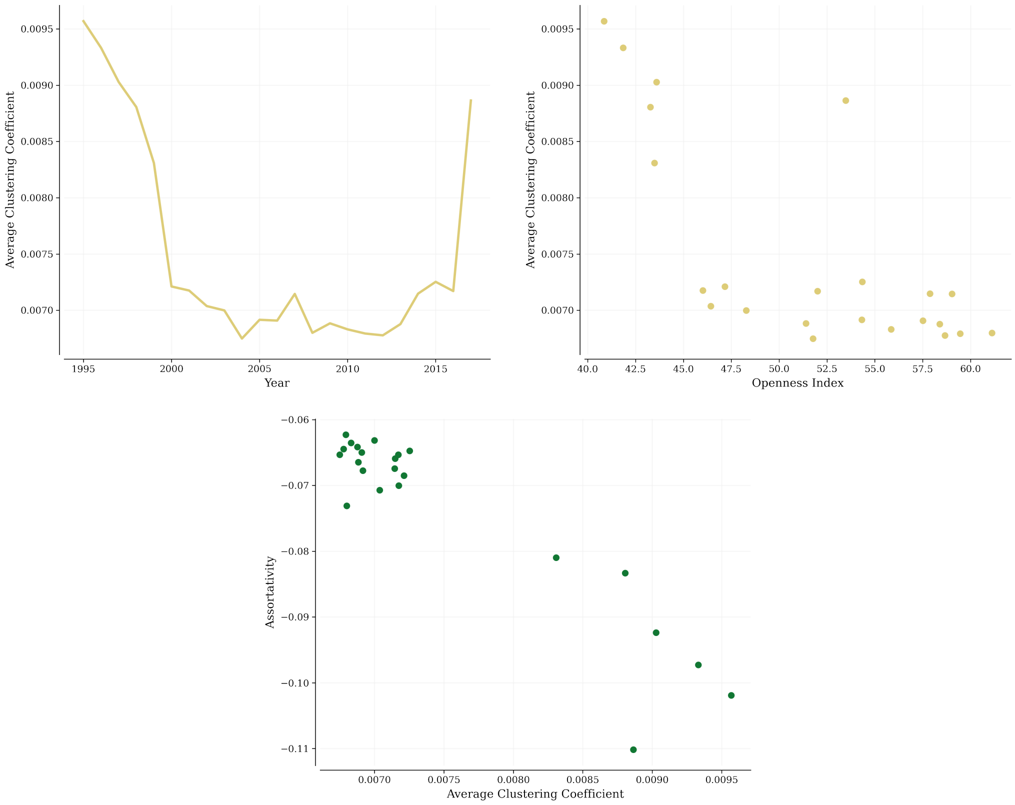

Figure 3: Average clustering coefficient for the WTN. The upper left panel shows the evolution of the assortativity over time. The upper right panel shows the correlation between assortativity and the Openness Index. The bottom panel shows the correlation between the assortativity and clustering coefficient.

4.2 Centrality

The strength centrality for China and the USA are shown in figure 4. The developments over time in the left panel underline the prevailing view of the increasing importance of China and the simultaneous decrease in American power. This suggests that in the analyzed time frame China has increased its overall importance as a trade partner. When plotting the centralities against the Openness Index, a

[5]For an introduction to preferential attachment models, see e.g. Newman (2001)

similar picture emerges: a decline of USA's centrality and an increase for China. This finding should not be used as strong evidence, but it is nonetheless consistent with the hypothesis when thinking of USA and China as two competing poles in the global order. If globalization leads to bound orders as predicted by Mearsheimer (2019), then their relative importance within the overall trade network should converge towards a similar value as seen here.

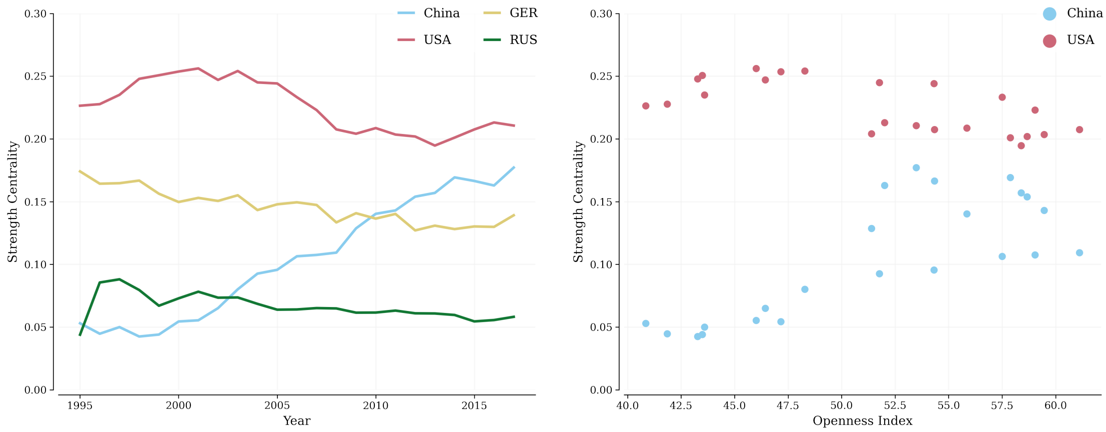

Figure 4: Strength Centrality of China and USA. The left panel shows the evolution of the centrality over time with the centralities of Germany and Russia as context. The right panel shows the correlation between centrality and the Openness Index.

4.3 Communities

In the following, I propose two approaches to investigate the correlation between globalization and multipolarity of the global order in the framework of network communities.

First, one can manually define communities that represent hypothesized bound orders based on additional data that reflects cooperation, e.g. bilateral treaties. One can then track how the closeness within this community and the distance from other communities changes with the levels of globalization. This supervised methods allows to confirm educated guesses on the future of the global order. I do not pursue this approach because I am missing such an educated guess to go forward with it.

Second, most community detection algorithms are sectioning the network according to a predefined number of communities. There are however Bayesian approaches that enable estimation of a posterior probability for the number of communities

(Peixoto, 2014b; Newman & Reinert, 2016). One can use these unsupervised algorithms such as to infer the most likely number of communities in the networks and track this number over all generated networks. If gloablization has an effect on the economic dimension of multipolarity, this metric should be positively correlated with the globalization index.

Figure 5 gives an example of the partition result of the 1996 and 2016 networks. The employed Nested Stochastic Block Model algorithm by the scholar Peixoto also allows for multiple vertical levels in the partition (Peixoto, 2014a, 2014b). The USA and China are both times in the same community which is not a surprising result since they are important trade partners. The edge weight has gone up from 0.51 to 0.75 in these two decades. The number of communities has gone down from 7 in 1996 to 6 in 2016. These results are preliminary and only single data points in time. Because of this lack of significance, I will restrain myself at this point from interpreting them in a sense that underlines or rejects the hypothesis. Lack of time and computational power prevented further investigation, especially into the explanation of the community structure itself. Does the algorithm capture a core-periphery structure with industrial nations in one group? Do the communities reflect geographic positions? Such questions need to be answered next. Yet, this analysis can be seen as a proof of concept for the measurement of multipolarity of the global order through the application of community detection.

5 Conclusion

By leveraging the BACI data set, I showed how the economic dimension of the global order, i.e. trade relations between countries, can be modeled and analyzed in a network theoretical framework, in a manner similar to previous studies (see Cepeda-López et al., 2019; Grassi et al., 2021; De Benedictis et al., 2014; Abbate et al., 2018). To test how globalization drives multipolarity or affects a country's affiliation to a bounded order, the model used relative trade strengths. The level of globalization was modeled by the value of world trade as a share of GDP, also known as the Openness Index. Future analysis should dig deeper into different representations of the concept of globalization and take into account different network model types and different representations.

The empirical analysis of structural properties of the network as a whole and the role of China and the USA does not give a strong indication for an effect that

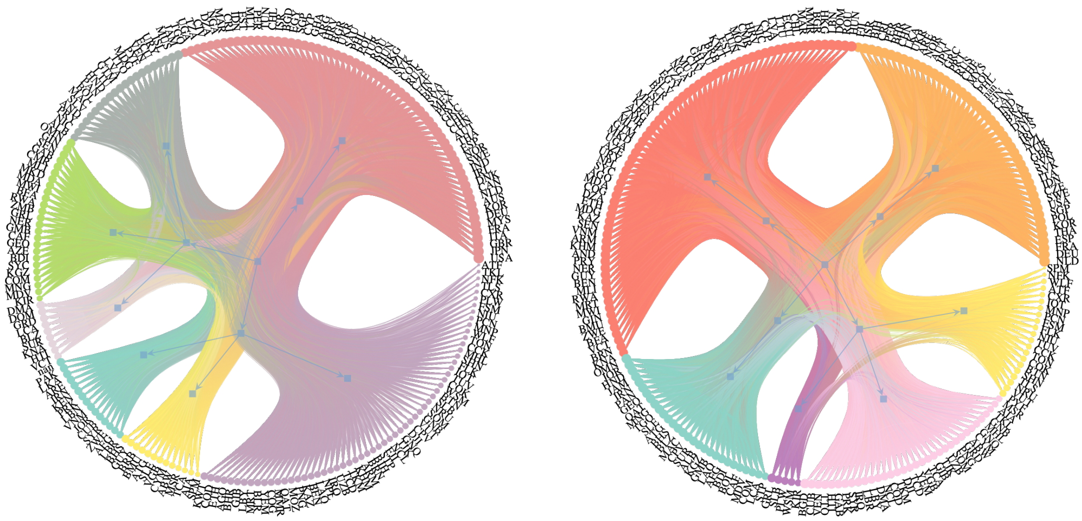

Figure 5: Partitioning of the WTN into communities for the 1996 and 2016 networks. The nested block model algorithm yields a multilevel description of the community structure. Colors of the communities do not translate from one plot to the other. Country names are given according to the ISO 3166-1 alpha-3 coding scheme. Germany, USA and China are both times in the same community in the upper right quadrant. At the lowest hierarchy the 1996 network is partitioned into 7 communities, while the 2016 only shows 6 communities.

is purely driven by an increase in globalization. Most structural change seems to be due to the increased density of the WTN, i.e. countries taking up new trade relations. However, this should be understood as a side effect of the early stage of globalization, as this effect will come to a halt once the WTN is quasi-complete.

At first glance, the findings in the analysis are not particularly surprising. Some measures, such as the centrality, are even closely related to traditional trade statistics (De Benedictis et al., 2014). But adapting the underlying model allows using tools from network analysis for different emphases. In this case, focus on relative trade strengths allowed to investigate closeness of trade partners instead of on mere economic power in the trade network. Additionally, using established methods allows for reliable, reproducible results.

Finally, I proposed two approaches for leveraging community detection to measure multipolarity. Because of lack of time, I only implemented the proof of concept for the estimation of the number of communities in the WTN. The resulting community affiliations by using this method are yet to be explained in more detail. The other approach of using pre-defined communities is particularly useful to avoid the problem that community detection is an unsupervised learning method.

All of the results are preliminary: more data is needed to better investigate the correlation with the globalization level and a more detailed preprocessing of data needs to be done to exclude the possibility that the registered effects are caused by data artifacts.

With this analysis, I motivated the more extensive use of data-based methods, in particular methods from network science, to induce a further empirical shift in the study of the global order.

References

Abbate, A., De Benedictis, L., Fagiolo, G., & Tajoli, L. (2018). Distance-varying assortativity and clustering of the international trade network. *Network Science*, *6*(4), 517–544. doi:10.1017/nws.2018.7

Amadi, L. (2020). Globalization and the changing liberal international order: A review of the literature. *Research in Globalization*, *2*, 100015. doi:10.1016/j.resglo.2020.100015

Barigozzi, M., Fagiolo, G., & Mangioni, G. (2011). Identifying the community structure of the international-trade multi-network. *Physica A: Statistical Mechanics and its Applications*, *390*(11), 2051–2066. doi:10.1016/j.physa.2011.02.004

Bartesaghi, P., Clemente, G. P., & Grassi, R. (2020). Community structure in the World Trade Network based on communicability distances. *Journal of Economic Interaction and Coordination*. doi:10.1007/s11403-020-00309-y

Cepeda-López, F., Gamboa-Estrada, F., León, C., & Rincón-Castro, H. (2019). The evolution of world trade from 1995 to 2014: A network approach. *The Journal of International Trade & Economic Development*, *28*(4), 452–485. doi:10.1080/09638199.2018.1549588

Copelovitch, M., Hobolt, S. B., & Walter, S. (2020). Challenges to the contemporary global order. Cause for pessimism or optimism? *Journal of European Public Policy*, *27*(7), 1114–1125. doi:10.1080/13501763.2019.1678666

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), 287–343. doi:10.1515/gej-2014-0032

De Lombaerde, P., Iapadre, L., Mccranie, A., & Tajoli, L. (2018). Using network analysis to study globalization, regionalization, and multipolarity—Introduction to special section. *Network Science*, *6*(4), 494–516. doi:10.1017/nws.2018.25

Eilstrup-Sangiovanni, M., & Hofmann, S. C. (2020). Of the contemporary global order, crisis, and change. *Journal of European Public Policy*, 14. doi:10.1080/13501763.2019.1678665

Feenstra, R. C., Inklaar, R., & Timmer, M. P. (2015). The next generation of the penn world table. *American economic review*, *105*(10), 3150–82. doi:10.15141/S5Q94M

Gaulier, G., & Zignago, S. (2010). BACI: International Trade Database at the Product-Level (the 1994-2007 Version). *SSRN Electronic Journal*. doi:10.2139/ssrn.1994500

Grassi, R., Bartesaghi, P., Benati, S., & Clemente, G. P. (2021). Multi-Attribute Community Detection in International Trade Network. *Networks and Spatial Economics*, *21*(3), 707–733. doi:10.1007/s11067-021-09547-4

Hafner-Burton, E. M., Kahler, M., & Montgomery, A. H. (2009). Network Analysis for International Relations. *International Organization*, *63*(3), 559–592. doi:10.1017/S0020818309090195

Hagberg, A., Swart, P., & S Chult, D. (2008). *Exploring network structure, dynamics, and function using networkx* (Tech. Rep. No. LA-UR-08-05495; LA-UR-08-5495). Los Alamos National Lab. (LANL), Los Alamos, NM (United States).

Hooghe, L., Lenz, T., & Marks, G. (2019). Contested world order: The delegitimation of international governance. *The Review of International Organizations*, *14*(4), 731–743. doi:10.1007/s11558-018-9334-3

Ikenberry, G. J. (2001). *After victory: Institutions, strategic restraint, and the rebuilding of order after major wars*. Princeton: Princeton University Press.

Ikenberry, G. J. (2009). Liberal Internationalism 3.0: America and the Dilemmas of Liberal World Order. *Perspectives on Politics*, *7*(1), 71–87. doi:10.1017/S1537592709090112

Ikenberry, G. J. (2011). The Future of the Liberal World Order: Internationalism After America. *Foreign Affairs*, *90*(3), 56–68.

Ikenberry, G. J. (2018). The end of liberal international order? *International Affairs*, *94*(1), 7–23. doi:10.1093/ia/iix241

Kentikelenis, A., & Voeten, E. (2021). Legitimacy challenges to the liberal world order: Evidence from United Nations speeches, 1970–2018. *The Review of International Organizations*, *16*(4), 721–754.

Lake, D. A., Martin, L. L., & Risse, T. (2021). Challenges to the Liberal Order: Reflections on International Organization. *International Organization*, *75*(2), 225–257. doi:10.1017/S0020818320000636

Liu, C., Xu, J., & Zhang, H. (2020). Competitiveness or Complementarity? A Dynamic Network Analysis of International Agri-Trade along the Belt and Road. *Applied Spatial Analysis and Policy*, *13*(2), 349–374. doi:10.1007/s12061-019-09307-5

Mazarr, M. J. (2017). *Measuring the health of the liberal international order*. Santa Monica, CA: RAND.

Mearsheimer, J. J. (2019). Bound to Fail: The Rise and Fall of the Liberal International Order. *International Security*, *43*(4), 7–50. doi:10.1162/isec_a_00342

Newman, M. E. J. (2001). Clustering and preferential attachment in growing networks. *Physical Review E*, *64*(2), 025102. doi:10.1103/PhysRevE.64.025102

Newman, M. E. J. (2003). Mixing patterns in networks. *Physical Review E*, *67*(2), 026126. doi:10.1103/PhysRevE.67.026126

Newman, M. E. J. (2010). *Networks: An Introduction*. Oxford University Press.

Newman, M. E. J., & Reinert, G. (2016). Estimating the number of communities in a network. *Physical Review Letters*, *117*(7), 078301. doi:10.1103/PhysRevLett.117.078301

Peixoto, T. P. (2014a). The graph-tool python library. *figshare*. Retrieved 2014-09-10, from `http://figshare.com/articles/graph_tool/1164194` doi:10.6084/m9.figshare.1164194

Peixoto, T. P. (2014b). Hierarchical Block Structures and High-Resolution Model Selection in Large Networks. *Physical Review X*, *4*(1), 011047. doi:10.1103/PhysRevX.4.011047

Reus-Smit, C. (2013). The Liberal International Order Reconsidered. In R. Friedman, K. Oskanian, & R. P. Pardo (Eds.), *After Liberalism? The Future of Liberalism in International Relations* (pp. 167–186). London: Palgrave Macmillan UK. doi:10.1057/9781137303769_10

Rosvall, M., Delvenne, J.-C., Schaub, M. T., & Lambiotte, R. (2019). Different Approaches to Community Detection. In *Advances in Network Clustering and Blockmodeling* (pp. 105–119). John Wiley & Sons, Ltd. doi:10.1002/9781119483298.ch4

Weiss, J. C., & Wallace, J. L. (2021). Domestic Politics, China's Rise, and the Future of the Liberal International Order. *International Organization*, *75*(2), 635–664. doi:10.1017/S002081832000048X

Yan, X., & Tang, Q. (2021). Network analysis regarding international trade network. *arXiv:2111.02633 [econ, q-fin]*.

Zhu, Z., Cerina, F., Chessa, A., Caldarelli, G., & Riccaboni, M. (2014). The Rise of China in the International Trade Network: A Community Core Detection Approach. *PLoS ONE*, *9*(8), e105496. doi:10.1371/journal.pone.0105496