Stability of Trading Blocs

Shotaro Beppu

August 2021

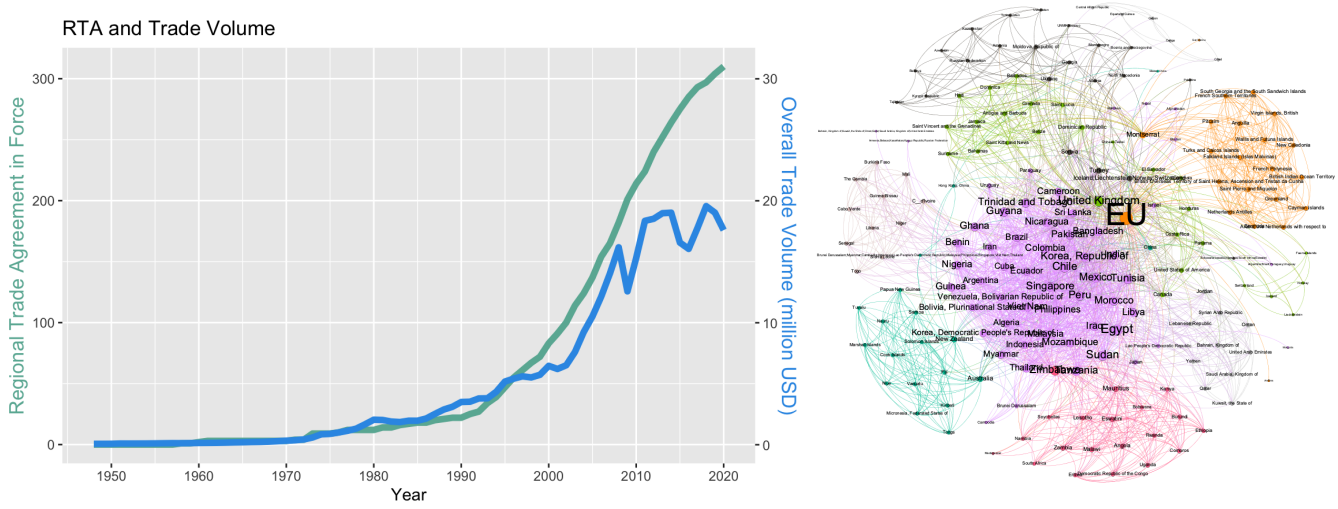
Abstract

In recent decades the world has seen an increasing number of regional trade agreements in force. Coinciding with increasing tariffs between the US and China, whether this phenomenon promotes protectionism whereby countries trade less with countries outside or functions as a stepping stone for global free trade is a central concern for answering how international trade evolves in the future. This paper gives insight for answering this question by investigating the stability of such regional trading blocs. Inspired by research in the theory of strategic network formation, the model formulated in this paper shows that, contrary to main findings from canonical models, trading blocs are stable in possibly many cases. The results imply that the importance of countries not belonging to trading blocs will increase its importance in the future. Furthermore, changes induced by globalisation do not necessarily lead to global free trade.

[1]I thank my supervisor Dr George Charlson for much useful advice. I am also grateful to my Director of Studies Dr Geeta Kasanga and other members of International Programmes Department team at Pembroke for the support. Note that any wrongdoings in this paper are solely my responsibility.

1 Introduction

In recent decades, regional trade agreements in force have been increasing (figure 1a/A3). Correspondingly, the number of countries involved in regional trade agreements have increased and the trade agreement network has become dense (figure 1b/A4). This raises the question of whether these regional trade agreements are stable. In other words, will the increase in the number of countries involved in regional trade agreements eventually lead to global free trade? The question has been one of the central questions in the international trade literature yet the question seems more important today as the trade conflict between the US and China has intensified and more quantitative works are being conducted (Fajgelbaum et al. (2020) for example). Whether the current trade agreements will emphasize protectionism and be more exclusive, and if so, whether those trading blocs are sustainable for a long time is thus a particularly important topic and motivates more theoretical work.



(a) Overall Statistics

(b) Current Trade Agreements

Figure 1: Regional Trade Agreements in force and Trade Volume

source WTO (2021)

For further investigation, inspired by the work of strategic network formation, specifically Goyal and Joshi (2006), this paper created a model where there exist many countries and for each country a firm that operates on both domestic and foreign markets. How many firms can operate are determined by tariffs set by the importing countries and countries are allowed to form bilateral trade agreements or regional trade agreements and thereby lower tariffs to facilitate trade. Countries trade so as to maximize their social welfare defined by the sum of consumer surplus and firm profit from their domestic market, firm profits in foreign markets, and tariff revenue. In order to analyze the stability of regional trading blocs the notion of stability was introduced. In addition, this paper introduces a partition of countries into trading blocs whereby tariff levels are zero within the trading bloc. Stable trading blocs implies that there will be no country that wants to leave its trading bloc.

In this setting, the signing of trade agreements impact countries directly in three ways. First, as the country signs more trade agreements, the consumer surplus will increase due to more competition and total output as foreign countries participate in the domestic market. Next, its firm will decrease its revenue in its domestic market due to increased competition. Lastly, the firm will also increase its profit due to larger foreign markets. In addition, there exists an

indirect effect whereby other countries are affected by the introduction of another firm in a different market to theirs. Both direct and indirect effects of trade agreements can be well-captured by network analysis. The paper finds the following when there are two mutually exclusive networks, i.e, two trading blocs. First, trade blocs are unstable even if the two trading blocs imposes an unrealistically severe condition to sustain its trading bloc; namely, a country is severed from all trade if it joins the other trading bloc. This suggests it is difficult to attain stable trade networks solely by imposing severe conditions for leaving. Following this result, the paper finds that introducing fixed utility derived just by trading or some sort of friction between trading blocs are, given some condition, enough for trading blocs to stabilize. The paper also finds that these effects can be close to null as the number of countries in the setting increases for trading blocs to be stable. These results give some insights as follows. One is that neutral countries will become more important in these trading bloc cases. Related, regional trading blocs do not necessarily lead to global free trade nor complete segregation of countries. Lastly, the effect of globalization in changing trade patterns is influenced by two opposing effects; the direction of which is uncertain. The main contribution of this paper is that it has added a new perspective on regional trading blocs by the methodology of network formation.

The paper is structured as follows. Section 2 is an overview of the results and methodology of analysing regional trade agreements. Section 3 defines the model. Section 4 presents the basic result concerning the stability of regional trade. Section 5 is the main results concerning the reasons which trading bloc are possibly stable. Section 6 suggests the implication of this result. Section 7 concludes.

2 Literature Review

This paper is related to two intersecting fields in economics: network theory and international trade. In addition, literature has also explored international trade from the political economy perspective. First, network theory has been applied to trade theory as networks can describe trade networks and supply chains. Correspondingly, many descriptive studies using network analysis were conducted in the past not limited to economic journals (Lombaerde et al. (2018), Benedictis and Tajoli (2011), Bhattacharya et al. (2008), Mahutga (2006)). However, more importantly to this paper, it has also given insights to trade formation and whether global free trade or regional trade blocs are stable. Trade theory can be a direct application of strategic network formation as in Jackson and Wolinsky (1996) whereby trade agreements are formed based on their welfare and cost. One notable literature in terms of this is Goyal and Joshi (2006), which this paper has referenced heavily. This paper created a network with many countries and introduced tariffs between countries. Namely, the paper considered each country's market as nodes and trade agreements as edges that allow trade between the two markets. Their main finding is that bilateral trade agreements lead to a complete network with all countries or all countries except one. This paper was followed by papers such as Furusawa and Konishi (2007) where heterogeneous market/sector size and differentiated goods were introduced to argue that global free trade may not be attainable in the case of asymmetric countries. The theory was also tested empirically by Chen and Joshi (2010) which confirmed the importance of other countries in forming trade agreements. The dynamics of this model were investigated by Zhang et al. (2014). This paper considers the model used in Goyal and Joshi (2006) as a canonical model and, in light of the prevalence of regional trade agreements in contrast to the general result Goyal and Joshi (2006) obtained, investigates possible reasons and consequences of the regional trade agreements. Furthermore, the analysis here is connected to the application of network theory in trade general. It connects to the study of supply chains whereby there are multiple firms in each country Ostrovsky (2008). Secondly, since this paper is interested in partitions of

countries in general it connects to hedonic games which seek to find the equilibrium conditions for disjoint network as in Bogomolnaia and Jackson (2002).

The second field is international trade. As exemplified in Bhagwati and Panagariya (1996), whether preferential trade agreements act as "building blocks" or "stumbling blocks" for global free trade has been one of the central questions ever since the work of Viner (2014). Hence, we observe at least two main strands in the analysis; one is theoretical and the other is empirical. Starting from literature such as Kemp and Wan (1976) and Ethier (1998), it is argued that custom unions or regional trade agreements can exist and enhance the welfare or lead to global free trade. Related to this paper, Baldwin (1993) used political equilibrium to show that as regional trading agreements become larger, more countries would want to join, i.e, the domino effect. However, there also exist papers such as Krugman (1989) which argued that as the world gets divided into trading blocs the overall welfare decrease and this is minimized at three trading blocs. Hence it motivates for when regional trade agreements can be beneficial. In relation to stability, Yi (1996) finds that different rules by custom unions, namely free to join or exclusive, determine whether regional trade agreements are stable and pave the road for global free trade. Similarly, Bond et al. (2004) show that regional free trade incentivise members to lower external tariffs. From a dynamic perspective, Bagwell and Staiger (1997) show that liberal multilateral trade policies can be restored after an initial setback by the signing of regional trade agreements. Other papers deal with the conditions for regional trade agreements by introducing asymmetries (Hadjiyiannis (2004), Saggi (2006), Aghion et al. (2007), Saggi et al. (2010), and Saggi et al. (2013)). The other strand in research on trade agreements is empirical analysis. Estevadeordal et al. (2008) showed, using data from Latin America, that negative effect of preferential liberalization on external trade liberalization are unfounded. Yet, a couple of papers point towards the contrary. Conconi et al. (2018) argues that NAFTA led to a sizable reduction in imports of intermediate goods from third countries relative to NAFTA partners. In addition, Limao (2006) finds that "stumbling blocks" is present from US tariff data. Based on the literature, this paper gives conditions in which, even in the symmetric case, regional trade agreements are stable and likely hinders the probability of free trade.

Lastly, there exists a wide range of literature on the reasons for regional trade agreements or, in other words, the reasons for no global free trade. Baldwin (1989) gives an overview at that time and categorized government reasons into two: economic self-interest and social concern. The former likely belongs to the literature provided above where countries consider its economic benefit. For the latter, one example could be security externalities in terms of power relations between countries (general studies such as Gowa and Mansfield (1993) and Liu and Woo (2018) for China-USA trade war specifically). Another Example could be a disproportional distribution of benefits from trade such that median voters will oppose multilateral agreements after regional trade agreements (Levy (1997)). It could also be that interest groups form alliances in order to protect its rent via activities such as lobbying (Baldwin (1989), Krishna (1998), Stoyanov and Yildiz (2015), and Grossman and Helpman (1995)). Lastly, Berger et al. (2013) arguing that the CIA and the political influence associated with the institution led to a dramatic increase in exports of US goods suggest these trade formations might be hugely influenced by huge nations. These insights were used in this paper for possible interpretations of the results which are explored in subsequent sections.

3 Model

The model follows the setting of Goyal and Joshi (2006). For this setting, we have N countries, each of which has a single firm that can operate on both domestic and foreign markets. However, the firms can operate in foreign markets in so far as the tariffs on their exports, which are set by

each country, are low enough. Free Trade Agreement (FTA) is one extreme where if two countries have bilaterally agreed to sign an FTA, these two countries offer each other a tariff-free market. Another extreme is where countries do not trade with each other because of high tariffs. The subsequent model explores how the distribution of FTA and other factors affect the global trade network formation.

3.1 Network Environment

Let $\mathbf{\Omega} = \{1, 2, ..., N\}$ denote a finite set of countries. For any $i, j \in \mathbf{\Omega}$, we denote $g_{ij} = 1$ if FTA is established between countries i and j while $g_{ij} = 0$ if FTA is not. By definition, $g_{ij} \in \{0, 1\}$ and for any $i, j \in \mathbf{\Omega}$, $g_{ii} = 1$ and $g_{ij} = g_{ji}$.

A *network*, $g = \{(g_{ij})_{i,j\in\mathbf{\Omega}}\}$, is a formal description of the FTAs that exist between the countries in $\mathbf{\Omega}$. Let $\mathbf{G}$ denote all the possible shapes of the network and we denote a *complete network* as g^c which satisfies $g_{ij} = 1\ \forall i, j \in \mathbf{\Omega}$ and an *empty network* as g^e where $g_{ij} = 0\ \forall i, j \in \mathbf{\Omega}$. In addition, let $g + g_{ij}$ and $g - g_{ij}$ denote the network whereby we replace $g_{ij} = 0$ with $g_{ij} = 1$ for the former and vice versa for the latter. In this context, the former means that the country i and j agreed on an FTA while the latter implies that the FTA broke up.

Let $E(g) = \{i \in \mathbf{\Omega} |\ \exists j \neq i, g_{ij} = 1\}$ which is the set of countries that are involved in at least one FTA. Therefore, $E(g^c) = \mathbf{\Omega}$ and $E(g^e) = \emptyset$. Similarly let $E_i(g) = \{j \in \mathbf{\Omega} | g_{ij} = 1\}$, denote the set of countries with whom i has an FTA in the trade network g. Furthermore, let $\eta_i(g) = |E_i(g)|$, which denotes the number of countries in each of these sets.

Finally, the paper introduces a couple of notations common in the network literature. There exists a *path* in g between countries i and j if either $g_{ij} = 1$ or there exists a distinct set of countries $\{i_1, i_2, ..., i_n\} \subset E(g)$ such that $g_{ii_1} = g_{i_1 i_2} = ... = g_{i_n j} = 1$. A network is *connected* if there exists a path between any pairs of countries; otherwise, the network is *unconnected*. In addition, a network $g' \subset g$ is a *component* of g if for all $i, j \in E(g'), i \neq j$, there exists a *path* in g' connecting i and j and for all $i \in E(g')$ and $j \in E(g)$, $g_{ij} = 1$ implies $g_{ij} \in g'$. A component is *complete* if $g_{ij} = 1\ \forall i, j \in E(g')$.

3.2 Competitive Environment

To aid the analysis of trading blocs, this paper introduces new notations to Goyal and Joshi (2006). Namely, let $x, y \in \mathbf{\Omega}$ denote specific countries which have the potential to form a trading bloc centred around itself. Concrete examples might be China, the U.S, and the EU. Denote $\Phi_x(g) \subset \mathbf{\Omega}$ and $\Phi_y(g) \subset \mathbf{\Omega}$ where $\Phi_x(g) \cap \Phi_y(g) = \emptyset$. In the case of $\Phi_x(g) \cup \Phi_y(g) = \mathbf{\Omega}$, this is a division of N countries into two disjoint sets. Using this notation, $g + g_{i\Phi_x}$ and $g + g_{i\Phi_y}$ are the network whereby country i will form a trade relationship with all the countries in $\Phi_x(g)$ and $\Phi_y(g)$ respectively. In addition, denote $X(g) = \{i \in \mathbf{\Omega} |\ \exists j \neq i, g_{ix} = 1\}$ which is the set of countries that have a trade agreement with x and likewise for $Y(g)$ for y. Furthermore, let $X_i(g) = \{j \in \mathbf{\Omega} | g_{ij} = 1 \cap g_{jx} = 1\}$ for the set of countries which has a FTA with both country x and i, and for y, $Y_i(g) = \{j \in \mathbf{\Omega} | g_{ij} = 1 \cap g_{jy} = 1\}$. Similar to the notation of $\eta_i(g)$, let $\eta^x(g) = |X(g)|, \eta^x_i(g) = |X_i(g)|, \eta^y(g) = |Y(g)|$, and $\eta^y_i(g) = |Y_i(g)|$.

From these notations regional trade agreements, or regional trade blocs, is defined as follows; let $B_x(g) = \{i \in \Omega | g_{ij} = 1\ \exists j \in \Phi_x(g) \wedge g_{ik} = 0\ \forall k \in \Phi_y(g)\}$ denote the set of countries in a trading bloc of nation x and likewise $B_y(g) = \{i \in \Omega | g_{ij} = 1\ \exists j \in \Phi_y(g) \wedge g_{ik} = 0\ \forall k \in \Phi_x(g)\}$ denote the set of countries in a trading bloc of nation y. Thus, in an environment where $\Phi_x(g) \cup \Phi_y(g) = \mathbf{\Omega}$, we have two *unconnected* networks. This implies that a country in a trading bloc does not trade with another trading bloc. Let the trading network the country x is in as g_x and for the bloc the country y is in as g_y and from the definition, g_x and g_y are components of g and $B_x(g) \cap B_y(g) = \emptyset$.

Furthermore, for the main analysis, the paper defines *punishment* as follows; without loss of generality, when a country $i \in B_y(g)$ *leaves* the trading network g_y and *joins* g_x, the network becomes $g + g_{i\Phi_x}$. Then the *punishment* is that all countries in $B_y(g)$ imposes a complete trade embargo on i. This means that the network after i leaves g_y for g_x becomes $g + g_{i\Phi_x} - g_{i\Phi_y}$.

3.3 Market Environment

We have only one good and each country has a single firm producing it. All firms have the same constant marginal cost of productivity $\gamma > 0$. The output of firm j in country i is denoted by Q_i^j and this is determined by the Cournot competition with multiple firms. The total output in the market i is given by $Q_i = \sum_{j \in \Omega} Q_i^j$. In each country, firms face an identical inverse linear demand function

$$P_i = \alpha - Q_i, \quad \alpha - \gamma > 0. \tag{1}$$

Denote the tariffs faced by firm j in country i as $T_i^j(g)$ and the paper defines social welfare for each country as

$$S_i(g) = \frac{1}{2}Q_i^2(g) + \left[(P_i(g) - \gamma)Q_i^i(g) + \sum_{j \neq i} (P_i(g) - \gamma - T_j^i(g))Q_j^i(g) \right] + \sum_{j \neq i} T_i^j(g)Q_i^j(g). \tag{2}$$

Social welfare is defined by the sum of consumer surplus, firm's profit from both domestic and foreign markets, and government revenue from tariffs imposed on other countries. Note that this social welfare puts equal weight on each of those components and the government aims to increase this social welfare when designing trade policies.

3.4 Stability and Efficiency

Following the definition from Jackson and Wolinsky (1996), this paper uses the relatively weak notion of stability. This means that in a stable network, no country wants to sever ties with a trading partner and two countries that have no FTA do not want to form one. This can be expressed as

$$\begin{aligned} &\text{(i)} \quad S_i(g) \geq S_i(g - g_{ij}) \cap S_j(g) \geq S_j(g - g_{ij}) \\ &\text{(ii)} \quad \text{if } S_i(g) < S_i(g + g_{ij}), \text{then } S_j(g) > S_j(g + g_{ij}) \end{aligned}$$

This definition of stability seems well-fit to trade. Namely, FTA exists when both countries see that the benefit outweighs losses and one country can severe FTA unilaterally.

This paper also introduces efficiency which is naively the sum of each social welfare. $S(g) = \sum_{i \in \Omega} S_i(g)$. A network, $g^\star \in \mathbf{G}$ is said to be most efficient if, for all $g \in \mathbf{G}$, $S(g^\star) \geq S(g)$.

4 Stability

This section explores the creation and the consequences of the division of countries in international trade, given the setup in section 3. In this section, tariffs are exogenously given where the pre-agreement tariff level is such that there is no trade (conditions such as $T > \alpha$ satisfies this) and FTA induces countries to set zero tariffs for signatory countries. Then, $\eta_i(g)$ becomes the

number of firms active in country i in the network g. Henceforth, from the Cournot competition firm's output in the market i is given by

$$Q_i^j = \frac{\alpha - \gamma}{\eta_i(g) + 1}. \tag{3}$$

From equation 2, 3 and the setup whereby tariffs are zero for trading partners, the social welfare for country i is

$$S_i(g) = \frac{1}{2}\left[\frac{(\alpha-\gamma)\eta_i(g)}{\eta_i(g)+1}\right]^2 + \sum_{j\in E_i(g)}\left[\frac{\alpha-\gamma}{\eta_i(g)+1}\right]^2. \tag{4}$$

Furthermore, in the main results, the network structure for each trading bloc is assumed to be *complete* and that there only exist two *components* in the network. Namely, both g_x and g_y are *complete* and $g = g_x + g_y$. This means, $\Phi_x(g) = X(g)$ and $\Phi_y(g) = Y(g)$. This is a direct application of Goyal and Joshi (2006) as a complete network is a stable and most efficient outcome in this setting. Note that as in 3.2, $g_x = \{(g_{ij})_{i,j\in B_x(g)}\}$ and $g_y = \{(g_{ij})_{i,j\in B_y(g)}\}$ and network g consists of trading blocs when $g = g_x + g_y$. The paper now first explores the base case in which there are two trading blocs and punishment as defined in 3.2. In this case, the following proposition holds.

Proposition 1. *A network consisting of trading blocs is unstable.*

Proof. Without loss of generality, consider social welfare of a country $i \in B_y(g)$. From the setting, $B_y(g) = X_(g)$. The country will compare two social welfare; one when the country decides to *leave* $B_y(g)$ and incur punishment from $B_y(g)$ for joining $B_x(g)$. The social welfare is for when the country decides to stay in $B_y(g)$. The social welfare then is as follows. Note that the network g is the status quo.

$$S(g - g_{i\Phi_y} + g_{i\Phi_x}) = \frac{1}{2}\left[\frac{(\alpha-\gamma)(\eta^x(g)+1)}{\eta^x(g)+2}\right]^2 + (\eta^x(g)+1)\left[\frac{\alpha-\gamma}{\eta^x(g)+2}\right]^2 \tag{5}$$

$$S(g) = \frac{1}{2}\left[\frac{(\alpha-\gamma)\eta^y(g)}{\eta^y(g)+1}\right]^2 + \eta^y(g)\left[\frac{\alpha-\gamma}{\eta^y(g)+1}\right]^2. \tag{6}$$

Calculation shows that the condition $S(g - g_{i\Phi_y} + g_{i\Phi_x}) > S(g)$ is satisfied if

$$(\alpha-\gamma)^2(\eta^x(g) - \eta^y(g) + 1) > 0. \tag{7}$$

This implies that country $i \in B_y(g)$ will switch its trading bloc to g_x if $\eta^x(g) \geq \eta^y(g)$. This will be true for country $i \in B_x(g)$ when $\eta^y(g) \geq \eta^x(g)$. Therefore the trade blocs is unstable as at least all of the countries in one of the two trading blocs consider forming new trade agreements. □

This implies that when $\eta^x(g) \geq \eta^y(g)$, a country that sided with y is better off leaving the alliance of y and join the network of x. Intuitively, countries have higher social welfare when joining a larger network since that increases firm profits in foreign markets and consumer surplus in their market, the combination more than compensates for the increased competition and thus less profit the firm gains in the domestic market. This holds even if every nation in the trading bloc which the country left does not trade with the leaver: unrealistic and harsh sanctions which is more severe than that against North Korea for example.

The implication is that given this simple setup we are likely to see more global free trade. This is clear in the following setting; all countries optimize their own social welfare and since all countries are homogeneous, if one country wants to join another trading bloc then all the others in the same trading bloc would want to join as well. Under this setting, if all countries decide

in a one-shot game, all countries are expected to join the larger network. Note that this holds even if there is a complete trade embargo and the leaving country and its former trade partners sever trade completely. It suggests that the world we observe today with multiple regional trade agreements do not come about solely by punishment.

5 Regional Trade Blocs

The basic model in section 4 indicates that when there are two disjoint complete networks, i.e., regional trade blocs, is unstable. This holds even in the case of one of the severest punishments for leaving which is a complete trade embargo. The intuition here is that a larger network, or for that matter, a same-sized network is more attractive for countries and incentivize countries to deviate from their original trading bloc. This is because a larger network guarantees a larger foreign market which the firm can capitalize on and also increased competition, albeit decreases domestic firm profit, raise consumer surplus. In this section, two hypotheses were tested as to why there might be regional trading blocs; exogenous utility factor which countries derive just by trading with a certain country (other than consumer surplus, firm profits, and tariffs), and some sort of friction that prevents countries to fully benefit as they can in a different trade bloc compared to their trading bloc. The analysis, as in section 4, is limited to two trading blocs which are both complete.

5.1 Residual Benefits to Trade

Section 4 illustrated the fact that punishments from the same or smaller trading bloc are ineffective in stabilizing its trade agreement. Here, we add *fixed utility*, f_{ij}, which represents a pure utility derived from trading. For the analysis, we set for each i, $f_{ij} = 0$ for all $j \in \mathbf{\Omega} \setminus \{x, y\}$ $f_{ix} \neq 0$,and $f_{iy} \neq 0$. Naturally, $f_{ix} > 0$ for $i \in B_x(g)$, $f_{iy} > 0$ for $i \in B_y(g)$ and $f_{iy} > f_{ix}$ for $i \in B_y(g)$. Denote $\Delta_i = f_{iy} - f_{ix}$ as the *magnitude of preference* for country $i \in \Omega$. Then the social welfare for country $i \in B_x(g)$ and $j \in B_y(g)$ is the following respectively.

$$S_i(g) = \frac{1}{2}\left[\frac{(\alpha-\gamma)\eta_i(g)}{\eta_i(g)+1}\right]^2 + \sum_{j\in B_x(g)}\left[\frac{\alpha-\gamma}{\eta_j(g)+1}\right]^2 + f_{ix}. \tag{8}$$

$$S_j(g) = \frac{1}{2}\left[\frac{(\alpha-\gamma)\eta_j(g)}{\eta_j(g)+1}\right]^2 + \sum_{i\in B_y(g)}\left[\frac{\alpha-\gamma}{\eta_i(g)+1}\right]^2 + f_{jy}. \tag{9}$$

The following result gives an important insight into why the world may have regional trade blocs.

Proposition 2. *There exists a threshold level Δ_i^*, expressed in terms of the number of countries in each trading bloc, $\eta^x(g)$ and $\eta^y(g)$, such that above that level the regional trading blocs are stable and below that level the trading blocs are unstable. In addition $\Delta_i^* \to 0$ as $\min(\eta^x(g), \eta^y(g)) \to \infty$.*

Proof. Conducting the same analysis as section 4, the equations modifies to

$$S(g - g_{i\Phi_y} + g_{i\Phi_x}) = \frac{1}{2}\left[\frac{(\alpha-\gamma)(\eta^x(g)+1)}{\eta^x(g)+2}\right]^2 + (\eta^x(g)+1)\left[\frac{\alpha-\gamma}{\eta^x(g)+2}\right]^2 + f_{ix} \tag{10}$$

$$S(g) = \frac{1}{2}\left[\frac{(\alpha-\gamma)\eta^y(g)}{\eta^y(g)+1}\right]^2 + \eta^y(g)\left[\frac{\alpha-\gamma}{\eta^y(g)+1}\right]^2 + f_{iy}. \tag{11}$$

The condition $S(g - g_{i\Phi_y} + g_{i\Phi_x}) < S(g)$ (which means i will stay in the trading bloc) holds true if

$$\Delta_i > \frac{(\alpha-\gamma)^2(\eta^x(g)-\eta^y(g)+1)(\eta^x(g)+\eta^y(g)+3)}{2(\eta^x(g)+2)^2(\eta^y(g)+1)^2} \quad (\eta^x(g) \geq \eta^y(g)). \tag{12}$$

This means if the above condition satisfies for all $i \in B_y(g)$, the trade blocs are stable. In addition, we can see that when we fix $\eta^y(g)$ and define the above function as $d(\eta^x(g), \eta^y(g))$,

$$\lim_{(\eta^x(g)-\eta^y(g))\to\infty} d(\eta^x(g), \eta^y(g)) = \frac{(\alpha-\gamma)^2}{2(\eta^y(g)+1)^2} \tag{13}$$

$$\lim_{\eta^y(g)\to\infty} \frac{(\alpha-\gamma)^2}{2(\eta^y(g)+1)^2} = 0 \tag{14}$$

Therefore, as the number of countries increases in both trading groups, the difference in the country's preference towards x and y can be close to zero but yet regional trade blocs are stable; no countries have an incentive to switch. □

The implication of this extension is two-folds. First, there is a threshold level of Δ_i^* which means that if countries in the trading bloc they belong to obtain sufficient fixed utility, the trading bloc is stable. We may consider the effect of "soft power," security reasons, or sustaining historical relationships as expressed by this term. These are important factors yet could not be captured directly by the sum of consumer surplus, firm profits, and tariff revenue. In this sense, this fixed utility can be considered as a term that captures all the factors that affect trade bloc formation not captured by equation 2. For example, when the trading blocs are formed by the US and China, if a country had historical ties with the US more, the fixed utility for the US is higher and this is expected to be higher if there is a deeper historical relationship; this assumes longer historical relationships may be beneficial due to international cooperation. The UK can be a notable example. In this case, if one of the trading blocs have high fixed utility due to long historical relationships, the trading bloc might be stable even if the number of members is much less than the other trading bloc with relatively shallow historical relationships.

Another point is that even a small preference towards the country in the same trade bloc is enough to prevent countries to switch to another trading bloc given a sufficient number of countries in the trade bloc; less probability of global free trade. For example, suppose the countries forming a trade bloc is China and the US. Similar to the distribution above, consider a distribution where each country has some preference towards the two countries. Then, Canada, for instance, has a bigger preference for the US compared to China. Likewise, Russia has a larger preference for China. Proposition 2 implies that if these two blocs are larger, countries such as Japan, which possibly have almost the same preference towards the two countries will not switch their initial trading bloc even if the other trading bloc becomes even larger. For example, suppose Japan belonged to the trade bloc of the US. Then if the trade bloc of the US is relatively small, a huge increase in the number of countries in the trading bloc of China will induce Japan to leave the US. However, if the trading bloc of the US is also large then even if China has rapidly expanded its trading bloc, Japan stays with the US. This means the trading blocs are stable and there is less likelihood that global free trade, in this case, a free trade between Japan and members of the trading bloc in China, will happen.

5.2 It's a Different World After All

In the above section 5.1, the existence of regional trading blocs was suggested even when there exists a small preference towards the country with a smaller trading bloc. In this section, the conditions for this is quantified in terms of firm profit and friction. Specifically, denote $\delta \in [0, 1]$

as a quantifier of friction that exists for firms to profit in another trading bloc. The social welfare including δ can be as follows.

$$S(g - g_{i\Phi_y} + g_{i\Phi_x}) = \frac{1}{2}\left[\frac{(\alpha-\gamma)(\eta^x(g)+1)}{\eta^x(g)+2}\right]^2 + \left[\frac{\alpha-\gamma}{\eta^x(g)+2}\right]^2 + (1-\delta)\eta^x(g)\left[\frac{\alpha-\gamma}{\eta^x(g)+2}\right]^2 \tag{15}$$

$$S(g) = \frac{1}{2}\left[\frac{(\alpha-\gamma)\eta^y(g)}{\eta^y(g)+1}\right]^2 + \eta^y(g)\left[\frac{\alpha-\gamma}{\eta^y(g)+1}\right]^2 \tag{16}$$

The following shows a quantifiable condition for sustaining regional trading blocs, in addition to strengthening the claim in section 5.1.

Proposition 3. *There exists a threshold friction level $\delta^* \in [0,1]$ where above that friction level regional trade blocs are stable and below that level regional trade blocs are unstable.*

Proof. Similar to the above analysis, $S(g - g_{i\Phi_y} + g_{i\Phi_x}) < S(g)$ holds true if

$$\delta > t(\eta^x(g), \eta^y(g)) \tag{17}$$

where

$$t(\eta^x(g), \eta^y(g)) = 1 - \frac{2\eta^y(g) + 4\eta^x(g)\eta^y(g) + \eta^y(g)^2 + 2\eta^x(g)\eta^y(g)^2 - 3 - 2\eta^x(g) - \eta^x(g)^2}{2\eta^x(g)(1+\eta^y(g))^2}. \tag{18}$$

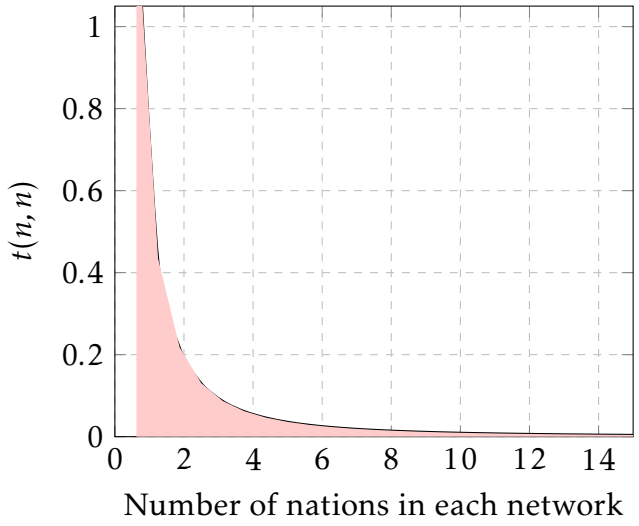
For $\eta^x(g) > 0, \eta^y(g) > 0$, it is the case that $0 \leq t(\eta^x(g), \eta^y(g)) \leq 1$. Therefore if $\delta > t(\eta^x(g), \eta^y(g))$, countries stay in their trading bloc and thus it is stable. Conversely, if $\delta \leq t(\eta^x(g), \eta^y(g))$, countries have incentive to switch and thus regional trading blocs are unstable. □

For further analysis assume $\eta^x(g) = \eta^y(g) = n$. Then the above function simplifies to

$$t(n,n) \equiv 1 - \frac{2n^3 + 4n^2 - 3}{2n(n+1)^2}. \tag{19}$$

The corresponding graph is below. The pink area is the level of friction where it is more beneficial for country Φ_y to switch from the trading bloc of y. The interpretation is as follows; $\delta = 0$ implies there is no friction and $\delta = 1$ implies no profit for operating. As the size of each network increases it is observed that, rapidly, less friction is necessary for switch its trading bloc to be beneficial. In actual terms, in this setting, if both trading blocs have 10 countries each, a country has no incentive to switch if the friction is more than 1 per cent relative to obtainable profits at a foreign market. This suggests that for global free trade to be realized, the economy requires a much more friction-less world.

Figure 2: Threshold of friction with respect to network size



One implication of proposition 3 is as follows. The δ factor could be interpreted in multiple ways. Some examples could be regional proximity (increased transportation cost), language/culture, and different regulations which force firms in a different trading bloc to incur additional costs. As figure 1b describes, countries close to each other tend to form trade agreements. This result justifies some of the aspects because we expect countries further away to be less likely to form trade agreements. In addition, as more countries join, the distance between trade agreements will likely decrease and thus less friction; the probability of switching and thus global free trade gets higher. Another implication is that if the smaller trading bloc hopes to retain its members, it can do two things; one is to increase the number of countries and the other is to increase relative friction between other trading blocs. Since the results from this model do not allow countries in bigger trade networks to leave and join the smaller network, the former can only be achieved by incorporating neutral countries, namely country $i \in \Omega \setminus \{B_x(g), B_y(g)\}$. For the latter, this implies that countries may want to achieve this by creating infrastructures among themselves such that the profit from other trading blocs will relatively have additional costs relative to their own (the transportation cost for trading with another trading bloc is relatively higher compared to its own). Then, projects such as the Belt and Road Initiative by China is can be seen as a notable example where it would be better to trade more within the initiative so that the cost of extra transportation for countries in other trading bloc is less.

6 A New Dimension

This section expands the results obtained. It focuses on two key elements in international trade: neutral countries and globalisation.

6.1 Neutral Countries

Previous sections, especially section 5.1 and 5.2, suggests that the number of nations N is important in whether the international stage with multiple regional trading blocs is stable or not. This discussion seems particularly important today as numerous developing countries have seen rapid growth, becoming from negligible players to influential players in a short period. In addition, powerful nations are actively engaging with developing countries hoping to reap benefits as they grow. A notable example in recent years is Belt and Road Initiative by China but USAID

and its fund ESF from the US also function similarly. This phenomenon can be considered in this model by introducing neutral countries previously belonging to neither trading blocs. From the result of Goyal and Joshi (2006), it is always beneficial to join trading blocs (the number of nations is at most $N-1$). Thus, neutral countries are expected to join a trading bloc. However, how those countries are incorporated into trading blocs are important. As propositions 2 and 3 indicate, there exists a threshold level of the number of countries in trading blocs that stabilize/destabilize trading blocs. For example, if most neutral countries join the bigger network, the world might observe countries from the other trading bloc joining as the incentive for joining gets larger. In this case, regional trading blocs become unstable and global free trade may ensue. On the other hand, suppose neutral countries do not always join the bigger network. Countries may join a smaller network by threat (as in the case of military or political interventions and this could be incorporated in the model as an exogenous shock to the number of nations) or from purely economic standpoints (the friction for joining the larger network may be too high). In this case, as previous results indicate, the regional trading blocs will be more stable; the probability of global free trade is lessened. Therefore, in either way, neutral countries might determine how the overall trade pattern will be in the future. This will also be the case if there exist three or more trade blocs. For example, a trading bloc merging with another trade bloc also might make other trading blocs unstable. In many cases it is possible that since trading blocs have numerous countries within, a merge between trading blocs are easier to destabilize trading blocs; this connects well to the domino theory proposed by Baldwin (1993). However, introducing fixed utility and friction between trading blocs might still stabilize trading blocs and this can be investigated by extending the framework in this paper.

6.2 Globalisation

The results also give us some insights as to how globalisation might play a role in international trade. This is because globalisation can have two effects. One is that it reduces friction between trading blocs. This means due to integration of culture, unification of standards, reduced cost in transportation and possibly many other effects, different trading blocs will be able to trade easier. This implies that the friction δ introduced in section 5.2 will decrease. As proposition 3 implies, this means that countries are more likely to switch their trading bloc. In this sense, globalisation encourages global free trade. However, another effect of globalisation might be that respective trading blocs might incorporate more countries due to economic growth or more integration. For example, the EU has increased its number of countries as countries mainly in east Europe became more wealthy (most recently Bulgaria and Romania joined the EU in 2007). In this case, section 5.2 implies that the increase in the number of trading countries makes it harder for countries to switch (the δ converges to zero meaning trading blocs need much less friction for it to be unstable). Thus, trading blocs may become more stable. Hence, globalisation likely causes two opposing effects in terms of stable network formation. Whether the first or second dominates the other is affected by a multitude of factors. For example, how much friction decreases and how fast countries are incorporated are the two main concerns here. It may be possible to investigate this further by using dynamic games as opposed to comparative statics which this paper employed.

7 Conclusion

This paper investigated whether regional trade agreements are stable to answer one of the central questions in international trade: will we ever see global free trade? For this purpose, this paper developed a model using network formation. In this model, countries are connected if they

have an agreement that lowers tariffs. Then each country, conditional on agreements among all the nations, decides whether to sever links and connect with others. To analyse regional trade blocs, this paper started with predetermined trade blocs. The result is that these trade blocs are unstable even if a trading bloc employs a strict deterrence strategy whereby countries leaving their trading bloc are forced to sever agreements with all the other members in that trading bloc. This suggests that the world we observe today with an increasing number of regional trade agreements does not come about by deterrence strategy on its own. However, regional trade blocs become stable by introducing fixed utility or frictions between different countries/trading blocs. Interestingly, the value of these can be small if the number of countries increases to guarantee stability. The implication is that neutral countries gain importance and that it may be possible that globalisation might lead to segregated markets. The model and the analysis can be extended in multiple ways. One example would be to apply it to the setting of multiple trading blocs. The result of which could be different because trade blocs, compared to a single country, can also induce other countries to join. Another extension could be to model the trade off between the number of countries and the level of friction which has opposing effects for investigating how globalisation affects international trade.

Appendices

A Figures

Below are all the figures in section 1 but larger and the current network that illustrates the changing dynamics of international trade focused on China and the US.

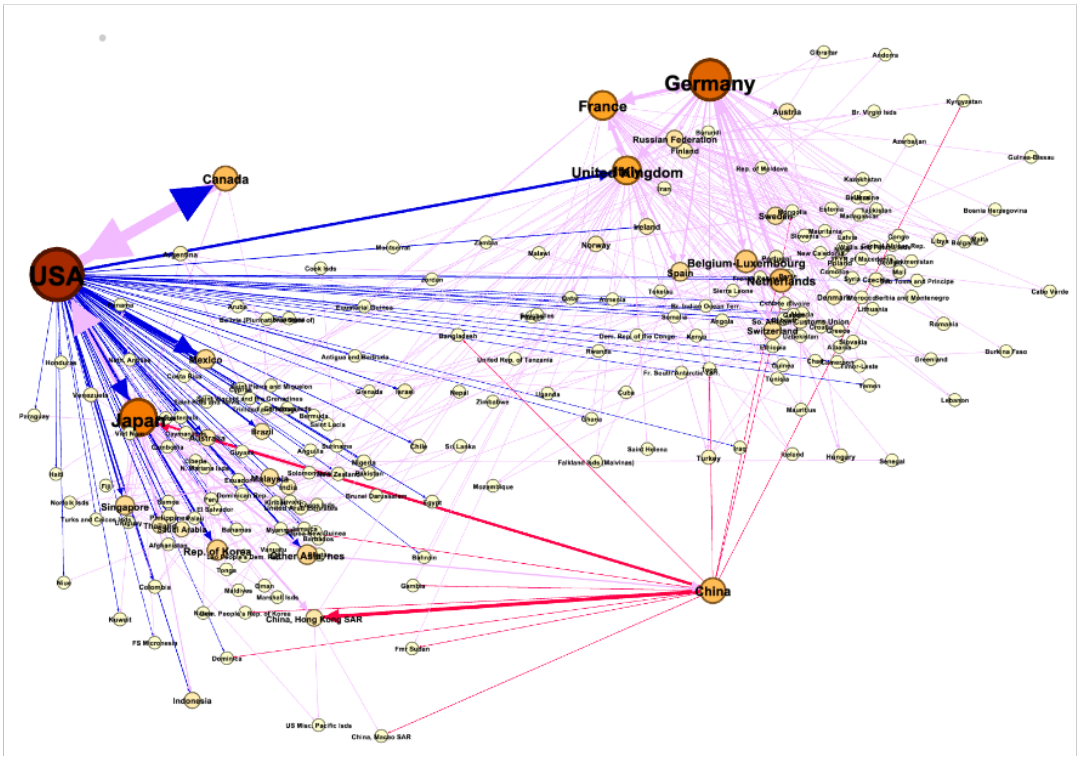


Figure A1: Top Trading Partners in the year 1997

source : BACI-CEPII Database Gaulier and Zignago (2010)

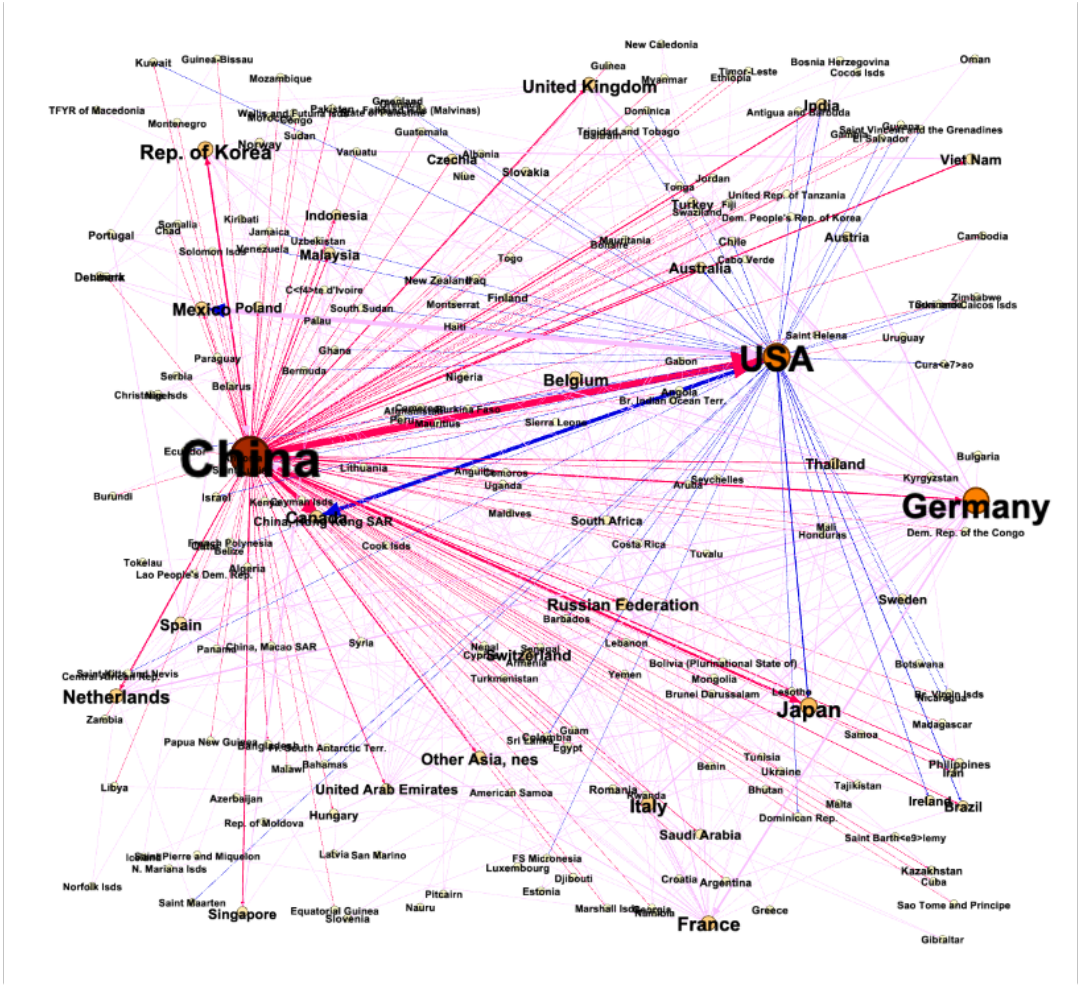


Figure A2: Top Trading Partners in the year 2017

source : BACI-CEPII Database Gaulier and Zignago (2010)

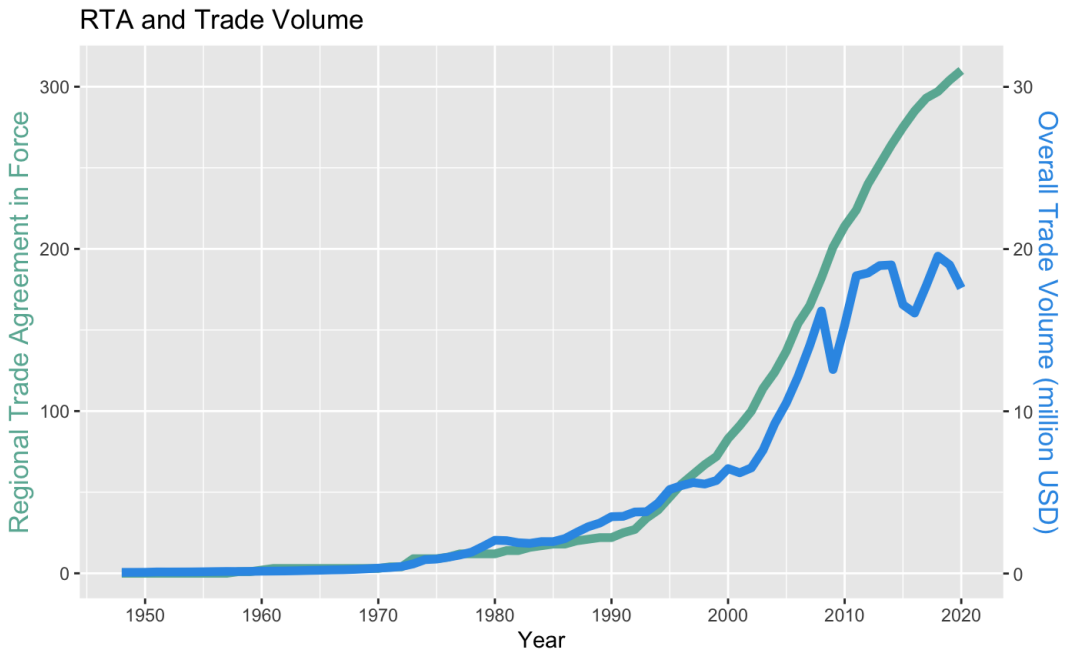


Figure A3: Overall Trade Volume

source WTO (2021)

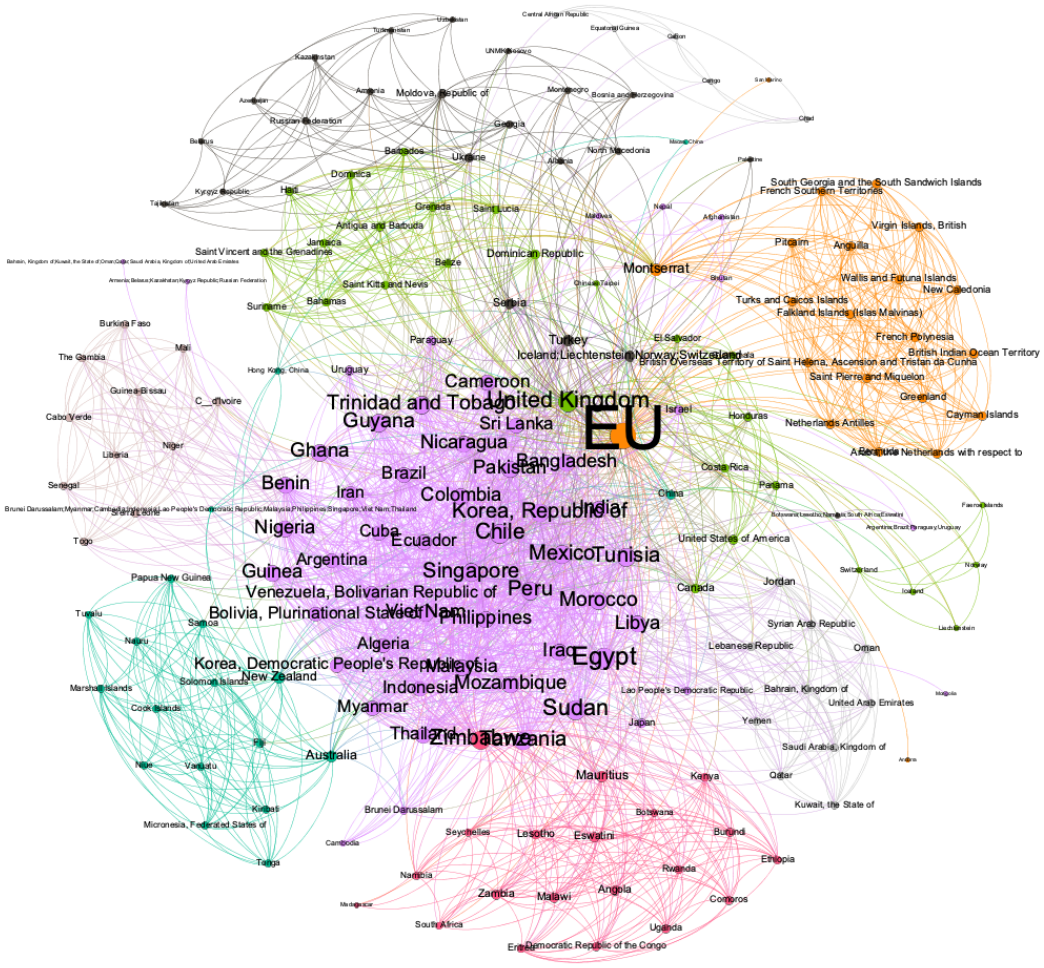


Figure A4: Regional Trade Agreements in force

source WTO (2021)

References

Aghion, P., Antràs, P., and Helpman, E. (2007). Negotiating free trade. *Journal of International Economics*, 73:1–30.

Bagwell, K. and Staiger, R. W. (1997). Multilateral tariff cooperation during the formation of free trade areas. *International Economic Review*, 38:291.

Baldwin, R. (1993). A domino theory of regionalism. Working paper, NBER.

Baldwin, R. E. (1989). The political economy of trade policy. *The Journal of Economic Perspectives*, 3:119–135.

Benedictis, L. D. and Tajoli, L. (2011). The world trade network. *The World Economy*, 34:1417–1454.

Berger, D., Easterly, W., Nunn, N., Satyanath, S., Amegashie, A., Baier, S., Bonfatti, R., Chisik, R., Dragusanu, R., Essaji, A., Feenstra, R., Head, K., Helpman, E., Katz, L., Mckeown, T., Maurer, N., Meissner, C., Miguel, E., Mitchener, K., Muendler, M., Naidu, S., and Reiter, D. (2013).

Commercial imperialism? political influence and trade during the cold war †. *American Economic Review*, 103:863–896.

Bhagwati, J. and Panagariya, A. (1996). The theory of preferential trade agreements: Historical evolution and current trends. *The American Economic Review*, 86(2):82–87.

Bhattacharya, K., Mukherjee, G., Saramäki, J., Kaski, K., and Manna, S. S. (2008). The international trade network: weighted network analysis and modelling. *Journal of Statistical Mechanics: Theory and Experiment*, 2008:P02002.

Bogomolnaia, A. and Jackson, M. O. (2002). The stability of hedonic coalition structures. *Games and Economic Behavior*, 38(2):201–230.

Bond, E. W., Riezman, R. G., and Syropoulos, C. (2004). A strategic and welfare theoretic analysis of free trade areas. *Journal of International Economics*, 64(1):1–27.

Chen, M. X. and Joshi, S. (2010). Third-country effects on the formation of free trade agreements. *Journal of International Economics*, 82:238–248.

Conconi, P., García-Santana, M., Puccio, L., and Venturini, R. (2018). From final goods to inputs: The protectionist effect of rules of origin. *American Economic Review*, 108:2335–2365.

Estevadeordal, A., Freund, C., and Ornelas, E. (2008). Does regionalism affect trade liberalization toward nonmembers? *Quarterly Journal of Economics*, 123:1531–1575.

Ethier, W. J. (1998). The new regionalism. *The Economic Journal*, 108(449):1149–1161.

Fajgelbaum, P. D., Goldberg, P. K., Kennedy, P. J., and Khandelwal, A. K. (2020). The return to protectionism. *The Quarterly Journal of Economics*, 135:1–55.

Furusawa, T. and Konishi, H. (2007). Free trade networks. *Journal of International Economics*, 72:310–335.

Gaulier, G. and Zignago, S. (2010). Baci: International trade database at the product-level. the 1994-2007 version. Working Papers 2010-23, CEPII.

Gowa, J. and Mansfield, E. D. (1993). Power politics and international trade. *American Political Science Review*, 87:408–420.

Goyal, S. and Joshi, S. (2006). Bilateralism and free trade. *International Economic Review*, 47:749–778.

Grossman, G. M. and Helpman, E. (1995). Trade wars and trade talks. *Journal of Political Economy*, 103(4):675–708.

Hadjiyiannis, C. (2004). Regionalism and multilateral trade liberalization with asymmetric countries. *Review of International Economics*, 12:395–411.

Jackson, M. O. and Wolinsky, A. (1996). A strategic model of social and economic networks. *Journal of Economic Theory*, 71:44–74.

Kemp, M. C. and Wan, H. Y. (1976). An elementary proposition concerning the formation of customs unions. *Journal of International Economics*.

Krishna, P. (1998). Regionalism and multilateralism: A political economy approach. *Quarterly Journal of Economics*, 113:226–251.

Krugman, P. (1989). Is bilateralism bad? Working paper, NBER.

Levy, P. (1997). A political-economic analysis of free-trade agreements. *American Economic Review*, 87(4):506–19.

Limao, N. (2006). Preferential trade agreements as stumbling blocks for multilateral trade liberalization: Evidence for the united states. *American Economic Review*, 96(3):896–914.

Liu, T. and Woo, W. T. (2018). Understanding the u.s.-china trade war. *China Economic Journal*, 11:319–340.

Lombaerde, P. D., Iapadre, L., McCranie, A., and Tajoli, L. (2018). Using network analysis to study globalization, regionalization, and multi-polarity—introduction to special section. *Network Science*, 6:494–516.

Mahutga, M. C. (2006). The persistence of structural inequality? a network analysis of international trade, 1965–2000. *Social Forces*, 84:1863–1889.

Ostrovsky, M. (2008). Stability in supply chain networks. *American Economic Review*, 98(3):897–923.

Saggi, K. (2006). Preferential trade agreements and multilateral tariff cooperation. *International Economic Review*, 47:29–57.

Saggi, K., Woodland, A., and Yildiz, H. M. (2013). On the relationship between preferential and multilateral trade liberalization: The case of customs unions †. *American Economic Journal: Microeconomics*, 2013:63–99.

Saggi, K., Yildiz, H. M., Saggi, K., and Yildiz, H. (2010). Bilateralism, multilateralism, and the quest for global free trade. *Journal of International Economics*, 81:26–37.

Stoyanov, A. and Yildiz, H. M. (2015). Preferential versus multilateral trade liberalization and the role of political economy. *European Economic Review*, 80:140–164.

Viner, J. (2014). *The customs union issue*. Oxford University Press.

World Trade Organization (2021). Regional trade agreements database. data retrieved from Regional Trade Agreements Database, https://rtais.wto.org/UI/About.aspx.

Yi, S. S. (1996). Endogenous formation of customs unions under imperfect competition: Open regionalism is good 1. *Journal of International Economics*, 41:153–177.

Zhang, J., Cui, Z., and Zu, L. (2014). The evolution of free trade networks. *Journal of Economic Dynamics and Control*, 38(C):72–86.