Bilateralism and Free Trade

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Abstract

In recent years, there has been a great deal of research on the relative merits of multilateralism and bilateralism and their implications for the nature of the trading regime between countries. In this paper we explore the scope of bilateral free-trade agreements as a foundation for free trade, using recent developments in the theory of strategic network formation.

We study a setting with many countries; in each country there are firms, which can sell in the domestic market as well as sell in the foreign markets. The possibility of selling in foreign markets depends on the nature of import tariffs faced by firms. Countries can sign bilateral free-trade agreements which lower import tariffs and thereby facilitate trade. We allow a country to sign any number of bilateral trade agreements. A profile of trade agreements defines the trading regime. We study the nature of trading regimes that are consistent with the incentives of individual countries. Our principal finding is that bilateralism is consistent with global free trade.

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1 Introduction

In recent years, there has been a great deal of research on the relative merits of multilateralism and bilateralism and their implications for the nature of the trading regime between countries. Considerable attention has been given to the welfare effects of regional free-trade associations and customs unions. A second set of issues concerns the incentives of nations to form such associations; this pertains to the strategic stability of particular trading regimes. Relatively little work has been done on this subject, specially concerning the stability of different free-trade structures.[1] This paper examines the incentives of countries to form bilateral free-trade agreements and the effects of these agreements on the welfare of third parties. In our work, we use a model which is inspired by recent developments in the theory of strategic network formation.

We study a setting with many countries; in each country there are firms, which can sell in the domestic market as well as sell in the foreign markets. The possibility of selling in foreign markets depends on the nature of import tariffs faced by the firms. Countries can sign bilateral trade agreements which lower import tariffs and thereby facilitate trade. We allow a country to sign any number of bilateral trade agreements. The network of such trade agreements defines the trading regime. We study the nature of trading regimes that are consistent with the incentives of individual countries.

There are three direct effects at work when a pair of countries sign a trade agreement which lowers import tariffs: one, the domestic firm is faced with greater competition from a foreign firm, two, the domestic firm gets greater access to the foreign market and three, domestic consumers benefit from greater competition, in terms of lower prices.

In addition, there is an interesting indirect effect of such bilateral agreements: they make the markets of the countries signing the agreement less valuable to other active firms in the market. In a recent paper, Wilfred Ethier has termed this effect *concession diversion*. He

[1] There is some literature on the stability of different types of customs union arrangements. We discuss this below.

argues that the potential for concession diversion implies that bilateral trade agreements will be unable to support liberal trading regimes.

We find that concession diversion does arise when countries form additional bilateral trade agreements. This effect should, however, be seen as a negative externality generated by individual countries. Standard intuition suggests that there will be 'excessive' incentives to create agreements. This is what our analysis also reveals: in a symmetric setting, the latter two direct effects dominate and countries have an incentive to form bilateral agreements. In particular, we show that a complete network, i.e., one in which every pair of countries has a bilateral trade agreement is a stable outcome. In our setting, bilateral trade agreements lower trade tariffs to zero. Thus we show that bilateralism is consistent with free trade.[2]

Recent years have witnessed the growth of a voluminous literature on whether *multilateral* trade negotiations under the auspices of GATT (and now the WTO) or a network of *bilateral* preferential trading agreements (within the larger framework of GATT) is most conducive to a movement towards global free trade and a maximization of world welfare. As noted by Deardorff and Stern (1997), bilateral trade agreements have a long history and have even played a key role in the early rounds of GATT in forging a multilateral trade agreement. Our results establish that the process of bilateral agreements can generate a free trade regime.

It is worth noting that the provisions of GATT allow preferential trading arrangements – such as Customs Unions (CU) and Free Trade Areas (FTA) – under certain circumstances. In particular, preferential trading agreements that are bilaterally negotiated between two countries should not lead to an increase in tariff duties on outside countries and should not lead to a reduction in world welfare. One of our findings is that if a pair of countries i and j signs a bilateral free trade agreement then this induces them to lower tariffs on third countries (which do not have a free trade agreement with either i or j). This in turn leads to

[2]We have also considered the case of non-tariff barriers, such as quotas. In this setting, each country first decides on the set of countries with whom it wishes to form bilateral free-trade agreements. Countries then decide on the level of quota on those countries with whom they have no agreements. Finally, the firms sell in the foreign markets and the home market. Our analysis of this case yields very similar results to those reported for the tariff case in the present paper. We would like to thank Francis Bloch for discussions on the subject of non-tariff barriers.

an increase in the welfare of such countries. Thus bilateral agreements are consistent with the spirit of GATT.

The principal contribution of our paper is the introduction of network games to the study of international trading regimes. Our model of network formation is inspired by recent work on strategic models of network formation; see e.g., Bala and Goyal (1999), Jackson and Wolinsky (1996) and Kranton and Minehart (1998). This approach allows us to explicitly consider individual country incentives and the spillovers bilateral trade agreements generate for third parties. To the best of our knowledge, the present paper is the first application of this approach to a study of the international trading system.[3]

We now elaborate on this approach. The simplest way to to do this to discuss the relationship of our paper with that of Yi (1996). In his paper, Yi uses the theory of coalition formation. This theory examines the strategic stability of different partititions of players: a partition is a division of the players into mutually exclusive groups which collectively account for all the players. This is a natural way of thinking about customs unions, since a country cannot typically be a member of two customs unions. Our interest is in free trade agreements and in this context the restriction to partitions is a strong one indeed. It rules out arrangements such as the following: countries 1 and 2 have a bilateral free trade agreement and countries 2 and 3 have a similar agreement but there is no agreement between 1 and 3. Clearly, 1 and 3 have a different relationship as compared to (say) 1 and 2. Thus it is not appropriate to view countries 1, 2 and 3 as one coalition. At the same time we cannot think of 1 and 2 and 2 and 3 being two distinct coalitions, since this violates the mutual exclusiveness property of coalitions. The theory of network games provides a natural way to think of such issues, since it allows for such intransitive relationships.

This is important since, in practice, the trading regime is characterized by such intransitive relationships. For instance, Israel has bilateral free-trade agreements with the United States and the European Community, respectively, but the latter two do not have such an agreement between them. Similarly, the Mexcico has bilateral free-trade agreements with Bolivia and

[3]For an application of network games to collaboration in oligopolies, see Goyal and Joshi (1999).

Costa Rica, respectively, but the latter two do not have such a free-trade agreement (WTO, 1995).

This difference in approach has implications for our findings: Yi shows that the formation of customs unions typically leads to an increase in the tariffs on third country products. This is in contrast to our finding: we show that tariffs on third countries decline as countries form additional bilateral agreements. This result is important due to the concerns of GATT.

Yi also shows that the rules of customs union formation are crucial: if open membership is allowed, then the only stable customs union structure is the grand coalition, i.e., free trade. However, under the rule that a union is formed if and only if all potential members agree to its formation, then such a coalition cannot arise. We study the nature of stable networks of bilateral trade agreements. A network is said to be stable if no pair of countries has an incentive to form an additional trade agreement while no single country has an incentive to dissolve any existing agreement. We show that the complete network, which supports free trade, is strategically stable.

We now place our paper in context by relating it to the existing literature in the theory of international trade. We first mention some work on the influence of trading structures. In an early paper, Krugman (1991) demonstrates, in a model with differentiated products, that world welfare is minimized when there are three equal size customs unions. He does not examine the stability of such an arrangement. Our results suggest that such symmetric size groups are not strategically stable. Ethier (1998) argues that since a PTA between two countries reduces the competitiveness of outside firms in the markets of these two countries, leading to "concession diversion". This effect will undermine bilateral trade agreements and they will be unable to support liberal trading regimes. In a recent paper, Maggi (1999) argues that in an asymmetric environment with bilateral imbalances of power, a multilateral institution such as the WTO can play a crucial role in verifying violations of trading agreements and facilitating multilateral enforcements, although this argument loses force in a symmetric environment. In a similar vein, Bagwell and Staiger (1999) argue that a FTA will impede the implementation of an efficient multilateral trade agreement (though a CU under

certain conditions may not). Bhagwati and Panagariya (1996) illustrate the possibility that PTAs may constitute "stumbling blocks" towards non-discriminatory trade liberalization.

In defense of bilateralism, Deardorrf and Stern (1997) argue that a multiplicity of countries may find it harder to reach consensus on trade issues. They also note that the result of Krugman (1991) is biased against PTAs because the assumption of differentiated products implies that each country will be importing goods from every other country and this creates a strong possibility of trade diversion with consequent reduction in world welfare. Instead, in their model, the incentive to negotiate PTAs is based on comparative advantage. The assumption that PTAs can only lead to symmetric trading blocs is also open to criticism for in our network setup such a configuration will be unstable and will lead to individual members in distinct trading blocs negotiating mutually profitable bilateral trade agreements. In response to Ethier, and Bhagwati and Panagariya, we find that bilateralism can constitute a "building block" leading to either a free trade regime or an almost free trade regime.[4]

These papers highlight the importance of trading agreements. Most of this work, however, proceeds by fixing some trading structure. In this paper, our interest is in the strategic stability of different bilateral free-trade arrangements. We therefore develop a model where any structure of trading agreements is in principle allowed. There is some research on the strategic stability of different customs union arrangements; see e.g., Baldwin (1995), Bond and Syropolous (1993), Kennan and Riezman (1990), and Yi (1996). To the best of our knowledge the present paper is the first study of the strategic stability of free-trade areas.

The paper is structured as follows. In section 2 we introduce the basic model. Section 3 studies the basic model with exogenous tariffs and a single firm in each country. Initially tariffs are prohibitively high. If two countries sign a trade agreement then tariffs between them are brought down to zero. Tariffs between countries which do not have an agreement remain prohibitive. In section 4 we examine generalizations of this model. In section 4.1 we allow countries to set the level of tariffs with non-agreement countries. We term this the case of endogenous tariffs. Here we examine the effects of tariff revenue on incentives

[4]Spilimbergo and Stein (1998) also find that a move towards PTAs can increase world welfare in a model of comparative advantage if transport costs are considered.

to form bilateral agreements. We also study the effects of bilateral trade agreements on tariffs against third countries. In section 4.2 we study a model with exogenous tariffs and oligopoly in each country. Section 4.3 examines the effects of market size on incentives to form bilateral agreements. Section 5 concludes.

2 The Basic Model

We consider a setting with N countries, each of which has one firm, which can sell in the domestic market as well as sell in each of the foreign markets. A country's ability to sell in foreign markets, however, depends on the level of import tariffs set by the different countries. If two countries have bilaterally negotiated a FTA, then each offers the other a tariff-free access to its domestic market; otherwise, each imposes a non-zero tariff on the imports from the other. Given a configuration of FTAs, firms then compete in different markets by choosing quantities. We are interested in the FTA network that emerges in this setting. We now develop the required terminology and provide some definitions.

2.1 Network of Bilateral Trading Agreements

In this section, we formalize the notion of a network of FTAs and provide some definitions. Let $\mathcal{N} = \{1, 2, ..., N\}$ denote a finite set of identical countries. To avoid trivialities, we shall assume that $N \geq 3$. For any $i, j \in \mathcal{N}$, the pair-wise relationship between the two countries is captured by a binary variable, $g_{ij} \in \{0, 1\}$; $g_{ij} = 1$ means that a FTA is established between countries i and j while $g_{ij} = 0$ means that no FTA is in effect. By definition, $g_{ii} = 1 \; \forall i \in \mathcal{N}$ and $g_{ij} = g_{ji} \forall i, j \in \mathcal{N}$. A *network*, $g = \{(g_{ij})_{i,j \in \mathcal{N}}\}$, is a formal description of the FTAs that exist between the countries in $\mathcal{N}$. Let $\mathcal{G}$ denote the set of all PTA networks. Two special cases are the complete network, g^c, in which $g_{ij} = 1 \; \forall i, j \in \mathcal{N}$, and the empty network, g^e, in which $g_{ij} = 0 \; \forall i, j \in \mathcal{N}$, $i \neq j$. Let $g + g_{ij}$ denote the network obtained by replacing $g_{ij} = 0$ in network g by $g_{ij} = 1$. Similarly, let $g - g_{ij}$ denote the network obtained by replacing $g_{ij} = 1$ in network g by $g_{ij} = 0$.

Let $N(g) = \{i \in \mathcal{N} : \exists j \neq i,\ g_{ij} = 1\}$. Each country in $N(g)$ is involved in a FTA with another distinct country in the network g. Therefore, $N(g^c) = \mathcal{N}$ and $N(g^e) = \emptyset$. There exists a *path* in g between countries i and j if either $g_{ij} = 1$ or there exists a distinct set of countries $\{i_1, i_2, \ldots, i_n\} \subset N(g)$ such that $g_{i,i_1} = g_{i_1,i_2} = \cdots = g_{i_n j} = 1$. A network $g' \subset g$ is a *component* of g if for all $i, j \in N(g')$, $i \neq j$, there exists a path in g' connecting i and j, and for all $i \in N(g')$ and $j \in N(g)$, $g_{ij} = 1$ implies $g_{ij} \in g'$. A component $g' \subset g$ is *complete* if $g_{ij} = 1$ for all $i, j \in N(g')$.

We will also let $N_i(g) = \{j \in \mathcal{N} :\ g_{ij} = 1\}$. $N_i(g)$ denotes the set of countries with whom i has a FTA in the trade network g and includes country i. Let $\eta_i(g)$ denote the cardinality of $N_i(g)$.

2.2 Demand and Cost Structure

In each country there is a single firm producing a homogeneous good and competing as a Cournot oligopolist in all countries. In section 4.2 we consider the case where there are many firms in each country. We let the output of firm j in country i be denoted by Q_i^j. The total output in country i is given by $Q_i = \sum_{j \in \mathcal{N}} Q_i^j$. In each country $i \in \mathcal{N}$, a firm faces an identical inverse linear demand given by:

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

Thus we are assuming symmetry in the nature of demand across countries. Section 4.3 briefly examines the effects of asymmetries in market size. All firms have a constant and identical marginal cost of production, $\gamma > 0$. We assume that $\alpha > \gamma$.

Let $T_j^i(g)$ be the tariff faced by firm i in country j in the network g. Note that $T_j^i(g) = T_i^j(g) = 0$ if $g_{ij} = 1$; however, in general, $T_j^i(g) \geq 0$ if $g_{ij} = 0$. The social welfare of country $i \in \mathcal{N}$ is given by the sum of consumer surplus, firm's profits, and tariff revenue:

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

2.3 Stable and Efficient Networks

We employ a relatively weak notion of stability based on Jackson and Wolinsky (1996), which is based on the idea that while FTAs are formed bilaterally, they can be severed unilaterally. Formally, the network g is stable if for all $i, j \in \mathcal{N}$:

(i) $S_i(g) \geq S_i(g - g_{ij})$ and $S_j(g) \geq S_j(g - g_{ij})$

(ii) if $S_i(g + g_{ij}) > S_i(g)$, then $S_j(g + g_{ij}) < S_j(g)$

In words, in a stable network, each country has no incentive to sever an existing FTA with another, and any two countries that are not involved in a PTA have no incentive to forge an agreement.

In order to study *efficient* networks, we need to consider world welfare. For any network, g, this is defined as the sum of social welfare of the N countries: $S(g) = \sum_{i\in\mathcal{N}} S_i(g)$. A network, $g^* \in \mathcal{G}$ is efficient if $S(g^*) \geq S(g)$ for all $g \in \mathcal{G}$.

3 The case of exogenous tariffs

Let the initial pre-agreement import tariff in each country be $T > \alpha$ and let the post-agreement tariff be given by 0. The natural interpretation of such an agreement is as a bilateral free-trade agreement. We suppose that tariffs remain prohibitively high between countries that do not have a bilateral free-trade agreement. This is the sense in which tariffs are exogenous. In section 4.1 we examine the case where countries adjust tariffs against non-agreement countries.

The assumption that $T > \alpha$ ensures that a firm i sells in country j if and only if there is a trade agreement between the two countries. Therefore, $\eta_i(g)$ is also the number of firms active in country i given the network g. If firm i is active in market j, then its output is given by $Q_j^i = (\alpha - \gamma)/(\eta_j(g) + 1)$. The social welfare of country i is given by:

$$S_i(g) \;=\; \frac{1}{2}\left[\frac{(\alpha-\gamma)\eta_i(g)}{\eta_i(g)+1}\right]^2 + \sum_{j\in N_i(g)}\left[\frac{\alpha-\gamma}{\eta_j(g)+1}\right]^2 \tag{3}$$

An important concern in the literature has been the negative effects of (regional and bilateral) free-trade agreements on third parties. One aspect of this effect is 'concession diversion'. The above expression allows us to examine the nature of concession diversion explicitly. Fix a network g and a country i. Consider a country $j \in N_i(g)$. The firm from country j earns profits $(\alpha - \gamma)^2/(\eta_i(g) + 1)^2$ from its operations in country i. Now consider what happens when country i forms an additional bilateral trade agreement with, say, country k. This allows the firm of country k to enter the market of country i, thus raising the level of competition. In this new network $g + g_{i,k}$, the profits of country j firm from its operations in country i are given by $(\alpha-\gamma)^2/(\eta_i(g)+2)^2$. Suppose that $j \notin N_k(g)$. It follows that profits from all other operations remain the same. Thus the effect of this additional free trade agreement between country i and country k on the profits of firm j is given by $(\alpha - \gamma)^2/(\eta_i(g) + 2)^2 - (\alpha - \gamma)^2/(\eta_i(g) + 1)^2$. This term is negative: this is the measure of concession diversion created by the new bilateral free-trade agreement.

The above observations concerning concession diversion suggest that bilateral links generate negative spillovers for third countries. We should then expect that there are 'excessive' incentives for signing such agreements. The following result builds on this insight. It delimits the class of networks that can be stable.

Proposition 1 *A stable trading network is either a complete network or consists of two components, one component has $N - 1$ countries and is complete, and the other component has a single country.*

Proof Consider a network g in which $g_{ij} = 0$. Note that a FTA between i and j leaves all other markets unaffected and raises the number of active firms in markets of country i and j by one each. Therefore:

$$\begin{aligned} S_i(g + g_{ij}) - S_i(g) &= \frac{1}{2}\left[\frac{(\alpha-\gamma)(\eta_i(g)+1)}{\eta_i(g)+2}\right]^2 - \frac{1}{2}\left[\frac{(\alpha-\gamma)\eta_i(g)}{\eta_i(g)+1}\right]^2 + \left[\frac{\alpha-\gamma}{\eta_i(g)+2}\right]^2 \\ &\quad - \left[\frac{\alpha-\gamma}{\eta_i(g)+1}\right]^2 + \left[\frac{\alpha-\gamma}{\eta_j(g)+2}\right]^2 \end{aligned} \tag{4}$$

Simplifying the above expression, we find that $S_i(g + g_{ij}) \geq S_i(g)$ if:

$$2\eta_i^2(g) - 5 + \frac{2(\eta_i(g)+2)^2(\eta_i(g)+1)^2}{(\eta_j(g)+2)^2} \geq 0 \tag{5}$$

It is easily seen that this inequality is satisfied if $\eta_i(g) \geq 2$, i.e. if there are two or more active firms in the market. Thus, if country i is involved in one or more FTAs, then it has an incentive to forge an additional FTA with j. This implies that in any network g, if i and j have one or more bilateral trade agreements, then stability demands that they have an agreement with each other as well. This means that any component in a stable trading network must be complete. Further, in any stable network, there can be at most one non-singleton component. Thus, if there are two or more components in a stable network, then at most one of them is a non-singleton component.

We next show that any two countries in autarky have an incentive to form a trade agreement. Suppose that a network g is such that i and j are in singleton components. Then, the social welfare of these countries is identical and is given by $S_i(g) = \frac{1}{2}\left[\frac{(\alpha-\gamma)}{2}\right]^2 + \left[\frac{(\alpha-\gamma)}{2}\right]^2$. If i and j establish a FTA, then the social welfare of i (and j, by symmetry) is given by $S_i(g + g_{ij}) = \frac{1}{2}\left[\frac{2(\alpha-\gamma)}{3}\right]^2 + 2\left[\frac{(\alpha-\gamma)}{3}\right]^2$. It is easily verified that $S_i(g + g_{ij}) > S_i(g)$. Thus two singleton components are not sustainable in a stable trading network.

We have thus shown that the only candidates for stable trading networks are the complete trading network and the network with a complete component with $N-1$ countries and an isolated country.

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Figure 1 provides examples of the networks that can be stable. The crucial step in the above proof is the derivation of the inequality (5). This expression suggests that the incentives of countries to have free trade agreements increase as they enter into more agreements. This is a very strong and noteworthy property. It shows how bilateral trade agreements can be a step toward a global free trade regime.

We discuss the intuition behind the stability of the network where $(n-1)$ countries are gathered in a complete network and country n is isolated. There are three effects when an autarkic country forms a bilateral free trade agreement. The foreign firm can enter the domestic market more easily. This increases domestic competition and thus increases consumers surplus and lowers profits of own firm from domestic operations. The free trade agreement also yields easier access to the domestic firm in the foreign market. This raises profits of the domestic firm from foreign operations. The last effect is positive. However, if the foreign country has a very competitive market than this effect is relatively small compared to the large negative effect on profits of the (erstwhile monopoly) domestic firm. Thus the overall effect of a bilateral free trade agreement can be negative. This prevents the autarkic country from forming a bilateral free trade agreement.

The above result leaves open the question whether the complete network, i.e., free trade regime, is actually a stable network. Our next result responds to this concern.

Proposition 2 *The complete trading network is stable.*

Proof Condition (ii) in the definition of stability is trivially satisfied since no further agreements are possible. The social welfare to country i in the complete network is given by:

$$S_i(g^c) \;=\; \frac{1}{2}\left[\frac{N(\alpha-\gamma)}{N+1}\right]^2 + \frac{N(\alpha-\gamma)^2}{(N+1)^2} \tag{6}$$

By contrast, the social welfare to country i from a network $g^c - g_{ij}$ is given by:

$$S_i(g^c - g_{ij}) \;=\; \frac{1}{2}\left[\frac{(N-1)(\alpha-\gamma)}{N}\right]^2 + \left[\frac{(\alpha-\gamma)}{N}\right]^2 + \frac{(N-2)(\alpha-\gamma)}{(N+1)^2} \tag{7}$$

It is easily established that if $N \geq 3$, then $S_i(g^c) > S_i(g^c - g_{ij})$. Thus, condition (i) of stability is also satisfied.

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What are the conditions for the unconnected network to be stable. In view of the intuition given above, the argument hinges on the number of countries in the non-singleton component. It is easily seen that the binding constraint is the incentive condition of the isolated country. Let country 1 be the isolated country. Fix a network g in which this country is isolated and all the other $(n-1)$ countries are part of a complete component. Using (4) we can rewrite the marginal payoff to this country from a bilateral free trade agreement as follows:

$$S_i(g + g_{ij}) - S_i(g) = 2 - 5 + \frac{2(3)^2(2)^2}{(\eta_j(g)+2)^2} \tag{8}$$

In the case of the network g, it follows that $\eta_j(g) = n - 1$. Thus we can rewrite the above expression as follows:

$$-3 + \frac{72}{(n+1)^2} \tag{9}$$

Simplifying, we find that this inequality is satisfied if and only if $n \geq 4$. Thus we have shown that the incomplete network is stable if there are 4 or more countries.

We briefly comment on a political economy aspect of our analysis. Propositions 1 and 2 show that if individual countries care about domestic social welfare then bilateral trade agreements will generate a free trade regime or an almost free trade regime. This raises the question:

what are the objectives of the governments? In this connection, we note an interesting but distressing fact: the profits of individual firms under autarky are given by $(\alpha-\gamma)^2/4$. By contrast, the profits of this firm under any symmetric trading regime in which every country has η active firms, are given by $\eta(\alpha-\gamma)^2/(\eta+1)^2$. It is then easily checked that individual firm's profits are higher in autarky. This suggests that the firm will have incentives to lobby against bilateral free trade agreements!

We now examine the nature of efficient networks. The following result summarizes our analysis.

Proposition 3 *The complete network is the unique efficient network.*

Proof: World welfare is given by $S(g) = \sum_{i\in N} S_i(g)$. Using (3) this can be expanded and written as:

$$S(g) \;=\; \sum_{i\in N} \frac{1}{2}\left[\frac{(\alpha-\gamma)\eta_i(g)}{\eta_i(g)+1}\right]^2 + \sum_{i\in N}\sum_{j\in N_i(g)}\left[\frac{\alpha-\gamma}{\eta_j(g)+1}\right]^2 \tag{10}$$

World welfare is thus the sum of the consumers surplus in each country plus the producer surplus of every firm in the world. It is convenient to express the latter term a little differently in terms of the sum of producers surplus generated in each of the different markets. Thus we can write world welfare as:

$$S(g) \;=\; \sum_{i\in N} \frac{1}{2}\left[\frac{(\alpha-\gamma)\eta_i(g)}{\eta_i(g)+1}\right]^2 + \sum_{i\in N}\eta_i(g)\left[\frac{\alpha-\gamma}{\eta_i(g)+1}\right]^2 \tag{11}$$

In the complete network, the welfare generated in every country is the same and is given by:

$$\frac{1}{2}\left[\frac{(\alpha-\gamma)n}{n+1}\right]^2 + n\left[\frac{\alpha-\gamma}{n+1}\right]^2 \tag{12}$$

By comparison, in an arbitrary network g, the welfare generated in country i is given by:

$$\frac{1}{2}\left[\frac{(\alpha-\gamma)\eta_i(g)}{\eta_i(g)+1}\right]^2+\eta_i(g)\left[\frac{\alpha-\gamma}{\eta_i(g)+1}\right]^2 \tag{13}$$

We wish to show that (12) is larger than (13) for every i. It is easily seem that this is true, for all $\eta_i < n$. Since the network g was arbitrary, the proof follows.

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A comparison of our results on stability and efficiency suggests that individual country incentives are quite consistent with overall world welfare.

4 Generalizations

The results from the basic model are striking and motivate an examination of more general settings. In this section, we examine three extensions. The first extension allows for endogeneous determination of tariffs, on non-agreement countries. The second extension considers the effects of a more general market structure in each country. The final extension looks at the role of market size in each country. In particular, we examine the incentives of small and large countries to engage in bilateral free trade agreements.

4.1 Endogeneous Tariffs

In the above section, we considered the case where tariffs are either prohibitive or zero. In reality, countries negotiate a range of trade agreements; moreover, the absence of an agreement is usually not the same as prohibitive tariffs. An important motivation for examining endogeneous tariff determination is the GATT clause which requires that the regional trade agreements not lead to an increase in tariffs/barriers against third parties. We wish to examine if individual countries have an incentive to raise tariffs with third parties as they form additional trade agreements.

We consider the following generalized model: In the first stage, countries bilaterally negotiate FTAs with each other. If two countries sign such an agreement then tariffs are set equal to zero for trade between them. In the second stage, each country non-cooperatively chooses an external tariff to levy on those countries with whom it does not have a FTA. In the third stage, firms in each country choose how much to produce for the domestic market and how much to export to the foreign countries.

Let g be a FTA network. Note that $T_i^j(g) = T_j^i(g) = 0$ if $g_{ij} = 0$. Further, since all countries are ex-ante symmetric, $Q_i^k(g) = Q_i^l(g)$ for all $k, l \in \mathcal{N}\backslash N_i(g)$. Therefore, $T_i^k = T_i$ for all $k \in \mathcal{N}\backslash N_i(g)$. The Cournot equilibrium outputs in country i are:

$$Q_i^j(g) \;=\; \frac{(\alpha-\gamma)+(N-\eta_i(g))T_i(g)}{(N+1)}\;, \quad j \in N_i(g) \tag{14}$$

$$Q_i^k(g) \;=\; \frac{(\alpha-\gamma)-(\eta_i(g)+1)T_i(g)}{(N+1)}\;, \quad k \in \mathcal{N}\backslash N_i(g) \tag{15}$$

Substituting (14) and (15) in (2) yields the following expression for social welfare in country i:

$$\begin{aligned} S_i(g) \;=\; & \frac{1}{2}\left[\frac{N(\alpha-\gamma)-(N-\eta_i(g))T_i(g)}{(N+1)}\right]^2 \\ & + \sum_{j:\, g_{ij}=1}\left[\frac{(\alpha-\gamma)+(N-\eta_j(g))T_j(g)}{(N+1)}\right]^2 \\ & + \sum_{k:\, g_{ik}=0}\left[\frac{(\alpha-\gamma)-(\eta_k(g)+1)T_k(g)}{(N+1)}\right]^2 \\ & + (N-\eta_i(g))T_i(g)\left[\frac{(\alpha-\gamma)-(\eta_i(g)+1)T_i(g)}{(N+1)}\right] \end{aligned} \tag{16}$$

Country i chooses its tariff non-cooperatively to maximize (16). This yields:

$$T_i^*(g) \;=\; \frac{3(\alpha-\gamma)}{\eta_i(g)(2N+5)-(N-2)} \tag{17}$$

Therefore, the optimal tariff is a *decreasing* function of the number of bilateral links of Country i. This is an important finding of our analysis. We provide some intuition for it now.

A rise in tariffs has three effects: the first effect is that it lowers competition in the domestic market, thus increasing the profits of the domestic firm. The second effect is that, by lowering competition, it lowers consumers welfare. The third effect is on the aggregate level of tariff revenue. To get some intuition for the above result let us look at the impact of an additional FTA on each of these three effects. This impact is clearly reflected in the first derivative of the social welfare function with respect to the tariff level, which is produced below.

$$\begin{aligned}\frac{\delta S_i(g)}{\delta t_i(g)} &= -\frac{N-\eta_i(g)}{N+1}\left[\frac{N(\alpha-\gamma)-(N-\eta_i(g))T_i(g)}{(N+1)}\right] \\ &+ \frac{N-\eta_i(g)}{N+1}\left[\frac{2(\alpha-\gamma)+2(N-\eta_i(g))T_i(g)}{(N+1)}\right] \\ &+ \frac{N-\eta_i(g)}{N+1}\left[(\alpha-\gamma)-2(\eta_i(g)+1)T_i(g)\right] \qquad (18)\end{aligned}$$

We note that a rise in the number of agreements from $\eta_i(g)$ to $\eta_i(g)+1$ has an impact on the marginal cost of tariffs (in terms of higher consumer surplus lost) and at the same time lowers the marginal benefit (in terms of lower profits of the domestic firm and lower tariff revenue) from higher tariffs. The sign of the first effect is unclear, but the latter two effects are straightforward. An additional free-trade agreement means that there are fewer countries on whom the tariff is effective. Hence there are fewer firms affected by such a tariff and this means that the positive effect on the profit of the domestic firm is less marked. Relatedly, fewer non-agreement countries means that the the pool from which the revenue is collected is smaller, and at the same time the quantity response to increases in tariff of the remaining firms (in the non-agreement countries) is more acute. Both these pressures work toward lowering the revenue gathering effects of higher tariffs. These considerations underlie the relationship between the number of bilateral free-trade agreements and the level of tariffs on goods from non-agreement countries.

We next consider the impact of bilateral trade agreements on third country welfare. First consider the case of a country k which does not have a bilateral trade agreement with either country i or j in the network g. A FTA between i and j only affects the export profits of k in the markets of i and j. After some simplification, the impact on such a country can be stated as follows:

$$S_k(g + g_{ij}) - S_k(g) \;=\; 9(\alpha - \gamma)\left\{\left[Q_i^k(g) + Q_i^k(g + g_{ij})\right] + \left[Q_j^k(g) + Q_j^k(g + g_{ij})\right]\right\} \qquad (19)$$

Thus bilateral trade agreements have positive externalities on such unconnected countries.

Consider next the welfare of a country k which has a bilateral free trade agreement with both i and j. It can be seen that such a country is only affected via the impact on its firm's profits from export operations in i and j.There are two effects in these markets: first, more firms can compete without paying tariffs, and second, the tariffs on the remaining countries fall. Both these effects make the market more competitive and thus lower the export profits of firm k. This the extent of concession diversion and this adversely affects welfare of country k.

Countries which have an agreement with i but not j (or vice-versa) fall in the intermediate category: there is some loss in welfare due to concession diversion (in the country with whom there is a free-trade agreement) but there is also increase in profits due to lowering of tariffs in the other country. The combined effect? What is the aggregate impact on the world welfare? We do not have an answer to this question yet.

Given the complexity of the computations involved, we have been unable to completely characterize the nature of stable networks in this setting. We do have some interesting partial results. These are presented next. The first result shows that free trade is consistent with stability.

Proposition 4 *The complete network is stable.*

Proof: Since $T_i^*(g^c) = 0$, social welfare of country i becomes:

$$S_i(g^c) \;=\; \frac{1}{2}\left[\frac{N(\alpha-\gamma)}{(N+1)}\right]^2 + N\left[\frac{(\alpha-\gamma)}{(N+1)}\right]^2 \tag{20}$$

There are no links to add so condition (ii) of stability is trivially satisfied. Now consider the network $g - g_{ij}$ and note that $T_i^*(g^c - g_{ij}) = T_j^*(g^c - g_{ij}) = T^*$.

$$\begin{aligned} S_i(g^c - g_{ij}) \;=\; & \frac{1}{2}\left[\frac{N(\alpha-\gamma)-T^*}{(N+1)}\right]^2 + \left[\frac{(\alpha-\gamma)+T^*}{(N+1)}\right]^2 + \left[\frac{(\alpha-\gamma)-NT^*}{(N+1)}\right]^2 \\ & + (N-2)\left[\frac{(\alpha-\gamma)}{(N+1)}\right]^2 + T^*\left[\frac{(\alpha-\gamma)-NT^*}{(N+1)}\right] \end{aligned} \tag{21}$$

It follows that:

$$S_i(g^c) - S_i(g^c - g_{ij}) \;=\; \frac{T^*}{2}\left[2(\alpha-\gamma)(N-3) + T^*(2N-3)\right] \;>\; 0 \tag{22}$$

Therefore, condition (i) of stability is also satisfied. $\triangle$

More generally, we are able to obtain the following property of stable networks.

Proposition 5 *Consider a stable network g. If for some i and j, $\eta_i(g) = \eta_j(g)$ then $g_{ij} = 1$.*

Proof We first note that since $\eta_i(g) = \eta_j(g)$, then from the expression for optimal tariffs, it follows that $T_i^*(g) = T_j^*(g) = T$ and also that $T_i^*(g + g_{ij}) = T_j^*(g + g_{ij}) = T'$. Note also that we can let $\eta \leq N-2$ since the proof for $\eta = N-1$ is identical to the one demonstrating that the complete network is stable. The change in consumer surplus, $\Delta CS(g)$, is given by:

$$\Delta CS(g) \;=\; \frac{1}{2}\left[\frac{(N-\eta)T - (N-\eta-1)T'}{N+1}\right]\left[\frac{2N(\alpha-\gamma) - (N-\eta-1)T' - (N-\eta)T}{N+1}\right] \tag{23}$$

The change in domestic profits, $\Delta\pi_i^i(g)$, is given by:

$$\Delta\pi_i^i(g) \;=\; \left[\frac{(N-\eta-1)T' - (N-\eta)T}{N+1}\right]\left[\frac{2(\alpha-\gamma) + (N-\eta)T + (N-\eta-1)T'}{N+1}\right] \tag{24}$$

The change in tariff revenues, $\Delta\tau_i(g)$, is given by:

$$\Delta\tau_i(g) \;=\; \frac{1}{(N+1)}\left[(N-\eta-1)T'\{(\alpha-\gamma) - (\eta+2)T'\} - (N-\eta)T\{(\alpha-\gamma) - (\eta+1)T\}\right] \tag{25}$$

The change in firm i's profit in country j's market, $\Delta\pi_j i(g)$, is given by:

$$\Delta\pi_j^i(g) \;=\; \left[\frac{(N-\eta-1)T' + (\eta+1)T}{N+1}\right]\left[\frac{2(\alpha-\gamma) + (N-\eta-1)T' - (\eta+1)T}{N+1}\right] \tag{26}$$

To show that $S_i(g+g_{ij}) > S_i(g)$, we first show that $\Delta CS(g) + \Delta\pi_i^i(g) > 0$. From (23) and (24), this requires showing that $2N(\alpha-\gamma) > 4(\alpha-\gamma) + 3(N-\eta)T + 3(N-\eta-1)T'$. Letting $\xi \equiv \eta(2N+5) - (N-2)$, this is equivalent to $2(N-2)\xi(\xi+2N+5) > 9(N-\eta)(\xi+2N+5) + 9(N-\eta-1)\xi$. Noting that $\xi \geq N+7$, this is easily verified to be true. Next, we show that $\Delta\pi_j^i(g) + \Delta\tau_i(g) > 0$. For this, it suffices to show that $[(N-\eta-1)T' + (\eta+1)T][2(\alpha-\gamma) + (N-\eta-1)T' - (\eta+1)T] > (N+1)[(N-\eta)T\{(\alpha-\gamma) - (\eta+1)T\}]$. Simplifying, it requires showing that $6\xi(N-\eta-1) > (N+1)(N-\eta)$. This is easily verified to be true for $\eta \leq N-2$.

$\triangle$

The above proposition has several interesting implications for the nature of stable networks. For instance, the empty network, g^e is not stable. Similarly, a stable network cannot have two or more singleton components. Finally, if there are two or more complete components then they must each have a different number of countries.

Our analysis of the exogenous tariffs case suggests that the sign of the expression $S_i(g + g_{i,j}) - S_i(g)$ is crucial for an understanding of the nature stable networks. It is difficult to identify down the sign of this term in general. We therefore used simulations to get some idea of this expression. In our simulations we set $n = 100$, $\alpha = 200$ and $\gamma = 100$.

There are four different effects by an additional bilateral free-trade agreement, $g_{i,j}$ on country i: the first effect is on the consumers surplus in country i. The second effect is on the profits of firm i in country j. The third effect is on the profits of firm i in its domestic market. The fourth effect is on the tariff revenue in country i. These effects are plotted respectively in Figures 2a-2d. We note that the signs of the effects correspond to our intuition. The first two effects are positive, while the latter two effects are negative.

We aggregate these effects in Figure 3. Figure 3a presents the results when we set $\eta_j(g) = 1$, while Figure 3b presents the results when we set $\eta_j(g) = 100$. These two numbers reflect the two extreme values for competitiveness in market j. Thus when $\eta_j(g) = 1$, the market is monopolized and hence very attractive for the firm from country i. When $\eta_j(g) = 100$, the market is very competitive and a free-trade agreement will not lead to any substantial increase in profits of firm i from its enhanced access of market j.

Our simulations suggest that $S_i(g + g_{i,j}) - S_i(g)$ is positive at all levels of $\eta_i(g)$, if $\eta_j(g) = 1$. If $\eta_j(g) = 100$ then the sign is positive for all values of $\eta_i(g)$ above a small number. Over all, it seems that country i has an incentive to form bilateral free-trade agreements. Since this country was chosen arbitrarily, this suggests that bilateral free-trade agreements should lead to every pair of countries signing similar agreements, leading to the global free trade regime. This result is broadly in conformity with the results in the case with exogenous tariffs.

4.2 Market Structure

In our basic model, we assumed that each country has a monopoly firm. In this section we examine the case of a oligopoly in each country. The principal finding is that Propositions 1-2 are robust to this generalization.

Suppose there are $k \geq 1$ firms in each market. Fix a network g. We examine the incentives of a country i to form a bilateral free trade agreement with a country j. We shall proceed as in the basic model with exogenous tariffs; thus if two countries do not have an agreement then they impose prohibitive import tariffs on each other's products. In this setting, we find the following result.

Proposition 6 *Suppose there are $k \geq 1$ domestic firms in each market. A stable trading network is either a complete network or consists of two components, one component has $N-1$ countries and is complete, and the other component has a single country.*

Proof: The crucial expression is $S_i(g+g_{i,j}) - S_i(g)$. With $k \geq 1$ firms, expression (4) can be rewritten as follows:

$$\begin{aligned} S_i(g+g_{ij}) - S_i(g) &= \frac{1}{2}\left[\frac{(\alpha-\gamma)(\eta_i(g)+1)k}{(\eta_i(g)+1)k+1}\right]^2 - \frac{1}{2}\left[\frac{(\alpha-\gamma)\eta_i(g)k}{\eta_i(g)k+1}\right]^2 + k\left[\frac{\alpha-\gamma}{(\eta_i(g)+1)k+1}\right]^2 \\ &\quad - k\left[\frac{\alpha-\gamma}{\eta_i(g)k+1}\right]^2 + k\left[\frac{\alpha-\gamma}{(\eta_j(g)+1)k+1}\right]^2 \end{aligned} \tag{27}$$

Simplifying the above term, we find that $S_i(g+g_{i,j}) - S_i(g)$, if

$$2\eta_i^2(g)k^2 + 2\eta_i(g)k - 2\eta_i(g)k^2 - 2k^2 - 3k] + \frac{2((\eta_i(g)+1)k+1)^2(\eta_i(g)k+1)^2}{((\eta_j(g)+1)k+1)^2} \geq 0 \tag{28}$$

The second term is clearly positive. The first term is positive and increasing in value for all $\eta_i(g) \geq 2$. Thus any country that has a bilateral agreement, and has therefore 2K or more firms, has an incentive to form additional agreements. This implies that in any stable network, any two countries with agreements also have an agreement with each other. Finally, it easily shown that if two countries are autarkic then they have an incentive to form a bilateral free trade agreement. This completes the proof.

△

The final result in this section shows that a stable network always exists; in particular, free trade is consistent with bilateralism.

Proposition 7 *The complete trading network is stable.*

The proof of this result uses computations analogous to those of Propositions 2 and 6 and is omitted.

4.3 Size of Countries

In the basic model we assumed that all countries had a a fixed market size and that it was the same across countries. In this section we briefly examine the role of country size.

We parameterize country size in terms of the value of $\alpha - \gamma$. The first observation concerns the impact of increasing demand size in a world where all countries are of equal size. It follows from expression (4) that market size enters as a multiplicative term in the overall incentive to form links. Thus it enhances the overall effect of forming a link. For $\eta_i(g) \geq 2$, this effect is clearly positive. In this sense, we may say that increasing market size encourages countries to have more bilateral free trade agreements.

The other issue we wish to examine is the relative payoffs of large and small countries form forming a link with each other. Recall that in the basic model with same country size, two countries with equal number of links have the same returns from forming an extra agreement. However, in case the countries are of unequal size the benefits are unclear.

We shall suppose that there are two types of countries, large and small. Large countries have a value of $\alpha - \gamma > 0$, while for small countries this value is exactly 1. Let country i be large and country j be small. It is then straightforward to show that

$$S_i(g + g_{i,j}) - S_i(g) = (\alpha - \gamma)^2 \left[2\eta_i^2(g) - 5\right] + \frac{2(\eta_i(g) + 2)^2(\eta_i(g) + 1)^2}{(\eta_j(g) + 2)^2} \tag{29}$$

Similarly, the benefits to the small country are given by

$$S_j(g + g_{i,j}) - S_j(g) = \left[2\eta_j^2(g) - 5\right] + (\alpha - \gamma)^2 \frac{2(\eta_j(g) + 2)^2(\eta_j(g) + 1)^2}{(\eta_i(g) + 2)^2} \tag{30}$$

Simple calculations then show that $S_j(g + g_{i,j}) - S_j(g) > S_i(g + g_{i,j}) - S_i(g)$. Thus the small country gets relatively larger benefits when a large and a small country form a bilateral free trade agreement. These computations suggest that we should expect to see relatively more bilateral free trade agreements between large countries and between small and large countries and few such agreements between small countries. This appears to be broadly in line with the empirically observed pattern.

5 Conclusion

Our interest has been in the following question: what structure of free-trading areas is consistent with the incentives of individual countries? We have developed a simple model of network formation to analyze this question. In this model, the points are the countries and the links between them represent bilateral free-trade agreements. We find that a complete network, i.e., one in which every pair of countries has a free-trade agreement and thus global free trade obtains, is consistent with the incentives of individual countries. This result suggests that bilateralism can be seen as a useful building step toward a liberal world trading system. A related finding of policy relevance is that tariffs on third countries are a declining function of the number of free-trade agreements a country has: this suggests that bilateralism is consistent with one important element of the GATT.

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