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Does free trade benefit all?*

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Abstract

Although global free trade is efficient, each country's benefit from free trade depends on the path that leads to the global trade agreement. Using a dynamic model of trading bloc formation, we show that when global free trade is reached gradually, the countries that are initially excluded gain less than the rest and may be even made worse-off by the final free trade agreement, compared with the initial state of autarkies.

1 Introduction

Does free trade benefit all? Ohyama [9] and Kemp and Wan [3] show that it is possible that no country suffers from the formation of a trading bloc. Consequently, global free trade can be established through a sequence of expanding trade agreements such that no country loses at any stage while some countries gain. Strategic issues notwithstanding, this result relies on altruism of the trading bloc members in setting compensating external tariffs.

We revisit the issue whether free trade benefits all in a dynamic strategic model where countries can form trading blocs or custom unions endogenously.

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By forming a customs union, member countries agree on the tariffs on mutual trade (often implying free trade among members) and on the tariffs on their imports from non-members. In our model, although global free trade eventually emerges as the equilibrium outcome, some countries may benefit more than others do. In fact, it is possible for a country to be worse off compared with the initial situation where all countries are alone. That is, free trade does not necessarily benefit all. The driving forces of such a possibility are the externalities a trading bloc imposes on outsiders and the strategic behavior the countries entertain in forming a trading bloc. In particular, it is possible for global free trade to transpire only via an intermediate stage where a subset of the countries form a trade union. As a result, the countries who are left out at this stage may become the "victim" of free trade.

The literature on international trade agreements often considers a two-stages process in order to depict the timing of such relationships. In the first stage, which is often referred to as the trade union (coalition) formation stage, countries choose their partners in the trade agreements. In the second stage, each trade union sets tariffs given the partition from the first stage. In this stage, countries within each trade union behave cooperatively to maximize their joint welfare, while the interactions among different trade unions are noncooperative.

Sharing this common structure, models in the literature differ in the formalization of both stages. The differences in the second stage depend on the underlying economic model, while the differences in the first stage depend on the approach to the coalition formation procedure. All the papers share the assumption that the grand coalition is efficient, which is often equivalent to asserting that free trade is the efficient organization.

Concerning the first stage, the core has been considered as a natural solution concept for analyzing a word-wide trade agreement and free trade. For example, Riezman [10] and Macho-Stadler et al. [8] use the core to identify the stable partition of countries into customs unions. These papers rule out the possibility of international transfers but account for the externalities that a customs union inflicts on other countries. Kowalczyk and Sjöström [7] and Konishi et al. [5] also take a cooperative approach to the first stage of the game, but they allow for monetary transfers among countries. However, these models do not consider externalities among the coalitions of countries, which simplifies the analysis of the transfer scheme within the countries when they sign a trade agreement. Kowalczyk and Sjöström [7], in a many-country monopoly trade model, show that the grand coalition may require international income transfers. They derive a formula for the transfers that leads to free trade (the grand coalition forms) and supports the Shapley value as a core allocation. Konishi et al. [5] study which of the Ohyama-Kemp-Wan sequence of agreements will actually form on the way to global free trade.

Burbidge et al. [2] consider a one-shot noncooperative game of coalition formation in the first stage where countries simultaneously announce their partners for trade unions. Their model allows for both transfers and externalities. They show that when there are more than two countries, global free trade may not be an equilibrium outcome. Our paper complements the previous papers by considering a dynamic noncooperative model of customs union formation. With such a framework, a subset of countries' forming a customs union does not preclude the global free trade agreement from being reached eventually. Casual observation does support gradual formation of trade unions. For example, before NAFTA was formed, the United States and Canada were already enjoying their bilateral trade agreements. Similarly, the European Union started with only six countries, to reach the present membership of twenty five countries through gradual admittance of new members.

Concerning the second stage, different models of custom unions have been analyzed in the literature. Kennan and Riezman [4] construct a pure exchange economy in which commodity demands in each country are generated by a linear demand system. In their model all countries charge optimal tariffs given the structure of customs union and the tariffs charged by other countries, but international transfers are not allowed. As the authors point out, the analysis of optimal tariffs is very complicated even when trade-agreements are not considered. They generate some examples with three countries and three goods that highlight some interesting aspects of the problem. In particular, the formation of custom unions can improve its members welfare relative to free-trade. Burbidge et al. [2] consider a one-good model of capital tax competition with interstate trade of mobile capital for the consumption good. While their model is quite appealing, it is not analytically tractable. They provide examples to illustrate, for example, that the grand coalition may not be an equilibrium outcome. In view of this, we employ a very simple three country model as in Macho-Stadler et al. [8] that is analytically solvable even for asymmetric situations[1] and at the same time generate payoff configurations qualitatively similar to those in Kennan and Riezman [4] and

[1]Yi [11] also provides a solvable model but only for symmetric countries.

Burbidge et al. [2]. Krishna [6] uses a model of imperfect competition similar to ours and examine how bilateral trade agreement affects multilateral trade liberalization.

In a recent paper, Aghion, Antràs, and Helpman [1] consider a three-country dynamic bargaining game where one country plays the role of a "leader" or agenda setter who has the power to choose how negotiation is to be conducted (multilaterally or sequentially). Their second-stage game is a partition function game. They analyze the incentive of the agenda setter in choosing the form of negotiation and show that free trade emerges when payoffs exhibit grand-coalition superadditivity.

We show that in equilibrium of our model the grand coalition is always formed and engages in free trade. However, the grand coalition is not necessarily formed in one step. Indeed, if countries are patient, a two country customs union is formed first, after which it merges with the third country to form the grand coalition. In doing so, the two countries that form the initial trading bloc extract more surplus at the expense of the third country's welfare in the final free trade agreement. In fact, the third country may be worse off in the end compared with the initial position where all countries are alone.

The organization of the paper is as follows. Section 2 presents the model. Section 3 examines the welfare properties of different trading bloc structures and determines each country's payoff as a function of the current trade bloc structure and the sequence that leads to this trade bloc structure. Section 4 presents and analyzes the dynamic game of trading bloc formation. Proofs are relegated to the Appendix.

2 The model

Consider a three country model where a homogeneous good is produced and sold in each period. Countries are indexed by 1, 2, and 3. Each country has one firm (also indexed by 1, 2, and 3) that produces the good and sells it in the domestic and foreign markets. The inverse demand function of country i, for $i = 1, 2, 3$, is

$$p_i = a_i - Q_i,$$

where p_i is the domestic price and Q_i is the total amount sold in country i. Let q_{ij} denote the quantity sold in country i by firm j. Then,

$$Q_i = q_{i1} + q_{i2} + q_{i3}.$$

Country i sets tariffs $t_{ij} \geq 0$ on firm j's product sold in country i, with t_{ii} interpreted as quantity tax on the domestic firm. The production cost function of firm i is $C_i(q) = c_i q$, where $c_1 \leq c_2 \leq c_3$. In each country i, firms choose quantity in a noncooperative fashion given the tariffs (t_{i1}, t_{i2}, t_{i3}). The effective unit costs of firm j's product sold in country i are $(c_i + t_{ij})$ if the solution leads firm j to produce in equilibrium. The reason for choosing such a model is two-fold: it is analytically tractable and can generate payoff structures similar to those in the literature. Moreover, for our purpose, a three country model is sufficient.

If the solution is interior, in the unique Cournot (Nash) equilibrium, firm j sells the following quantity in country i :

$$q_{ij} = \frac{a_i + (c_\ell + t_{i\ell}) + (c_k + t_{ik}) - 3(c_j + t_{ij})}{4}, \tag{1}$$

where $j, k, l \in \{1, 2, 3\}$ are distinct numbers. In equilibrium, the output that firm j sells in country i is decreasing in its own effective costs and increasing in its rivals' effective costs. Note that by setting t_{ij} high enough, country i could induce firm j not to sell in i's domestic market. For simplicity, we assume throughout the paper that the demand in every country is high enough relative to costs, so that in equilibrium all firms are always active in all three markets.[2] Let π_{ij} be firm j's profits in country i. Then,

$$\pi_{ij} = q_{ij}^2. \tag{2}$$

The consumer surplus in country i, if all firms sell in this country, is

$$CS_i = \frac{1}{32}\left(3a_i - \sum_{j=1}^{3}(c_j + t_{ij})\right)^2. \tag{3}$$

Note that each firm's profits and consumer welfare in country i depend only on the tariff structure set in country i. The domestic firm's profits are increasing in the tariffs applied to foreign firms and decreasing in the tax on

[2]For asymmetric firms, with $c_1 \leq c_2 \leq c_3$, a sufficient condition is $a_i > 11c_3 - 5c_2 - 5c_1$. For symmetric firms (equal costs) this reduces to assume that $a_i > c$ for every country i.

its own product. Consumer surplus in each country is increasing in the total quantity sold in that country. This implies that it is decreasing in the effective costs of the firms that sell in the domestic market and hence in the tariffs t_{i1}, t_{i2} and t_{i3}.

Total welfare per period in country i is the sum of its consumer surplus, the total profits of the domestic firm, and the total revenue from tariffs/tax:

$$W_i = CS_i + \sum_{j=1}^{3} \pi_{ji} + \sum_{j=1}^{3} t_{ij} q_{ij}. \tag{4}$$

Note that total welfare in country i depends on the whole set of tariffs since the profits of the domestic firm depend on the tariffs set by the three countries.

A group of countries can form a trading bloc. A partition describes how the three countries organize themselves into trading blocs. The set of possible partitions is given by $\mathcal{P} = \{I, [12], [13], [23], N\}$, where,

$$\begin{aligned} I &= (\{1\}, \{2\}, \{3\}) \\ [ij] &= (\{i, j\}, \{k\}), \text{ where } i, j, k \in \{1, 2, 3\} \text{ are distinct} \\ N &= (\{1, 2, 3\}). \end{aligned}$$

In the first partition, all three countries remain alone while all three countries form one trading bloc (the grand trading bloc or the grand coalition) in the last partition. Each of the other partitions involves a two-country trading bloc and one country being alone. Given a partition of the three countries (into trading blocs), the blocs choose tariffs noncooperatively and each bloc maximizes the joint welfare of its members. That is, we assume that transfers among countries in the same trading bloc are possible while transfers across different trading blocs are not.

For any partition of the countries into trading blocs, we can determine the equilibrium tariffs and taxes given this partition. Taxes on domestic firm decrease both domestic consumer surplus (3) and domestic firm's profits due to the decrease in its production (1) but increase tax revenue. Tariffs on foreign firms decrease domestic consumer surplus (3) while increasing domestic firm's profits and tariff revenue. In equilibrium, any trading bloc chooses free trade among its members and sets zero taxes on the domestic firms. In addition, the tariffs on the outsider(s) are increasing in the domestic demand and decreasing in the production costs of the outsider(s). Full characterization of the equilibrium taxes and tariffs is presented in Appendix 1.[3]

Given the above equilibrium taxes and tariffs we can determine each trading bloc's welfare for every partition. Let W_i^I be country i's welfare in equilibrium when no trading blocs are formed. Let W_T^N denote the total (global) welfare when the grand coalition/trading bloc forms and optimally chooses free trade. Lastly, given partition $[ij]$, let $W_{ij}^{[ij]}$ be the joint welfare of countries i and j and $W_k^{[ij]}$ country k's welfare.

3 Payoffs

In this section we ascertain countries's payoffs associated with any trade agreement structure $P \in \{I, [12], [13], [23], N\}$. We first examine the properties of the welfare functions defined in the previous section.

3.1 Welfare Properties

Obviously the grand coalition is efficient in that it generates the highest total welfare, since a tariff agreement for any trading bloc can be mimicked by the grand coalition. As for any trade agreement structure in which two countries form a trading bloc, the next two propositions state the impact of this trading bloc on the outsider and the incentives of the two insiders in forming the trading bloc.

Proposition 1 *The game is of negative externalities in that when two countries merge the third one suffers:* $W_k^{[ij]} < W_k^I$ *for any* i, j, k *distinct.*

Therefore, when two countries i and j form a trade union, the third country k's welfare is reduced, as compared to the situation where no trading bloc is formed and this is true irrespective of the level of demand or production cost in country k.

It can be shown that $\left(W_k^{[ij]} - W_k^I\right)$ is decreasing in a_i and a_j but does not depend on a_k. In addition, $\left(W_k^{[ij]} - W_k^I\right)$ is increasing in c_k and, if demands

[3]Let us note that autarchy is always a possible outcome, if a country sets tariffs in such a way that no foreign firm sells in the domestic market. However, under our condition on demands, as it is shown in Appendix 1, this does not arise in equilibrium.

a_i and a_j are not too different, it is decreasing in c_i and c_j. Hence, the higher the demands of the two countries in the trading bloc and the more efficient the outsider, the more harmful the agreement is for the outsider.

Proposition 2 *Any two countries have an incentive to cooperate. That is,* $W_{ij}^{[ij]} > W_i^I + W_j^I$ *for* $i, j \in \{1, 2, 3\}$.

It is worth noting that the incentive for two countries to cooperate, measured by $\left(W_{ij}^{[ij]} - W_i^I - W_j^I\right)$, increases with the size of their demands, a_i and a_j, and does not depend on the demand of the outsider a_k. This expression is increasing in the cost of the outsider, c_k and, when demands of the two countries are not too different, it is decreasing in the costs of the cooperating countries, c_i and c_j. Hence, the higher the demands of the two firms entering an agreement and the less efficient the outsider, the more incremental surplus two countries will generate by forming a trading bloc.

3.2 Payoffs Associated with Each Partition

When a new trading bloc is created, the change in each member country's welfare depends on the surplus generated by the new trade agreement and the sharing rule the trading bloc adopts. To characterize each country's payoff, we assume that members of the new trading bloc *share equally the incremental surplus*[4] (possibly via transfers). In doing so, we take the view that each country's payoff depends not only on the current trade agreement structure but also on the sequence of trade agreement structures that precede the current one. In particular, how the three countries in our framework share the gain from free trade when the grand coalition forms depends on whether the grand trading bloc forms directly or through some intermediate stage where two of the countries form a trading bloc first.

If all countries are alone, each country i's, where $i \in \{1, 2, 3\}$, status quo payoff is W_i^I. If no trading bloc emerges, country i's payoff in each period remains W_i^I. A subset of countries can form a trading bloc. If the first trading bloc has only two members, then they share the surplus equally while the third country sees its welfare reduced. Each country's payoff remains the

[4]Different sharing rules can be employed without altering the qualitative results, as we shall illustrate in the next subsection.

same until the first trading bloc merges[5] with the third country to form the grand coalition, in which case all countries share the incremental surplus equally. Another possibility is that the three countries may decide to form the grand coalition directly when they are alone. Once the grand coalition forms, each country's payoff in each period stays the same thereafter. Therefore, each country's payoff only depends on the sequence of *distinct* partitions that have emerged thus far. The set of possible sequences of partitions, each of which starts with I, is

$$\mathcal{S} = \{I, I - [ij], I - [ij] - N, I - N\}_{i,j \in N, i \neq j},$$

where I depicts, for example, that no trading bloc has been formed and I remains the current partition, while $I - [ij] - N$ depicts that the grand coalition forms via intermediate partition $[ij]$.

We now start with I and determine recursively the payoff allocations associated with each of the above sequences. We shall denote by $V_i(S)$ the payoff (per period) of country i following sequence $S \in \mathcal{S}$. Obviously, $V_i(I) = W_i^I$.

If the grand coalition is formed in one step, as denoted by sequence $I - N$, the incremental surplus is

$$\Delta(I - N) = W_T^N - \left(W_1^I + W_2^I + W_3^I\right).$$

In this case country i receives the payoff

$$V_i(I - N) = W_i^I + \frac{1}{3}\Delta(I - N).$$

If trading bloc $\{i, j\}$ is formed (from I), it generates a surplus in the amount of

$$\Delta(I - [ij]) = W_{ij}^{[ij]} - \left(W_i^I + W_j^I\right).$$

The payoff of country $\ell \in \{i, j\}$ associated with sequence $I - [ij]$ is

$$V_\ell(I - [ij]) = W_\ell^I + \frac{1}{2}\Delta(I - [ij]),$$

while country k's (who stays isolated) payoff is

$$V_k(I - [ij]) = W_k^{[ij]}.$$

[5] We adhere to the assumption that once a trading bloc has been formed, it never dissolves but it can merger with other countries or trading blocs.

Consider now the case in which the grand coalition is formed through an intermediary step where two countries, i and j, form a trade union first. This corresponds to the sequence $(I - [ij] - N)$.

The incremental surplus generated by forming the grand coalition via an intermediary trading bloc $\{i, j\}$ is

$$\Delta(I - [ij] - N) = \left(W_T^N - \left(W_{ij}^{[ij]} + W_k^{[ij]}\right)\right).$$

Countries' payoffs associated with the sequence $(I - [ij] - N)$ are as follows:

$$\begin{aligned} V_\ell\,(I - [ij] - N) &= V_\ell(I - [ij]) + \frac{1}{3}\Delta(I - [ij] - N) \text{ for all } \ell \in \{i, j\}, \\ V_k\,(I - [ij] - N) &= V_k(I - [ij]) + \frac{1}{3}\Delta(I - [ij] - N). \end{aligned}$$

Once we have determined each country's per period payoff associated with every sequence in $\mathcal{S}$, we proceed to present some properties of the countries' payoff functions.

Proposition 3 *If the grand coalition eventually forms, being left out in the first round always results in the worst final payoff. Formally,*

$$V_k\,(I - [ij] - N) < \min\{V_k\,(I - [jk] - N)\,, V_k\,(I - [ik] - N)\,, V_k(I - N)\}$$

for distinct $i, j,$*and* k.

The next proposition shows that among the sequences leading to the (eventual) formation of the grand coalition, any two countries prefer the one in which they form a trading bloc first.

Proposition 4 *Any pair of countries* i *and* j *benefit by forming a trading bloc first. Formally,*

$$V_i\,(I - [ij] - N) > \max\{V_i\,(I - [jk] - N)\,, V_i\,(I - N)\}$$

for distinct $i, j,$ *and* k.

Recall that when countries i and j form a trading bloc first, a negative externality is imposed on country k. In fact, such a negative externality may be large enough to make country k worse off in the grand trading bloc than when all countries are independent, although once i and j form a trading bloc, it is in k's best interest to join them subsequently.

To illustrate the previous results, take the example where countries 1 and 2 are identical with $a_1 = a_2 = 100$ and $c_1 = c_2 = 0$, and country 3 has $a_3 = 22$ and $c_3 = 2$. Then the payoff of the countries as a function of the coalition structure and the path are:[6]

Sequence S	$V_1(S)$	$V_2(S)$	$V_3(S)$
I	4090.75	4090.75	335.22
$I-[12]$	4471.945	4471.945	206.852
$I-[12]-N$	**4578.947**	**4578.947**	**313.854**
$I-[13]$	4266.543	4015.703	$511,013$
$I-[13]-N$	4492.706	4241.866	737.176
$I-N$	**4409.093**	**4409.093**	**653.563**

Note that in the previous example, country 3 is worse off in the end when the grand coalition is form via $(I-[12]-N)$ than in the singleton case.

While the above properties that our payoff functions exhibit (Propositions 1, 2 and 3) can be attributed to the Cournot model we employ, other models in the literature share the same characteristics as the previous example. This is the case for the four examples in Kennan and Riezman [4] (pages 77 and 78). Taking the first example of their paper (where countries are symmetric), and adding transfers by applying the equal sharing of the surplus, we can compute the countries' payoff for the different sequences:

Sequence S	$V_1(S)$	$V_2(S)$	$V_3(S)$
I	79.77	79.77	79.77
$I-[12]$	88.56	88.56	68.80
$I-[12]-N$	**96.73**	**96.73**	**76.96**
$I-N$	**90.14**	**90.14**	**90.14**

Note that as in this example, by merging sequentially, players 1 and 2 may increase their payoff; however, country 3 losses at the end. The same happens in the other examples presented in Kennan and Riezman [4].

The same features are present in the example presented by Burbidge et al. [2]. For their example all countries share the same production technology, a Cobb-Douglas function that uses capital and labour as inputs. Countries

[6]Note that $(I-[23]-N)$ will be similar to $(I-[13]-N)$ changing the payoffs of player 1 and 2 since these countries are identical.

differ in their input endowments. Countries 1 and 2 are similar and are relatively capital-abundant. Country 3 has no capital, but has a large labour endowment. Table 1 of their paper summarizes the payoffs in terms of the Nash Equilibrium in capital tax competition as a function of the coalition structure. We add the payoff of the grand coalition when it is reached through the path $(I-[12]-N)$ or $(I-[13]-N)$ and we apply the equal sharing of surplus generated when a trade bloc is formed. Then we have:

Sequence S	$V_1(S)$	$V_2(S)$	$V_3(S)$
I	0.0736	0.0736	0.8235
$I-[12]$	0.1217	0.1217	0.6835
$I-[12]-N$	**0.1460**	**0.1460**	**0.7079**
$I-[13]$	0.0771	0.0793	0.8270
$I-[13]-N$	0.0775	0.0846	0.8327
$I-N$	**0.0834**	**0.0834**	**0.8332**

Note that 1 and 2 receive higher payoff by forming a trading bloc first then subsequently merging with 3. On the other hand, 3 is worse off comparing with the situation without any trading blocs.

4 Dynamic Formation of Trading Blocs

The previous section characterizes the payoffs as a function of the trade agreement structure reached by the countries. In this section we shall examine whether and how the grand trading bloc forms. In particular, we shall identify which of the sequences specified in the previous section emerges as an equilibrium outcome of a dynamic coalition formation game.

The formation of trading blocs is modeled as an infinite horizon dynamic game. For simplicity, all the countries are assumed to have the same discount factor $\delta \in [0,1)$.

Each period τ consists of two stages. Stage 1 determines the formation of a trading bloc. At stage 2 countries simultaneously set tariffs and firms produce and sell the output in the three markets. Stage 2 determines the payoffs of the three countries as specified in Section 3: the payoffs depend on the current partition of countries and on the sequence of the trading blocs that have been formed previously. The surplus generated by a trading bloc is shared equally among its members.

We consider a sequential bloc formation game with a fixed protocol. In particular, we assume that countries take their actions in stage 1 according to the following exogenously given order (i, j, k). If the grand coalition forms, the game ends. If a two-country trading bloc forms, it behaves like a single entity. We can specify the protocol in such a way that the two-country trading bloc and the third country take actions alternately with the third country acting first. It is worth noting that the order specified here does not affect the equilibrium outcome.

At each period a country or a two-country trade bloc becomes the proposer and makes an offer to form a trading bloc. The game starts with all countries being alone. Country i proposes a trading bloc that includes i. All other members of the proposed bloc answer sequentially according to the protocol by saying "yes" or "no". If all members say yes, the bloc forms. Otherwise, j becomes the next proposer. In the next period the protocol selects a country or a trading bloc in the current partition to propose unless the grand coalition has already formed, in which case the game ends.

Formally, at $\tau = 1$:

1.1 Country i, selected by the protocol, makes an offer to a subset $B_1 \subset \{1, 2, 3\}$, $i \in B_1$, to form a trading bloc. The members of $B_1 \setminus \{i\}$ sequentially (following the protocol) decide whether to join or not. The trading bloc B_1 is formed if all the members agree. If B_1 contains any country other than $\{i\}$, the sequence is then $S_1 = I - B_1$. Otherwise, no new trading bloc is formed and the sequence is $S_1 = I$. Let us denote by $P_1 \in \{I, [12], [13], [23], N\}$ the resulting partition at the end of $\tau = 1$.

1.2 Each country $i \in N$ obtains, at $\tau = 1$, payoff $V_i(S_1)$.

Consider any time $\tau > 1$. Let the partition structure after period $\tau - 1$ be $P_{\tau-1}$ and the sequence of (distinct) partitions until this time be $S_{\tau-1}$. If $P_{\tau-1}$ is the grand coalition N, then the coalition structure after period τ is $P_\tau = P_{\tau-1}$, and the sequence $S_\tau = S_{\tau-1}$. Otherwise:

τ.1 A country or a two-country trading bloc in $P_{\tau-1}$ is selected by the protocol. The proposer makes an offer to a subset $B_\tau \subset P_{\tau-1}$ to form a trading bloc. The proposer has to belong to B_τ. The members of B_τ sequentially (following the protocol) decide whether to join or not. The trading bloc B_τ is formed if all the members agree.

τ.2 The coalition structure at time τ is P_τ. The sequence of trading blocs is given by $S_\tau = S_{\tau-1}$ if $P_\tau = P_{\tau-1}$, and $S_\tau = S_{\tau-1} - B_\tau$ if $P_\tau \neq P_{\tau-1}$. Country $i \in N$ obtains the payoff $V_i(S_\tau)$ at time τ.

$V_i(S_\tau)$ for $S_\tau \in \{I, I - [ij], I - [ij] - N, I - N\}_{i,j\in N, i\neq j}$ is the payoff function defined in the previous section: whenever a **new** trading bloc forms, its members share the surplus equally and if no new trading bloc forms, every country's payoff remains the same. Note that each country's payoff in period τ depends only on the sequence of partitions that lead to the current partition. Country i maximizes $\sum_{\tau=1}^{\infty} \delta^\tau V_i(S_\tau)$.

Note that in the above process of trading bloc formation, a trading bloc, once formed, cannot dissolve but it remains in the negotiation with the possibility of entering a larger trading bloc. A profile of strategies constitutes a subgame perfect equilibrium if its restriction to every subgame induces a Nash equilibrium for that subgame. As in most of the literature on coalition formation, we shall focus on pure strategy Markov Perfect Equilibrium (MPE) in which each proposing country's strategy only depends on the sequence of (distinct) partitions that have been formed thus far and each responding country's strategy depends only on this sequence and the current proposal (but neither depends on the period or the details of the past history of the game such as for how many periods a particular partition of countries has been existed).

Given a MPE, let $EV_i(S_\tau)$ be the discounted (at the beginning of $\tau + 1$) payoff of country i in the subgame where the sequence of partitions formed at period τ is S_τ.

Given that the grand coalition remains together once it is formed, it is obvious that for $S_\tau \in \{I - [ij] - N, I - N\}$

$$EV_i(S_\tau) = \sum_{\tau'=1}^{\infty} \delta^{\tau'-1} V_i(S_\tau).$$

In addition, it is easy to see that

$$EV_i(I - [ij]) \leq \sum_{\tau'=1}^{\infty} \delta^{\tau'-1} V_i(I - [ij] - N),$$

since the grand coalition is efficient. Moreover,

$$EV_i(I) \leq \max_{j\neq i} \left(V_i(I - [ij]) + \delta EV_i(I - [ij])\right),$$

since $V_i(I-N) < V_i(I-[ij]-N)$.

Lemma 5 *Consider a sequence ending in a partition* $[12], [13]$, *or* $[23]$ *and the subgame following this sequence. Then in every MPE any proposer offers to form the grand coalition and all the countries/trading blocs agree on it.*

Lemma 5 says that, for any discount rate, if two countries have formed a trading bloc then the grand coalition will form in the next period. It also implies that $EV_i(S_\tau) = \frac{\delta}{1-\delta}V_i(S_\tau - N)$ for any sequence $S_\tau \in \{I-[12], I-[13], I-[23]\}$.

Now let us consider the countries' behavior following sequence $S_\tau = I$. We start with the case where countries have a low discount factor.

Proposition 6 *If the discount factor* δ *is sufficiently low and the countries are not too asymmetric, in the only MPE the grand coalition is formed at period* 1*.*

We now examine under what conditions a two-country trade bloc is formed first.

Proposition 7 *Let* $[i^*j^*]$ *be the solution to*

$$\max_{[ij]\in\{[12],[13],[23]\}} \left[\frac{1}{2}\Delta\left(I-[ij]\right) + \left(V_k\left(I\right) - V_k\left(I-[ij]\right)\right)\right].$$

When δ *is high enough, countries* i^* *and* j^* *form a trading bloc first in the unique MPE.*

For symmetric countries the result in terms of the discount rate can be stated more precisely:

Corollary 8 *Assume that the three countries are identical and let*

$$\underline{\delta} = \frac{V_i(I-N) - V_i(I-[ij])}{V_i\left(I-[ij]-N\right) - V_i(I-[ij])} \in (0,1).$$

Then if $\delta < \underline{\delta}$ *the grand coalition forms immediately and if* $\underline{\delta} < \delta < 1$*, the grand coalition forms via an intermediary trading bloc.*

Our final comment concerns the sharing rule. Our analysis thus far employs the following equal sharing rule: when a two-country trading bloc merges with the third country, each country receives a third of the surplus. A genuine concern is to ask whether Proposition 7 is driven by this particular sharing rule. To see that this is not the case, let us revisit the example where countries 1 and 2 are identical with $a_1 = a_2 = 100$ and $c_1 = c_2 = 0$, and country 3 has $a_3 = 22$ and $c_3 = 2$. Now we shall consider an alternative sharing rule: merging trading blocs share the surplus equally. This implies, for example, that when merging with country 3, trading bloc $\{1, 2\}$ receives $\frac{1}{2}$ of the surplus generated, which is shared equally between countries 1 and 2. That is, countries 1 and 2 received only 1/4 of the surplus. Then the payoff of the countries as a function of the sequence of coalition structures will be:

Sequence S	$V_1(S)$	$V_2(S)$	$V_3(S)$
I	4090.75	4090.75	335.22
$I-[12]$	4471.945	4471.945	206.852
$I-[12]-N$	**4552.197**	**4552.197**	**367.355**
$I-[13]$	4266.543	4015.703	511,013
$I-[13]-N$	4436.165	4354.947	680.635
N	**4409.093**	**4409.093**	**653.563**

Thus, even with this less favorable sharing rule, countries 1 and 2 still prefer to form a trading bloc first.

5 Appendix 1: Equilibrium taxes and tariffs

Taxes on domestic firm decrease both domestic consumer surplus (3) and domestic firm's profits due to the decrease in its production (1) but increase tariff/tax revenue. Unless the domestic firm is very inefficient relative to the domestic demand, the negative effect on domestic consumer surplus and profits dominates the positive effect on tariff/tax revenue. If demand in every country is high enough this implies that no taxes should be imposed on the domestic firm. Formally:

Remark 9 *In any partition of the countries into trading blocs, taxes on the domestic firm are set equal to zero, i.e.,* $t_{ii} = 0$, $i = 1, 2, 3$.

Proof of Remark 9. We omit the proof since it is included in the proof of the following Lemmas. ■

Now, let us consider countries' decisions on tariffs. Obviously, these decisions depend on the existing partition of trading blocs.

Lemma 10 *The grand coalition chooses free trade and no taxes on domestic firms, i.e.,* $t_{ij} = 0$ *for all* $i, j = 1, 2, 3$.

Proof of Lemma 10. The grand coalition sets the vector (t_{ij}), $i, j = 1, 2, 3$, in order to maximize total welfare $\sum_{i=1}^{3} W_i$. It is easy to show that

$$\frac{\partial\left(\sum_{\ell=1}^{3} W_\ell\right)}{\partial t_{i1}} - \frac{\partial\left(\sum_{\ell=1}^{3} W_\ell\right)}{\partial t_{i2}} = (c_1 - c_2) \text{ and } \frac{\partial\left(\sum_{\ell=1}^{3} W_\ell\right)}{\partial t_{i2}} - \frac{\partial\left(\sum_{\ell=1}^{3} W_\ell\right)}{\partial t_{i3}} = (c_2 - c_3).$$

Thus, given that $c_1 \leq c_2 \leq c_3$, we have

$$\frac{\partial\left(\sum_{\ell=1}^{3} W_\ell\right)}{\partial t_{i1}} \leq \frac{\partial\left(\sum_{\ell=1}^{3} W_\ell\right)}{\partial t_{i2}} \leq \frac{\partial\left(\sum_{\ell=1}^{3} W_\ell\right)}{\partial t_{i3}}.$$

Moreover, when $a_i > 11c_3 - 5(c_1 + c_2)$, then $\frac{\partial\left(\sum_{\ell=1}^{3} W_\ell\right)}{\partial t_{i3}} < 0$ and all of these derivatives are negative, implying that the solution will be free trade and zero taxes. Hence, if demands are high enough (a sufficient condition is $a_i > 11c_3 - 5c_2 - 5c_1$ for all i) the grand coalition sets free trade. ■

The intuition under this result is simple. Tariffs set by country i on country j decrease the domestic consumer surplus and firm j's profits in country i while increase country i's revenue from tariffs. However, when demands are high enough as compared to production costs, the negative effects dominate the positive ones. For any country, tariffs on the most efficient firm (i.e., the firm with lowest unit cost) are the most harmful for global welfare. When the countries collude on tariffs, they fully internalize the effects of tariffs. Therefore, if countries' demands are sufficiently high, it is optimal to have all the firms producing in the most efficient way (i.e., not increasing the effective costs of any firm in such a way that this firm does not produce for this market).

Lemma 11 *When all countries are alone, in equilibrium country i sets $t_{ij} = \frac{3}{10}a_i - \frac{1}{10}c_i + \frac{3}{20}c_k - \frac{7}{20}c_j$, where i, j, and k are distinct countries.*

Proof of Lemma 11. The Nash equilibrium in tariffs is the fixed point of the best reply functions of the three countries. Country i sets (t_{ij}), $j = 1, 2, 3$, in order to maximize W_i. The first order conditions of this problem do not depend on the tariffs set by the other two countries, implying that the Nash equilibrium is in fact an equilibrium in dominant strategies. By analyzing the first order conditions, we conclude that there is no interior solution where the three tariffs take positive values. Domestic welfare W_i is decreasing in the tariff on the own firm for all the combinations of the other tariffs (that are compatible with non-negative production levels). Hence, $t_{ii} = 0$. When a_i is high enough (a sufficient condition is $a_i > 11c_3 - 5c_2 - 5c_1$), tariffs on the imports by the foreign firms are interior and are given by $t_{ij} = \frac{3}{10}a_i - \frac{1}{10}c_i + \frac{3}{20}c_k - \frac{7}{20}c_j$ for distinct i, j, and k. ■

Since the domestic welfare does not take into account the effects of tariffs on foreign firms' profits, the tariffs on these firms are positive. However, under our assumption on demands all the firms are active in the domestic market. Optimal tariffs are increasing in the domestic demand and decreasing in the production cost of the domestic firm. In addition, the foreign firm that has a cost advantage will pay a higher tariff.

Finally, there are three possible cases (partitions) where two countries form a trading bloc that we have to consider: $(\{1,2\},\{3\})$, $(\{2,3\},\{1\})$ and $(\{1,3\},\{2\})$. Let us consider the general case of $(\{i,j\},\{k\})$.

Lemma 12 *Assume that countries i and j form a trading bloc and k is the outsider. Then in equilibrium countries in the trading bloc set*
a) $t_{ii} = t_{jj} = t_{ij} = t_{ji} = 0$ (i.e., free trade within the trading bloc and no taxes on domestic firms) and
b) $t_{\ell k} = \frac{5}{19}a_\ell + \frac{1}{19}(c_\ell + c_m) - \frac{7}{19}c_k$ where $\ell, m \in \{i, j\}$ and $\ell \neq m$,
while country k sets
c) $t_{k\ell} = \frac{3}{10}a_k - \frac{1}{10}c_k - \frac{7}{20}c_\ell + \frac{3}{20}c_m$, where $\ell, m \in \{i, j\}$ and $\ell \neq m$.

Proof of Lemma 12. Consider first $(W_i + W_j)$, the joint welfare for the countries in the trading bloc $\{i, j\}$. It is easy to check that if the demands are high enough, we have $\frac{\partial(W_i+W_j)}{\partial t_{\ell m}} < 0$ for all $\ell, m \in \{i, j\}$, implying that it is optimal to set free trade and zero taxes in the trading bloc. In fact, doing so is a dominant strategy since, since the best response function for the trading bloc does not depend on the outsider's tariffs. Moreover, when the demands are high enough, the trading bloc sets positive tariffs on the outsider k's products $t_{\ell k} = \frac{5}{19}a_\ell + \frac{1}{19}(c_\ell + c_m) - \frac{7}{19}c_k$ where $\ell, m \in \{i, j\}$ and $\ell \neq m$. The maximization problem of country k (who is not in the trading bloc) resembles the case where all countries are alone: When demands are high, country k imposes zero taxes on the domestic firm and sets positive tariffs on the foreign firms. These tariffs depend on production costs of the foreign firm: a higher tariff is applied to the more efficient firm. These tariffs are such that both foreign firms sell in the domestic market if domestic demand is high enough.

The outsider sets tariffs in the same way as in the case where the other countries do not reach a trade agreement. ■

6 Appendix 2

Proof of Proposition 1. We show algebraically that $W_k^{[ij]} < W_k^I$:
$W_k^{[ij]} - W_k^I = \frac{1449}{36\,100}a_ic_k - \frac{683}{18\,050}a_ic_i + \frac{1449}{36\,100}a_jc_k + \frac{439}{36\,100}a_ic_j + \frac{439}{36\,100}a_jc_i - \frac{6057}{72\,200}c_kc_i - \frac{683}{18\,050}a_jc_j - \frac{6057}{72\,200}c_kc_j + \frac{2117}{18\,050}c_ic_j - \frac{261}{36\,100}a_i^2 - \frac{261}{36\,100}a_j^2 + \frac{3159}{72\,200}c_k^2 - \frac{557}{144\,400}c_i^2 - \frac{557}{144\,400}c_j^2$
First of all, note that $\left(W_k^{[ij]} - W_k^I\right)$ does not depend on a_k. In addition, it is decreasing in a_j (respectively in a_i) :
$\frac{\partial\left(W_k^{[ij]} - W_k^I\right)}{\partial a_j} = \frac{1}{36100}(1449c_k + 439c_i - 1366c_j - 522a_j) < 0.$
Then, if $W_k^{\{ij\}} - W_k^I < 0$ holds for the minimum countries' demand it would hold for all the range of parameters. We take $a_i = a_j = a$. Then:
$\left(W_k^{[ij]} - W_k^I\right) = \frac{1449}{18\,050}ac_k - \frac{927}{36\,100}ac_i - \frac{927}{36\,100}ac_j - \frac{6057}{72\,200}c_kc_i - \frac{6057}{72\,200}c_kc_j + \frac{2117}{18\,050}c_ic_j - \frac{261}{18\,050}a^2 + \frac{3159}{72\,200}c_k^2 - \frac{557}{144\,400}c_i^2 - \frac{557}{144\,400}c_j^2.$

This expression is increasing in c_k and decreasing in c_i and c_j. Hence, we have to verify three different cases. Imagine that k is the most efficient country (country 1). Then, the inequality holds for the case where the three countries have the same cost:
$\left(W_k^{[ij]} - W_k^I\right) = -\frac{261}{18\,050}(c-a)^2 < 0,$
then the inequality holds everywhere.

Now consider that k is the less efficient country (country 3). Then if the inequality holds for $c_k = \frac{1}{11}a$ and $c_i = c_j = 0$, then the inequality holds for all combination of parameters in this region. This is the case since at this point:

$$\left(W_k^{[ij]} - W_k^I\right) = -\frac{59\,409}{8736\,200}a^2 < 0.$$

Finally, if k is the intermediary country in efficiency terms (country 2), then the inequality holds for $c_k = c_i = \frac{1}{11}a$ and $c_j = 0$:

$$\left(W_k^{[ij]} - W_k^I\right) = -\frac{172\,277}{17\,472\,400}a^2 < 0,$$

and hence it holds everywhere.

This proves the result given our assumption on demands.

For completeness let us remark how $\left(W_k^{[ij]} - W_k^I\right)$ changes with costs. This difference is increasing in c_k :

$$\frac{\partial\left(W_k^{[ij]} - W_k^I\right)}{\partial c_k} = \frac{1449}{36\,100}a_i + \frac{1449}{36\,100}a_j - \frac{6057}{72\,200}c_i - \frac{6057}{72\,200}c_j + \frac{3159}{36\,100}c_k > 0,$$

and decreasing in the cost of the countries in the trading bloc if these countries are not too different in demand:

$$\frac{\partial\left(W_k^{[ij]} - W_k^I\right)}{\partial c_i} = \frac{1}{72200}\left(-2732a_i + 878a_j - 6057c_k + 8468c_j - 557c_i\right).$$

The larger the demand parameter of country i and the smaller the demand parameter of country j the more negative is this derivative. Since the opposite happens for $\frac{\partial\left(W_k^{\{ij\}} - W_k^I\right)}{\partial c_j}$ both are negative if a_i and a_j are not too different. ■

Proof of Proposition 2. We show algebraically that $W_{ij}^{[ij]} > W_i^I + W_j^I$.

$W_{ij}^{[ij]} - W_i^I - W_j^I = \frac{113}{950}a_jc_j - \frac{439}{1900}a_ic_j - \frac{439}{1900}a_jc_i + \frac{71}{1900}a_ic_k + \frac{113}{950}a_ic_i + \frac{71}{1900}a_jc_k - \frac{217}{950}c_ic_j - \frac{213}{3800}c_ic_k - \frac{213}{3800}c_jc_k + \frac{71}{1900}a_i^2 + \frac{71}{1900}a_j^2 + \frac{1507}{7600}c_i^2 + \frac{1507}{7600}c_j^2 + \frac{71}{3800}c_k^2.$

Note that this expression does not depend on a_k and is increasing in a_i and a_j:

$$\frac{\partial\left(W_{ij}^{[ij]} - W_i^I - W_j^I\right)}{\partial a_i} = -\frac{439}{1900}c_j + \frac{71}{1900}c_k + \frac{113}{950}c_i + \frac{71}{950}a_i > 0.$$

Hence, it suffices to show that it is positive for the lowest value of $a_i = a_j = a$. The expression becomes:

$$-\frac{213}{1900}ac_j - \frac{213}{1900}ac_i + \frac{71}{950}ac_k - \frac{217}{950}c_ic_j - \frac{213}{3800}c_ic_k - \frac{213}{3800}c_jc_k + \frac{71}{950}a^2 + \frac{1507}{7600}c_i^2 + \frac{1507}{7600}c_j^2 + \frac{71}{3800}c_k^2.$$

The expression above is decreasing in c_i and c_j and increasing in c_k.

$\frac{\partial\left(W_{ij}^{[ij]} - W_i^I - W_j^I\right)}{\partial c_i} = -\frac{213}{1900}a - \frac{217}{950}c_j - \frac{213}{3800}c_k + \frac{1507}{3800}c_i < 0$ (and similar with respect to c_j), and

$$\frac{\partial\left(W_{ij}^{[ij]} - W_i^I - W_j^I\right)}{\partial c_k} = \frac{71}{950}a - \frac{213}{3800}c_i - \frac{213}{3800}c_j + \frac{71}{1900}c_k > 0.$$

Since $\left(W_{ij}^{[ij]} - W_i^I - W_j^I\right)$ is increasing in c_k and decreasing in c_i and c_j we have to verify three different cases. Imagine that k is the most efficient country (country 1). Then if the inequality holds for the lowest c_1, $c_1 = 0$, and for the highest c_2 and c_3, a largely sufficient condition is $c_2 = c_3 = \frac{1}{11}a$, then the inequality always holds. This is the case since at this point:
$\left(W_{ij}^{[ij]} - W_i^I - W_j^I\right) = \frac{1349}{24\,200}a^2 > 0.$

Now consider that k is the less efficient country (country 3). Then if the inequality holds for $c_i = c_j = c_k = c$ then the inequality holds for all combination of parameters in this region. This is guaranteed because at this point:
$\left(W_{ij}^{[ij]} - W_i^I - W_j^I\right) = \frac{71}{950}\left(a - c\right)^2 > 0.$

Finally, if k is the intermediary country in efficiency terms (country 3), then since the inequality holds for $c_1 = c_2 = c$ and $c_3 = 11a$,
$\left(W_{ij}^{[ij]} - W_i^I - W_j^I\right) = \frac{1}{7600}\left(172407a^2 + 1223c^2 - 24066ac\right) > 0,$
then it holds everywhere for this last case.

This proves the result given our assumption on demands. ■

Proof of Proposition 3. First of all note that

$$V_i\left(I - [im] - N\right) - V_i\left(I - N\right) = \frac{1}{6}\Delta\left(I - [im]\right) + \frac{1}{3}\left(V_k\left(I\right) - V_k\left(I - [im]\right)\right),$$

where the two terms in the right side are positive (by Proposition 1 and 2), and forming an intermediary trading bloc is always profitable for the countries involved. Hence, $\min\{V_k\left(I - [jk] - N\right), V_k\left(I - [ik] - N\right), V_k(I - N)\} = V_k(I - N)$.

We shall show that $V_k\left(I - [ij] - N\right) - V_k(I - N) < 0$.

$V_k\left(I - [ij] - N\right) - V_k(I - N) = \frac{24\,401}{433\,200}a_ic_j + \frac{24\,401}{433\,200}a_jc_i + \frac{36\,521}{433\,200}a_ic_k - \frac{40\,579}{433\,200}a_jc_j + \frac{53}{1200}a_kc_i + \frac{36\,521}{433\,200}a_jc_k + \frac{53}{1200}a_kc_j + \frac{23\,663}{86\,640}c_ic_j - \frac{67}{1200}a_kc_k + \frac{6233}{86\,640}c_ic_k + \frac{6233}{86\,640}c_jc_k - \frac{6781}{288\,800}a_i^2 - \frac{40\,579}{433\,200}a_ic_i - \frac{6781}{288\,800}a_j^2 - \frac{13}{800}a_k^2 - \frac{30\,487}{173\,280}c_i^2 - \frac{30\,487}{173\,280}c_j^2 - \frac{22\,237}{173\,280}c_k^2.$

The expression $\left(V_k\left(I - [ij] - N\right) - V_k(I - N)\right)$ is decreasing in the demand of the three countries.

$\frac{\partial(V_k(I-[ij]-N)-V_k(I-N))}{\partial a_j} = \frac{53}{1200}c_i + \frac{53}{1200}c_j - \frac{67}{1200}c_k - \frac{13}{400}a_k < 0.$

$\frac{\partial(V_k(I-[ij]-N)-V_k(I-N))}{\partial a_i} = \frac{24\,401}{433\,200}c_j + \frac{36\,521}{433\,200}c_k - \frac{6781}{144\,400}a_i - \frac{40\,579}{433\,200}c_i < 0$

and similarly for the derivative with respect to a_j by symmetry. Hence, if $\left(V_k\left((ij), N\right) - V_k(N)\right)$ is negative for the highest demand a for the three countries, it would be negative everywhere. For a common (and high) demand a we can rewrite:

$V_k\,(I-[ij]-N) - V_k(I-N) = \frac{197}{28\,880}ac_i + \frac{197}{28\,880}ac_j + \frac{3257}{28\,880}ac_k + \frac{23\,663}{86\,640}c_ic_j + \frac{6233}{86\,640}c_ic_k + \frac{6233}{86\,640}c_jc_{kk} - \frac{3651}{57\,760}a^2 - \frac{30\,487}{173\,280}c_i^2 - \frac{30\,487}{173\,280}c_j^2 - \frac{22\,237}{173\,280}c_k^2$.

When a goes to infinite this expression is negative. ■

Proof of Proposition 4. Similar to the proof of Proposition 3. ■

Proof of Lemma 5. For all the countries the relevant comparison is not to form the grand coalition and then receive a payoff equal to $V_i(S_\tau) + \delta EV_i(S_\tau)$ or to propose the grand coalition and agree on forming it in which case the expected payoff is $\sum_{\tau=1}^{\infty} \delta^{\tau-1} V_i(S_\tau - N)$ for any $S_\tau \in \{I-[12]\,, I-[13]\,, I-[23]\}$. Since $EV_i(S_\tau) < \sum_{\tau=1}^{\infty} \delta^{\tau-1} V_i(S_\tau - N)$ the lemma holds. ■

Proof of Proposition 6. If the following conditions hold, the grand coalition is form in the MPE

(i) the proposer i prefers the grand coalition than other outcome:

$$\sum_{\tau=1}^{\infty} \delta^{\tau-1} V_i(I-N) \geq \max\left\{V_i(I) + \delta EV_i(I), V_i(I-[ij]) + \delta EV_i(I-[ij]) \text{ for } j \neq i\right\}.$$

(ii) the other two countries agree:

$$\sum_{\tau=1}^{\infty} \delta^{\tau-1} V_j(I-N) \geq V_j(I) + \delta EV_j(I).$$

When $\delta \to 0$ the countries care only about their current payoffs. The previous conditions can be rewritten as:

$$V_i(I-N) \geq \max\left\{V_i(I), V_i(I-[ij]) \text{ for } j \neq i\right\}$$

and

$$V_j(I-N) \geq V_j(I) \text{ for } j \neq i.$$

Since the grand coalition is efficient and the surplus is share equally, the second inequality holds while the first one holds if the countries are not too asymmetric. ■

Proof of Proposition 7. When δ goes to 1, waiting to be the proposer is costless, the relevant comparison for any country is:

$$V_i\,(I-[ij]-N) \geq \max\left\{V_i(I), V_i(I-N)\right\}$$

for i, j, k distinct.
Since the condition is satisfied for any pair of countries then the coalition that would form depends on with one generates more surplus for a two-country trade bloc and which two-country trading bloc implies a higher lost for the third country.[7] To see this, first note that is easy to see that for the exogenous equal sharing rule of the surplus that we use:

$$V_i\left(I-[ij]-N\right)-V_i\left(I-N\right)=\frac{1}{6}\Delta\left(I-[ij]\right)+\frac{1}{3}\left(V_k\left(I\right)-V_k\left(I-[ij]\right)\right).$$

Where both terms in the right side are positive. Hence, the coalition that forms is the one that

$$\underset{[ij]\in\{[12],[13],[23]\}}{Max}\left[\frac{1}{2}\Delta\left(I-[ij]\right)+\left(V_k\left(I\right)-V_k\left(I-[ij]\right)\right)\right]$$

for i, j, k distinct. ■

Proof of Corollary 8. For symmetric countries, the grand coalition will always form. The sequence may depend on countries discount factor. The condition for the grand coalition to form immediately can be written as

$$\sum_{\tau=1}^{\infty}\delta^{\tau-1}V_i(I-N)\geq V_i(I-[ij])+\delta\sum_{\tau=1}^{\infty}\delta^{\tau-1}V_i\left(I-[ij]-N\right).$$

From this condition we can determine $\underline{\delta}$ that makes both sides to be equal. In this case: $\underline{\delta}=\frac{V_i(I-N)-V_i(I-[ij])}{V_i(I-[ij]-N)-V_i(I-[ij])}$. Hence, for all $\delta<\underline{\delta}$ the grand coalition forms immediately in the only MPE outcome of the game. Forming a two-country coalition, anticipating that the grand coalition will be formed in the next period, is superior for the proposer than to form the grand coalition straight away if

$$V_i(I-[ij])+\delta\sum_{\tau=1}^{\infty}\delta^{\tau-1}V_i\left(I-[ij]-N\right)\geq\sum_{\tau=1}^{\infty}\delta^{\tau-1}V_i(I-N),$$

which is equivalent to say that $\delta>\underline{\delta}$. ■

[7] If only a pair of countries (i, j) satisfies this condition the first time that i or j is called to be the proposer the two-country coalition forms.

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