A Computable General Equilibrium Model of Endogenous Coalition Formation in Trading Blocs*

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Abstract

Using a computable general equilibrium model with 5 regions (NA, SA, EU, ASIA, ROW) and 12 goods, we calculate optimal tariffs in a Nash tariff-setting game when regions are free to form trading blocs. Using Riezman's (1999) notion of *blocking coalitions*, we endogenously determine which trading bloc structure forms when regions can form a Free Trade Area or a Customs Union, to evaluate whether Preferential Trade Agreements can facilitate attainment of Global Free Trade.

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1 Introduction

The proliferation of trade agreements in recent years has again raised the issue of whether regional free-trade blocs help or hinder the ultimate objective of global free trade. Notwithstanding the political pressures that exist within a country debating the virtues of free or freer trade, there is the theoretical question of whether regional coalitions will eventually evolve into a global coalition, or whether regional coalitions effectively block further expansion. Consider a world with many trading nations where the first-best or economically efficient solution is to have undistorted trade between all nations. Beginning from an initial equilibrium where trade between nations is distorted, suppose some subset of nations forms a Preferential Trade Agreement (PTA), liberalizing trade between members of the PTA while maintaining distorted trade between members of the PTA and non-members. The primary concern of this paper is the following question: Would allowing PTA's to exist and expand ultimately lead to an equilibrium with global free trade, or might competing PTA's block attainment of this *grand coalition*?

A considerable literature has developed which considers this problem from a number of different points of view, using a number of different modelling tools. This literature can usefully be divided into three groups: (i) theoretical models of international trade, often concentrating on the trade-creating and trade-diverting aspects of preferential trade agreements; (ii) numerical models looking at the effects of particular preferential trade agreements; (iii) game-theoretic models of coalition formation.

In evaluating whether PTA's are welfare-improving or welfare reducing, theoretical trade models often use the notions of trade creation and trade diversion described in Viner (1950). As such, a PTA will be welfare-improving as the reductions in tariffs on trade between PTA-members increases trade. However, given existing tariffs on non-member trade, these tariff reductions imply greater discrimination on non-member trade, leading to a potential diversion of trade from a lower-cost non-member supplier. Kemp and Wan (1976) show that in a customs union (CU), where CU members set a common external tariff (CET) on non-member trade, the CET can always be adjusted in such a way so that the trade-creating benefits of expansion of a CU outweigh the losses due to trade diversion. In this setting, expansion of a CU will ultimately lead to an equilibrium where all regions are members of a single CU: global free trade.

More recently, using a trade model with monopolistic competition, Krugman (1991) shows that world welfare is minimized with three trading blocs, so that allowing the formation of CU's ultimately blocks the attainment of global free trade. Bhagwati and Panagariya (1996) conclude that PTA's are overall welfare-reducing, owing to the substantial amount of trade diversion which they engender. Bhagwati (1992) suggests that trade diversion can be reduced by ruling out FTA's where members maintain separate tariffs on non-member trade, and only allowing CU's. Krueger (1996) also highlights the role of trade diversion in the formation of interest groups who oppose multilateral tariff reductions. On the other side, some argue that PTA's may enhance the pursuit of multilateral trade liberalization. Campa and Sorenson (1996), for example, argue that regional trading blocs permit small countries to undermine the market power of larger trading economies, in a model where all produced goods are imperfect substitutes. Richardson (1993) argues that small countries have a greater incentive to reduce protection when joining in a FTA with larger countries, particularly since they are not bound to adopt a partner's tariff on trade with non-member countries. The elimination of protection on trade with other FTA members leads to further endogenous reduction in protection on non-member trade.

This theoretical literature identifies two important aspects of PTA's. How members of a CU set their CET on non-member trade is extremely important in affecting results. A higher CET implies greater trade diversion. And the relative size of countries joining a PTA is very important in affecting both the extent to which a country is better off joining a PTA, and the extent to which non-members are worse off after a PTA is formed. Common to both of these issues is the notion that a larger PTA essentially presents non-members with a larger trading bloc which has greater monopoly power in international trade. Even given the trade-creating benefits of tariff reductions within a PTA, greater monopoly power of a larger PTA means further benefits due to positive terms-of-trade effects, necessarily implying negative terms-of-trade effects for non-members.

A small literature has developed which looks at how members of a PTA set tariffs against non-members, and what the welfare implications are of particular PTA's using data from particular trading nations. Markusen and Wigle (1989) solved for Nash equilibrium tariffs between Canada and the U.S. using a Computable General Equilibrium (CGE) model with eight trading blocs each producing and trading six goods. Due to computational constraints, they assumed that Canada and the U.S. maintained the same tariff mix, so that tariffs were all scaled up or down together, and the behaviour of other trading regions was held constant. They considered the effects of country size, scale economies, and capital mobility, and showed that in their model, smaller country size, the presence of increasing returns to scale in production of manufactured goods and the presence of capital mobility all contributed to smaller optimal tariffs.[1] More recently, Perroni and Whalley (1994) have considered the outcomes of various Nash equilibrium tariff games in a CGE model with six regions. While coalition structure was exogenous, a number of different coalitions were considered, including FTA's and CU's between different groups of regions. CU's were typically preferred by member countries due to the implicit increase in market power of the coalition, and small regions benefited from coalition membership due to the insurance that membership would afford them against the threat of retaliation.

An important failing of this literature is that the structure of any PTA is specified exogenously. Kennan and Riezman (1990) suggest a novel way to attack this problem. Using a three-country model and using the Nash equilibrium tariffs to represent the status quo, they examine the welfare implications of various forms of coalition structure. In particular, Kennan and Riezman consider three structures: a FTA between two of the countries, a CU between two of the countries, and free trade between all three countries (global free trade). The results show that a country may be better-off in a CU than with global free trade. In a subsequent paper, Riezman (1999) finds that banning bilateral trade agreements may result in more, not less, protection. In each of these papers, an important factor in determining whether a preferential trading agreement like a CU or an FTA can work as a stepping-stone towards Global Free Trade is the relative size of regions forming a particular trade bloc. This factor is also important in determining which trading blocs ultimately form when membership of trading blocs is determined endogenously.

The approach pioneered by Kennan and Riezman has a couple of drawbacks. First, the Kennan-Riezman models are based on pure exchange economies, ruling out the production sector and the possible influence of imperfect competition on the results. Second, the Kennan-Riezman models are completely abstract and have no connection to trade data. This is significant given that many of the arguments for and against regional trading blocs are based on their effects on trade flows and trade diversion.

The present paper addresses these shortcomings of the Kennan-Riezman models, and builds on

[1]The Nash equilibrium tariff rates for Canada and the U.S. in Markusen and Wigle (1989) were 6% and 18%, respectively.

the earlier work by Markusen and Wigle (1989) and Perroni and Whalley (1994) by endogenizing the coalition-formation process between regions. Specifically, we examine a general equilibrium model of production and trade that is benchmarked to a world trading equilibrium where five regions produce and trade 12 goods. We then investigate the welfare implications of CU's, FTA's, and global free trade. Using Riezman's (1999) notion of *blocking coalitions*, we then determine which coalition of trading blocs will form endogenously in a Nash tariff-setting game. The model and the data are described in Section 2. Methodological issues are discussed in Section 3. Preliminary results are presented and discussed in Section 4. Section 5 contains some concluding remarks.

2 General Equilibrium Model

This section describes the general equilibrium model and data set. The model has five regions: North America (NA), South America (SA), the European Union (EU), Asia and Australia (ASIA), and an aggregate region comprising the rest of the world (ROW). The regional disaggregation is displayed in Table 1, so that the set of all regions is:

$$\text{REGS} = \{\text{NA, SA, EU, ASIA, ROW}\}.$$

This Table also indicates total income in each region in the initial data set, to give an idea of the relative size of each region. In each region, final goods are produced using three primary inputs—land, labour, and capital—and intermediate inputs.[2] The production side of the economy is disaggregated so that twelve final goods are produced. Each region produces, imports and exports all twelve goods, so there is cross-hauling in all goods. Trade is accommodated using the so-called "Armington assumption", so that the same goods produced in different regions are imperfect substitutes for one another. The commodity disaggregation is displayed in Table 2, so that the set of all commodities is:

$$\text{GOODS} = \{\text{AGR, FFM, FOO, TEX, PPP, CRP, MET, TRN, MAN, UTI, T\&T, SER}\}.$$

This Table also displays total world output of each good as a share of total world output, as well as exports as a share of domestic production by region for each good. These latter columns give an indication of the importance of trade in any one commodity for each region. As is evident, the data set reports very little trade in services, though the three service sectors (UTI, T&T, SER) account for over 60% ot total world output. As such, we would expect that the welfare effects of changes in tariffs on merchandise trade (the first 9 goods) will be relatively small.

[2]The primary factor land is used only in the production of agriculture.

The final consumption goods in any region are consumed by a representative consumer in each region. The representative consumer in each region owns all primary factors of production, and supplies all land and capital to the production sector. Labour is either supplied to the production sector or consumed as leisure. All primary factors are completely mobile within a region but immobile between regions. There are a number of distortions in the initial equilibrium data set, including production taxes, export taxes and import taxes. The data set is an aggregated version of version 4 of the GTAP data set described in Hertel (1995), for a world trading equilibrium in the year 1995.

For each sector $i \in$ GOODS, finished goods (y_i) are produced using intermediate inputs from sector $j \in$ GOODS (x_{ij}) and primary inputs: land (H_i), labour (L_i), and capital (K_i). We assume that production technology displays constant returns to scale, and is represented by nested CES production functions of the form:

$$\begin{aligned} y_i &= \left[\sum_{j \in \text{GOODS}} \delta_j x_{ij}^{-\gamma_i} + \delta_{VA} V_i^{-\gamma_i} \right]^{\frac{-1}{\gamma_i}} \\ \text{where} \quad V_i &= \left[\alpha_H H_i^{-\rho_i} + \alpha_L L_i^{-\rho_i} + \alpha_K K_i^{-\rho_i} \right]^{\frac{-1}{\rho_i}}, \qquad \forall\, i \in \text{GOODS} \end{aligned}$$

where x_{ij} is the amount of good j used in production of good i. The substitution elasticity between primary inputs, $1/(1+\rho_i)$, is given in Table 3. Intermediate inputs x_{ij} and the aggregate value-added V_i are combined using fixed-coefficients production technology, so $\gamma_i \to \infty\ \forall\, i$. The structure of production is shown in Figure 1. All markets are assumed to be perfectly competitive, with free entry and exit of firms, so economic profits are equal to zero in all industries in equilibrium. Producers take all output and input prices as given, and these are all normalized to unity in the initial equilibrium.

The demand side of each economy is represented by a system of demand functions derived from the solution to the representative consumer's utility maximization problem when utility for the representative consumer in region r is represented by a Linear Expenditure System of the form:

$$U^r = \Pi_{i=0}^{n} \left(z_i^r - \bar{z}_i^r \right)^{\theta_i^r} \qquad \forall\, r \in \text{REGS},\ i \in \{\text{GOODS, LEI}\},$$

where z_i^r is the consumption of good i and $\bar{z}_i^r$ is the *subsistence consumption* of good i by the representative consumer in region r. As an example, the structure of consumption of agriculture in North America is described in detail in Figure 2, with a corresponding description of the structure of consumption goods applying for all goods (except leisure) in all regions. The LES is used to represent

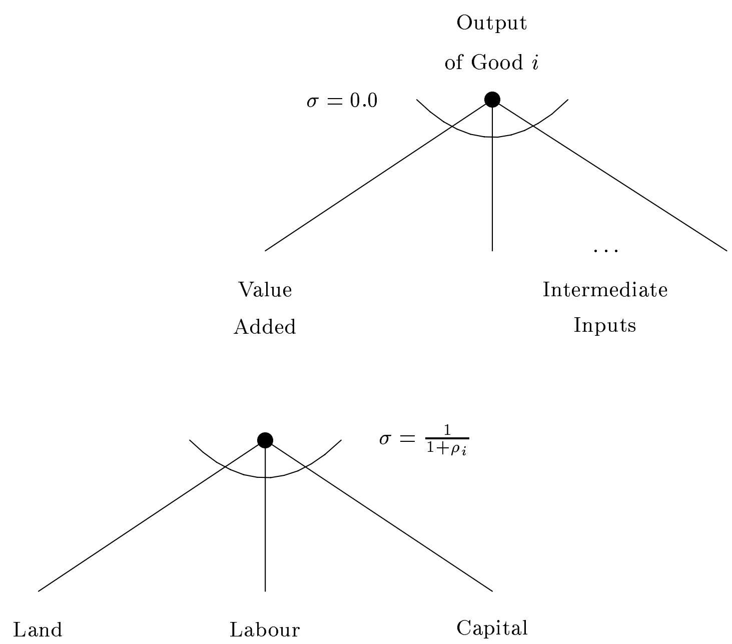

Figure 1: Structure of Production of Output

preferences since it allows different income elasticities of demand for different commodities. This allows for greater flexibility in benchmarking the initial data set than the Cobb-Douglas or CES utility function, which would restrict all income elasticities to unity. Also, along with the fact that the representative consumer supplies some labour to the consumption sector and consumes the rest as leisure, using the LES functional form allows the data set to be benchmarked to some chosen labour supply elasticity, allowing aggregate labour supply to change in response to any comparative statics shocks. The income elasticities for all consumption goods $i \in \{\text{GOODS}\}$ are based upon those used in Jomini *et al* (1994). The income elasticity for leisure demand is set at 0.30. When the ratio of the consumer's total endowment of labour to total labour supplied to the production sector is set to $\zeta = 1.75$[3], this implies a leisure demand elasticity of -0.24, or a labour supply elasticity of 0.18, which is consistent with labour supply elasticities for developed economies in the literature.[4]

Of total output of industry i in region r, some amount is exported, and the remainder is consumed within region r. Trade must be balanced, so exports of good i by region r must equal imports of good

[3]As noted in Ballard *et al.* (1985: 135), this is consistent with a representative consumer who works 40 hours out of a possible 70-hour week.

[4]See Gunderson and Riddell (1993: 177–179). For a complete description of the relationship between own- and cross-price demand elasticities and income elasticities, see Fisher and Waschik (forthcoming).

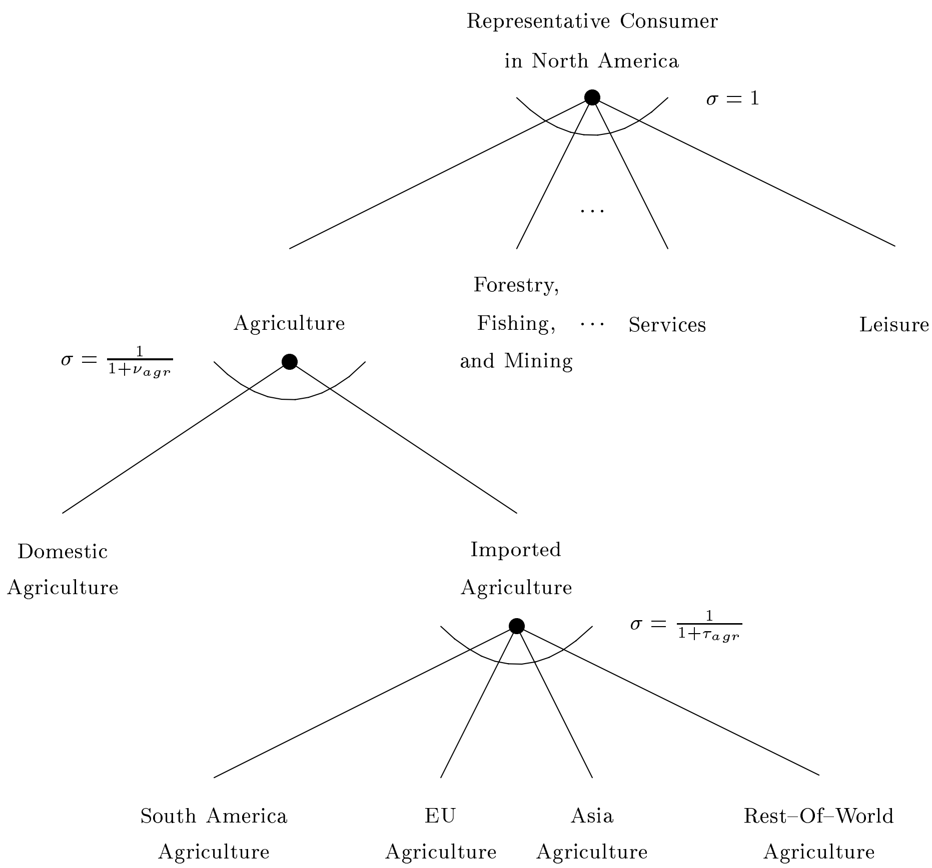

Figure 2: Structure of Consumption in the BEDS

i by all other regions. Trade in any region can be distorted by the presence of export taxes/subsidies and import taxes. Trade taxes in the initial equilibrium are available from the authors on request. Import taxes are a combination of tariffs and tariff-equivalents of quantity restrictions on imports.

Inter-regional trade in the model is accommodated using the *Armington assumption* that goods produced by the same industry in different regions are imperfect substitutes. The nesting structure of traded goods is illustrated in Figure 2. The final good i in region r is a nested CES aggregate of domestically produced finished goods and imported goods. The substitution elasticity between imported goods is $1/(1+\tau_i)$, and is reported in Table 3. The aggregate imported good is then combined with the domestically produced good with a substitution elasticity given by $1/(1+\nu_i)$, reported in Table 3.[5]

3 Modeling Trade Liberalization

The starting point for all our experiments is the initial BEDS. Compared to this initial equilibrium, we consider the following simulations:

1. Nash Equilibrium (Nash): no preferential trade agreements or coalitions form between trading regions. Each region charges an optimal tariff on trade with all other regions, given that all other regions are also charging optimal tariffs.

2. Free Trade Association (FTA): trade liberalization where two or more regions reduce their tariffs on each other's imports to zero while individually charging optimal tariffs on imports from other regions.

3. Customs Union (CU): trade liberalization where two or more countries reduce their tariffs on each other's imports to zero while charging a common external tariff against imports from other countries.

4. Global Free Trade (GFT): multilateral trade liberalization where all countries reduce their tariffs to zero.

The model is solved as a two-stage game. In the second stage, regions take the structure of any PTA(s) as given, and set tariffs on trade with all trading partners. For example, a region in an

[5]The import substitution elasticities $1/(1+\tau_i)$ are consistent with the import substitution elasticities reported in Table 3.7 of Jomini *et al.* (1994: 81). The elasticity of substitution between domestic and aggregate imported goods $1/(1+\nu_i)$ are derived from those reported in Table 3.5 of Jomini *et al.* (1994: 77).

FTA computes the optimal tariffs on imports from all non-member countries, given zero tariffs on imports from regions which are also members of the FTA. Other regions then react by choosing their optimal tariffs, subject to any trading arrangements (FTA's or CU's) of which they may be a part. Once these (retaliatory) tariffs have been computed, the original region re-computes its optimal set of tariffs. The process continues until there is no region that wants to change its tariffs.

This second-stage problem is solved for all potential PTA's which can form. Then in the first stage, regions choose which PTA they will join, given the utility difference between any trading arrangement and the initial BEDS. In evaluating which coalition to join, side payments are ruled out completely.

The various trading arrangements essentially constrain the tariff matrix of each region. The key difference between FTA's and CU's is that the external tariffs are set independently under an FTA, whereas they are set jointly under a CU.[6] As Kennan and Riezman (1990) observe, a CU internalizes a tariff externality between member countries if the countries import the same good. As one region increases its tariff, the terms of trade improve for all member countries. The common external tariff takes this externality into account in determining the optimal tariff. There is a complication with CU's, however: there is a conflict of interest between member countries on the level of the Common External Tariff (CET).

Thus, an important issue in the formation of a Customs Union is how the CET is set. We consider three different mechanisms by which a CU sets its CET:

1. the CET is adjusted so as to maximize the weighted sum of changes in income of each member of the CU, where the weights are the share of each region's income in the total income of the CU.

2. the CET is adjusted so that no member of the CU is made worse off by an increase in the CET up to its chosen level.

3. the CET is set at the level of the tariff charged by the CU member with the lowest initial tariff.

The first mechanism does not address how gains from CU membership are divided between member regions. This issue is important, since an individual region's membership within a trading

[6] The FTA assumes that rules of origin are strictly and costlessly enforced so that different tariffs between member countries can exist.

bloc will be motivated by changes in income within the individual region. For example, if members of a particular trading bloc are of considerably different size, we might expect that one region would prefer a higher CET while another would prefer a lower CET. In the second mechanism, no CU member suffers a decrease in utility as the CET is increased, but some overall CU gains from further tariff increases are left unexploited. This problem could be resolved if side payments between CU members were allowed. The third mechanism imposes a considerable amount of discipline on any CU. This rule is proposed by Bhagwati (1992), p.455, when he makes his argument that CU's should be allowed while FTA's should be banned, to minimize trade diversion.[7]

There are 5 regions in the model implying a total of 152 possible configurations for world trading arrangements. The Nash equilibrium tariffs and global free trade account for two of the possible configurations. Consider FTA's first. There are 10 purely bilateral trading blocs (i.e., two regions form a bloc and the other regions remain independent), 10 purely trilateral blocs (i.e., only three regions form a bloc), and 5 purely quadrilateral (four-region) blocs that could form from the 5 regions. There are also 15 pairs of bilateral FTA's (i.e., two blocs of two regions each) and 10 pairs of bilateral-trilateral FTA's (i.e., one bloc of two regions and another bloc of three regions) that could form. For FTA's, therefore, there are 50 total possible configurations. Similarly, there are 50 possible configurations for the CU's. Then there are another 50 possible configurations with two blocs where one bloc is an FTA and the other is a CU. Together with the Nash equilibrium and global free trade outcomes, this yields the total of 152 configurations.

In order to determine which coalition or trading bloc will ultimately evolve, we need a mechanism to compare one trading bloc to another. A natural method is the *core*, described in Kennan and Riezman (1990) and used in Riezman (1999). But in order to describe the *core*, we first need to describe how individual regions evaluate membership within a coalition or trading bloc. Following Kennan and Riezman (1990), consider a coalition made up of a subset S of the set of all regions R, $S \subset R$. Given this coalition of S regions, we use our CGE model to compute the change in utility (relative to the initial BEDS) for any member of the coalition, denoted $U^s(S)$. A member s of this trading bloc or coalition S will prefer membership in the coalition S to any other allocation A_j as long as $U^s(S) > U^s(A_j)$. So now, following Riezman (1999), we can define *blocking* and the *core* as follows:

[7]Riezman (1999) assumes that regions split the utility difference from the individually most-preferred set of tariffs.

Definition: A coalition S *blocks* allocation j if for all regions $s \in S$:

$$U^s(S) \geq U^s(A_j) \quad \forall\, s \in S,$$

with $U^s(S) > U^s(A_j)$ for at least one s.

Definition: An allocation A_j is in the *core* if it is *not blocked* by any feasible coalition.

Of course, the *core* may be empty, or there may be more than one allocation in the *core*.

4 Results

Now that we have described how regions and trading bloc members choose optimal tariffs, and how regions evaluate membership in different coalitions, we can turn to the question of which coalitions will form. We begin by supposing that CU's set their CET according to mechanism 1, where the CU maximizes an income-weighted average of regional welfare changes, and then continue by considering the cases where the CU's set their CET according to mechanism 2, and then mechanism 3. Of course, there are 152 possible configurations to compare in each of these three cases, so for the sake of brevity, we include in the paper only those coalitions which *block* all others when purely bilateral, trilateral, or quadrilateral blocs, or when pairs of bilateral or bilateral-trilateral blocs can form.[8]

4.1 Mechanism 1

All blocking coalitions when CU's choose the CET by maximizing the income-weighted average of member's income changes are listed in Table 4. To understand these results, it is instructive to begin with the smallest coalition, and then consider increases in either the size of a coalition or an increase in the number of trading blocs. Of course, to solve for any coalition(s) in the core, we need to compare and consider all possible allocations at the same time, since this must properly be viewed as a static Nash game. But given the large number of possible coalitions which must be considered, it is simpler to begin with only the smallest possible coalitions, thereby eliminating a number of *blocked* coalitions from consideration, and then moving on to increase the size and number of trading blocs.

[8]The results from all possible coalitions, including welfare changes, terms-of-trade changes, and the optimal tariff vectors, can be viewed at http://www.wlu.ca/ wwwsbe/faculty/rwaschik/research.htm.

If one trading bloc will form with only two members, then 9 of the 10 possible coalitions are blocked by a coalition between NA and ASIA. This result obtains whether NA and ASIA form an FTA or a CU.[9] In either case, NA and ASIA each receive the largest welfare increase by joining together to form a Preferential Trade Agreement, so FTA(NA, ASIA) *blocks* all other bilateral FTA's, and CU(NA, ASIA) *blocks* all other bilateral CU's.

Now suppose a pair of bilateral FTA's can form (we will ignore CU's for the moment). If NA and ASIA form an FTA, then EU and ROW receive their highest payoff by joining together to form an FTA, so {FTA(NA, ASIA), FTA(EU, ROW)} *blocks* all pairs of bilateral FTA's, given that NA and ASIA form an FTA. However, EU would receive an even higher payoff by joining in an FTA with NA and ASIA, and both NA and ASIA receive their highest payoff of all trilateral FTA's when joined by EU, so FTA(NA, EU, ASIA) *blocks* all trilateral FTA's.

We can also solve for the quadrilateral FTA and the pair of 2-member and 3-member trading blocs which *blocks* all others, given that FTA(NA, ASIA) *blocks* all bilateral FTA's. But note that both NA and ASIA are worse off when FTA(NA, EU, ASIA) is expanded to include SA, and ROW is (slightly) worse off after joining in and FTA with SA, compared to FTA(NA, EU, ASIA), so of the 50 possible FTA's, FTA(NA, EU, ASIA) is in the core.

It is interesting to note that the same bilateral, trilateral, quadrilateral, and pairs of coalitions *block* all others when regions can form CU's. But when regions can form CU's, CU(NA, SA, EU, ASIA) is in the core, even though NA, EU and ASIA are each worse off compared to CU(NA, EU, ASIA). This result obtains because SA and ROW are both better off by joining together to form a CU against NA, EU, and ASIA, and NA, EU, and ASIA are all better off in CU(NA, SA, EU, ASIA) compared to {CU(NA, EU, ASIA), CU(SA, ROW)}. The smaller region (SA) uses the threat of joining in a CU with ROW to gain admission to the *blocking* quadrilateral CU.

If we consider those coalitions where two trading blocs form, one of which is an FTA and the other a CU, then the *blocking* coalitions are {FTA(EU, ROW), CU(NA, ASIA)} and {FTA(SA, ROW), CU(NA, EU, ASIA)}. Of these two, EU is certainly better off in a CU with NA and ASIA, so of these 50 coalitions, {FTA(SA, ROW), CU(NA, EU, ASIA)} is in the core.

Of these coalitions, CU(NA, SA, EU, ASIA) *blocks* FTA(NA, EU, ASIA) and {FTA(SA, ROW), CU(NA, EU, ASIA)}. {FTA(SA, ROW), CU(NA, EU, ASIA)} is *blocked* by CU(NA, EU, ASIA),

[9] Complete results are summarized at http://www.wlu.ca/ wwwsbe/faculty/rwaschik/fta/fta.pdf, for the FTA case, or at http://www.wlu.ca/ wwwsbe/faculty/rwaschik/cu/cu.pdf, for the CU case.

since ROW would rather this latter coalition than form an FTA with SA, but CU(NA, EU, ASIA) is blocked by CU(NA, SA, EU, ASIA), as was described above. Finally, all members of the CU in CU(NA, SA, EU, ASIA) would be made worse off by a move to Global Free Trade (GFT), so it is clear that Global Free Trade is not an automatic outcome of the coalition formation process. In fact, If we ban FTA's and allow only CU's, or if we allow FTA's and ban CU's, GFT is blocked, either by CU(NA, SA, EU, ASIA) if FTA's are banned, or by FTA(NA, EU, ASIA) if CU's are banned. In this example, allowing Preferential Trade Agreements impedes attainment of Global Free Trade.

4.2 Mechanism 2

Now suppose that CU's choose their CET so that no CU member is made worse off as the CET is increased. For example, if NA and SA form a CU, they will increase the CET on AGR imports from EU. If either NA or SA is made worse off, the tariff is decreased until neither NA nor SA are worse off. If both NA and SA are better off, the tariff is increased until either NA or SA is made worse off. In this way, membership in the CU is individually rational for all members. Note that this was not the case using mechanism 1.

Also note that the results for all FTA's from subsection 4.1 will not change. However, at this point we have not yet completed all simulations for cases using mechanism 2 where two trading blocs form, where one bloc is an FTA and the other is a CU.

4.3 Mechanism 3

Bhagwati (1992) has argued that the (negative) trade diverting effects of CU's can be alleviated if the CET adopted by any CU is set at the level of the tariff of the CU member with the lowest initial tariff on non-member trade.

At this point we have not yet completed all simulations for cases using mechanism 3 where two trading blocs form, where one bloc is an FTA and the other is a CU.

5 Conclusion

Thus far we have provided an example where allowing PTA's to form and expand endogenously does not result in PTA's evolving into the *grand coalition*, so that PTA's *block* attainment of Global Free Trade. A number of other results are also apparent. It is evident that as PTA's expand, those regions which remain outside of the existing PTA's are increasingly worse off. The lone region outside of the quadrilateral PTA in the *core* of the experiment in Subsection 4.1 maintains a vector of optimal tariffs which are relatively large, but still sees a reduction in welfare of almost 4% from the initial BEDS. It is interesting to note that ROW's optimal tariffs are all rather uniform, ranging from a low of 28% to a high of 32%. In contrast, the PTA maintains much higher tariffs on some goods, but charges tariffs which range from a low of 29% on imports of Transport Equipment to a high of 69% on imports of Forestry, Fishing and Mining.

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Table 1: Regional Aggregation for Benchmarked General Equilibrium Data Set, 1995

	NA	SA	EU	ASIA	ROW
	Canada	Central America	UK	Australia	EFTA
	USA	Caribbean	Germany	New Zealand	Central European Associates
	Mexico	Venezuela	Denmark	Japan	Former Soviet Union
		Colombia	Sweden	Korea	Turkey
		Rest of Andean Pact	Finland	Indonesia	Rest of Middle East
		Argentina	Rest of EU	Malaysia	Morocco
		Brazil		Philippines	Rest of North Africa
		Chile		Singapore	South African Customs Union
		Uruguay		Thailand	Rest of Southern Africa
		Rest of South America		Viet Nam	Rest of sub-Saharan Africa
				China	Rest of World
				Hong Kong	
				Taiwan	
				India	
				Sri Lanka	
				Rest of South Asia	
Share of World Income	0.282	0.049	0.290	0.286	0.094

Table 2: Industry Aggregation for Benchmarked General Equilibrium Data Set, 1995

Description	Canadian SIC Codes	Industry's Share of Total Value Added in World (Percent)	Exports as a Share of Total Domestic Production (Percent)				
			NA	SA	EU	ASIA	ROW
Agriculture	01, 02	3.6	14.8	11.7	16.6	4.3	8.0
Forestry, Fishing, Mining	03-09	2.0	13.8	30.7	26.1	14.5	45.4
Food Processing	10-12	6.0	5.8	10.0	17.5	5.7	8.3
Textiles	17-19, 24	2.4	9.2	10.4	37.3	29.3	24.0
Pulp and Paper	25-28	3.4	12.1	10.0	21.1	6.9	14.3
Chemicals and Refining	15, 16, 36-37	5.8	13.3	10.0	33.0	11.2	18.7
Minerals, Metals, Metal Products	29-31, 35	5.4	9.2	11.5	22.0	9.0	23.5
Transportation Equipment	32	2.9	20.5	9.4	40.0	28.1	14.1
Other Manufacturing	33, 39	5.9	30.0	8.2	45.0	34.0	30.0
Utilities and Construction	40-44	11.6	0.1	0.0	1.4	0.1	1.4
Trade and Transportation	45-69	17.3	5.1	6.6	10.5	7.7	14.4
Government and Private Services	70-77, 81-86, 91-92, 96-99	33.7	2.3	2.2	3.5	1.9	3.7

Table 3: Independent Primary Input Substitution and Trade Elasticities

Industry	Primary Input Substitution Elasticity $\frac{1}{1+\rho_i}$	Domestic/Import Substitution Elasticity $\frac{1}{1+\nu_i}$	Trade Elasticity $\frac{1}{1+\tau_i}$
Agriculture	0.40	2.2	4.4
Forestry, Fishing, Mining	0.60	2.1	4.2
Food Processing	0.80	2.2	4.4
Textiles	0.90	2.2	4.1
Pulp and Paper	0.80	1.7	3.4
Chemicals and Refining	0.90	1.9	3.8
Minerals, Metals, Metal Products	0.90	2.1	4.2
Transportation Equipment	0.80	3.0	6.0
Other Manufacturing	0.90	2.1	4.2
Utilities and Construction	1.00	2.0	4.0
Trade and Transportation	1.20	2.0	4.0
Government and Private Services	0.90	1.9	3.8

Table 4: Blocking Coalitions - Mechanism 1

Nash Equilibrium:

NA	SA	EU	ASIA	ROW
0.019	−0.468	−0.234	−0.350	−2.290

FTA's

1 Bloc with 2 Regions:

Bloc 1: NA, ASIA	
NA	0.201
SA	−0.386
EU	−0.110
ASIA	0.202
ROW	−2.036

2 Blocs with 2 Regions:

Bloc 1: NA, ASIA Bloc 2: SA, ROW	
NA	0.223
SA	−0.245
EU	−0.079
ASIA	0.271
ROW	−0.491

1 Bloc with 3 Regions:

Bloc 1: NA, EU, ASIA	
NA	0.294
SA	−0.256
EU	0.000
ASIA	0.431
ROW	−1.604

2 Blocs, One with 3 Reg's:

Bloc 1: NA, EU, ASIA Bloc 2: SA, ROW	
NA	0.301
SA	−0.073
EU	0.014
ASIA	0.445
ROW	−1.605

CU's

1 Bloc with 2 Regions:

Bloc 1: NA, ASIA	
NA	0.206
SA	−0.689
EU	−0.280
ASIA	0.289
ROW	−2.519

2 Blocs with 2 Regions:

Bloc 1: NA, ASIA Bloc 2: SA, ROW	
NA	0.145
SA	−0.862
EU	−0.146
ASIA	0.104
ROW	−0.956

1 Bloc with 3 Regions:

Bloc 1: NA, EU, ASIA	
NA	0.336
SA	−1.093
EU	0.115
ASIA	0.515
ROW	−3.715

2 Blocs, One with 3 Reg's:

Bloc 1: NA, EU, ASIA Bloc 2: SA, ROW	
NA	0.315
SA	−0.882
EU	0.077
ASIA	0.491
ROW	−3.609

1 Bloc with 4 Regions:

Bloc 1: NA, SA, EU, ASIA	
NA	0.326
SA	0.646
EU	0.077
ASIA	0.499
ROW	−3.875

FTA's and CU's

2 Blocs with 2 Reg's:

Bloc 1: EU, ROW Bloc 2: NA, ASIA	
NA	0.227
SA	−0.532
EU	−0.256
ASIA	0.347
ROW	−0.855

2 Blocs, One with 3 Reg's:

Bloc 1: SA, ROW Bloc 2: NA, EU, ASIA	
NA	0.345
SA	−0.863
EU	0.140
ASIA	0.533
ROW	−3.717

Global Free Trade:

NA	SA	EU	ASIA	ROW
0.258	0.493	0.010	0.360	0.123