Free-Trade Areas and Welfare: An Equilibrium Analysis

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Abstract

This paper examines the welfare effects of the formation of a free-trade area (a set of countries that abolish tariffs among member countries but let individual member countries to set external tariffs). If a representative consumer has love-of-variety preferences, the welfare function exhibits *supermodularity* in external tariffs: when a country is constrained to charge lower tariffs on imports of some countries (because of a free-trade agreement), it is in the self-interest of that country to reduce external tariffs as well, because the reduction in external tariffs helps restore a balanced consumption portfolio. The reduction in external tariffs induced by free-trade agreements is shown to be sufficiently large to make nonmember countries better off. Since only privately beneficial free-trade agreements are voluntarily signed, the formation of a free-trade area is a Pareto improvement. Due to free-riding problems, however, the global free-trade area may not be an equilibrium outcome under either the Open Regionalism rule or the Unanimous Regionalism rule.

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1. Introduction

The recent resurgence of regional trading blocs has rekindled trade economists' interest in examining the welfare effects of regional trade agreements.[1] Broadly speaking, there are two types of preferential trading agreements: customs unions and free-trade areas. One crucial difference between custom unions and free-trade areas lies in how external tariffs are determined. Typically, members of a customs union set *common* external tariffs, but members of a free-trade area each set external tariffs *individually.* The point of this paper is that when tariffs are chosen for welfare maximization, this difference in the determination of external tariffs has profound implications on the welfare of *nonmember* countries. This paper examines a simple model of intra-industry trade among symmetric countries with love-of-variety preferences which highlights this point. In this model, the formation of a welfare-maximizing customs union makes nonmember countries worse off, but the formation of a welfare-maximizing free-trade area makes nonmember countries better-off.

The underlying cause for the welfare-augmenting nature of free-trade areas is the *supermodularity of the welfare function in tariffs*. With love-of-variety preferences, other things being equal, a balanced consumption portfolio is preferred to an unbalanced portfolio. If a country is constrained to charge lower tariffs on imports from some countries (because of a free-trade agreement), it is in the self-interest of that country to reduce tariffs on imports from other countries as well, because the reduction in tariffs on imports from other countries helps to restore a balanced consumption portfolio. In other words, an individual country's welfare function is *supermodular* in external tariffs: country *A*'s individual welfare-maximizing tariffs on imports from country *C* go down if country *A* reduces its tariffs on imports from country *B* by a free-trade agreement. If the reduction in external tariffs induced by free-trade agreements is sufficiently large, the formation of a free-trade area makes nonmember countries better off. Indeed, in the current model, the signing of a free-trade agreement results in a sufficiently big reduction in external tariffs so as to make nonmember

[1] Given the enormous number of papers that have been written on this topic, it is impossible to list them all. Some recent papers that are close to the current paper are: Bagwell and Staiger (1997a, 1997b), Bond and Syropoulos (1996), Krishna (forthcoming), Kennan and Riezman (1990), Krugman (1991), Levy (1997), and Riezman (1985).

countries better off. Since only privately beneficial free-trade agreements are voluntarily signed, the formation of a privately beneficial free-trade area is a then Pareto improvement: both member and nonmember countries benefit from the signing of a free-trade agreement.

In sharp contrast, Yi (1996) shows that the formation of a welfare-maximizing customs union makes nonmember countries *worse off*. The key factor that leads to this stark difference between customs unions and free-trade areas is the *tariff externalities*. If country *A* raises its tariffs on imports from country *B*, country *B*'s exports to country *A* decline. As a result, country *A*'s residual demand for imports from *other* countries increase, raising their equilibrium export profits to country *A*.[2] In other words, tariffs imposed by country *A* on imports from country *B* create *positive externalities* on other countries. Member countries of a customs union internalize these positive externalities on other member countries in setting external tariffs jointly. Hence, the joint welfare-maximizing external tariffs of a customs union are *higher* than the individual welfare-maximizing external tariffs of a free-trade area of the same size. Indeed, Yi (1996) shows that joint welfare-maximizing external tariffs of a customs union are sufficiently high so as to make nonmember countries worse off.[3]

After establishing the welfare effects of the formation of a trading bloc, I turn to a brief analysis of stable structures of free-trade areas among symmetric countries. As in Yi (1996), I examine two different membership rules: the Open Regionalism rule and the Unanimous Regionalism rule. Under the Open Regionalism rule, any country can join an existing free-trade area. In contrast, joining an existing free-trade area requires a unanimous approval by existing member countries under the Unanimous Regionalism rule. The key observation that emerges from the following analysis is that the formation of a free-trade area creates potential *free-rider problems*: a member country of a free-trade area is constrained to eliminate tariffs on other member countries, but a nonmember country (which does not belong to any free-trade area) optimally chooses its tariffs on all other countries. As a result,

[2] This observation carries over to a general-equilibrium model of trade with many products. If country *A* raises its tariffs on imports from country *B*, the world prices of country *B*'s products decline. Countries other than *A* and *B* typically become better off from the reduction of the world prices of country *B*'s exports.

[3] But because the supermodularity factor also works in the case of customs unions, the expansion of a customs union may result in *lower* external tariffs than before (Yi, 1996, Proposition 2).

the global free trade area (which maximizes *world* welfare) may not be a stable outcome under both rules. This result is in sharp contrast to Yi's (1996) findings which show that the grand customs union (global free trade) is the unique equilibrium outcome under the Open Regionalism rule but typically not under the Unanimous Regionalism rule. Yi shows that members of a large customs union have a *strategic* incentives to limit membership, that is, in order to improve terms of trade against nonmember countries.

The rest of this paper is organized in the following way. Section 2 introduces a quasi-linear quadratic model of intra-industry with love-of-variety preferences, which is the same model as in Yi (1996). Section 3 examines the external welfare effects of free-trade areas and contrasts them to the case of customs unions. Section 4 presents a brief analysis of stable structures of free-trade areas. Section 5 concludes.

2. The Model

There are N ex-ante symmetric countries. Each country transforms the endowment (numeraire good, denoted by M) to a final product (denoted by q_i) using a linear production function. Let c be the constant unit cost of producing q_i. There are no transportation costs. The representative consumer in country i has a utility function of the form

$$u^i(\mathbf{q}_i; M_i) = v(\mathbf{q}_i) + M_i = aQ_i - \frac{\gamma}{2} Q_i^2 - \frac{1-\gamma}{2} \sum_{j=1}^{N} q_{ij}^2 + M_i, \tag{1}$$

where q_{ij} is country i's consumption of country j's product, $\mathbf{q}_i = (q_{i1,\dots,}q_{iN})$ is country i's consumption profile, $Q_i = \sum_{j=1}^{N} q_{ij}$, M_i is country i's consumption of the numeraire good, and γ is the substitution index between products, ranging from 0 (independent goods) to 1 (homogenous products). The numeraire good is transferred across countries to settle the balance of trade.

Consumers have a taste for variety: for any given Q_i, the more balanced the consumption bundle is and the more goods there are, the higher the utility. There are two gains from trade. First, trade increases the variety of goods available, and second, trade restrains the domestic firm's monopoly power.

The profits of the domestic firm and the tariff revenues are rebated back to the consumers. Thus, country i's welfare (W^i) consists of four components: the domestic consumer surplus (CS^i), the domestic firm's profit in home market (π^{ii}), the tariff revenue (TR^i), and the home firm's export profits (π^{ij}, $j \neq i$):

$$W^i = CS^i + \pi^{ii} + TR^i + \sum_{j \neq i} \pi^{ji} . \tag{2}$$

Let τ_{ij} be country i's *specific* tariff on imports from country j. Then, country j's *effective* marginal cost of exporting to country i will be

$$c_{ij} = c + \tau_{ij} . \tag{3}$$

I assume that markets are segmented so that firms compete by choosing quantities in each country.[4] In country i, country j's firm solves

$$\max_{q_{ij}} \pi^{ij} = (p_{ij} - c_{ij})q_{ij}, \tag{4}$$

where country i's inverse import demand for country j's product is given by

$$p_{ij} = a - \gamma Q_i - (1-\gamma) q_{ij} = a - q_{ij} - \gamma \sum_{k \neq j} q_{ik} . \tag{5}$$

Assuming an interior solution, country j's firm's first-order condition for optimal sales in country i is

$$\partial \pi^{ij} / \partial q_{ij} = p_{ij} - c_{ij} - q_{ij} = a - c - \tau_{ij} - (2 - \gamma) q_{ij} - \gamma Q = 0, \tag{6}$$

[4] The qualitative results of this paper hold even if firms compete in prices rather than in quantities. I assume Cournot competition mainly for analytical simplicity. See footnote 6 for more discussion on this point.

where equation (3) and (5) are used. Without loss of generality normalize $a - c = 1$. Summing the first-order condition (6) over $j = 1, ..., N$, in the unique Nash equilibrium,

$$Q_i = \frac{N - \mathrm{T}_i}{\Gamma(N)}, \tag{7}$$

where $\mathrm{T}_i \equiv \sum_{j=1}^{N} \tau_{ij}$ is the sum of country i's tariffs on all imports and

$$\Gamma(k) \equiv 2 - \gamma + k\gamma,\ k = 0, 1, ..., N. \tag{8}$$

Substituting (7) into (6) yields country j's Nash equilibrium exports to country i:

$$q_{ij} = \frac{\Gamma(0) - \Gamma(N)\tau_{ij} + \gamma \mathrm{T}_i}{\Gamma(0)\Gamma(N)}. \tag{9}$$

By the first-order condition (6), country j's export profit margin to country i is equal to its equilibrium volume of exports to country i. Hence, country j's export profits to country i is

$$\pi^{ij} = (p_{ij} - c_{ij})q_{ij} = q_{ij}^2. \tag{10}$$

If country i raises its tariffs on imports from country j, country j's equilibrium volume of exports (and its export profit margins) to country i decrease, all other countries' volumes of exports (and their export profit margins) to country i increase, but total amount of consumption in country i falls. Country i's domestic firm increases its domestic sales and earns a higher profit margin:

$$\frac{dQ_i}{d\tau_{ij}} = \frac{-1}{\Gamma(N)} < 0,\ \frac{dq_{ij}}{d\tau_{ij}} = \frac{\gamma - \Gamma(N)}{\Gamma(0)\Gamma(N)} < 0,\ \frac{d\pi^{ij}}{d\tau_{ij}} = 2q_{ij}\frac{dq_{ij}}{d\tau_{ij}} < 0 \tag{11}$$

and

$$\frac{dq_{ik}}{d\tau_{ij}} = \frac{\gamma}{\Gamma(0)\Gamma(N)} > 0 \text{ and } \frac{d\pi^{ik}}{d\tau_{ij}} = 2q_{ik}\frac{dq_{ik}}{d\tau_{ij}} > 0, k \neq j. \tag{12}$$

3. Trading Blocs and Welfare

3.1. The External Welfare Effects of the Formation of a Free-Trade Area

Consider a free trade area of size k.[5] Without loss of generality, suppose that countries 1, 2, ..., k belongs to the free-trade area and consider country i, i = 1, ..., k. It solves:

$$\underset{\{\tau_{ij}\}_{j=k+1}^{N}}{\text{Max}} \quad W^i = CS^i + \pi^{ii} + TR^i + \sum_{j \neq i} \pi^{ji}, \tag{13}$$

where $\tau_{ij} = 0$ for j = 1, ..., k. Define

$$\Psi^F(k) \equiv [\Gamma(0) + 1]\Gamma(k) - \Gamma(2) \text{ and } D^F(k) \equiv \Psi^F(k)\Gamma(N) + \Gamma(k)\Gamma(2). \tag{14}$$

Denote the equilibrium sales of a member country of a free-trade area by $q_I^F(k)$ and the sales of a nonmember country by $q_O^F(k)$. In the Appendix, I show that the above maximization problem has a unique optimal solution:

Lemma 1. The optimal external tariff of a member of a size-k free trade area is

$$\tau^F(k) = \frac{\Gamma(0)\Gamma(2)}{D^F(k)} = \frac{[2-\gamma][2+\gamma]}{[4+3(k-2)\gamma-(k-1)\gamma^2][2+(N-1)\gamma]+[2+(k-1)\gamma][2+\gamma]}. \tag{15}$$

Proof. See the Appendix.

[5] Since countries are assumed to be ex-ante symmetric, the *composition* of a free-trade area does not matter. Extending the current analysis to the setting of asymmetric countries is a topic of future research.

It is straightforward to see that $\tau^F(k)$ is a *monotonically* decreasing function of k: as the free trade area expands, the optimal *individual* external tariff of the member countries decreases:

Lemma 2. $\frac{d\tau^F(k)}{dk} < 0$.

Recall that the members of a free-trade area are constrained to eliminate tariffs on *member* countries. Lemma 2 shows that a member country of the free-trade area finds it in its individual self-interest to cut tariffs on nonmember countries. In order to understand Lemma 2, suppose that country i reduces tariffs on country j (say, due to the formation of a free-trade area which includes countries i and j.) What happens to country i's optimal tariffs on other countries? Put differently, how does a reduction in τ_{ij} change the *marginal* welfare effects of changes in τ_{ik}, $k \neq j$? The next result shows that $dW^i/d\tau_{ik}$, the marginal net benefit to country i of a slight increase in its tariffs on country k, is an increasing function of τ_{ij}. As a result, country i's optimal tariff on imports from country k ($k \neq j \neq i$) is a *increasing* function of its tariffs on imports from country j.

Lemma 3. $\frac{dW^i}{d\tau_{ij}d\tau_{ik}} > 0$, $k \neq j \neq i$. If country i reduces its tariff on imports from country j, country i's optimal tariff on imports from country k decreases.

Proof. See the Appendix.

The intuition behind this result is as follows. Suppose that country A cuts its tariffs on imports from country B. First, goods are (imperfect) substitutes with each other. Country B's effective cost of exporting to country A is now lower because of lower tariffs. Thus, country B's firm expands its exports to country A, thereby reducing the residual demand for imports from country C.[6] As a result, country C's export sales in country A go down. Second, in the

[6] This result is robust to the change in the mode of competition to from Cournot (quantity) competition to Bertrand (price) competition. When country A reduces tariffs on imports from

current model, the benefit of tariffs is to extract foreign firms' rents in the home market, but tariffs reduce domestic consumer surplus. Since country *A*'s tariff revenue on imports from country *C* is proportional to country *C*'s sales in country *C*, the marginal tariff revenue is now lower. Third, consumers value variety so that a balanced consumption portfolio is preferred to a unbalanced one, other things being equal. When tariffs on imports from country *B* are reduced, consumers in country *A* buy more imports from country *B* and less from country *C*. Since the social planner in country *A* weighs tariff revenues against the losses from both overall reduction in consumption and the imbalance in the consumption portfolio when choosing optimal tariffs, she wants to lower tariffs on imports from country *C* when she cuts tariffs on imports from country *B*. In other words, country *A*'s welfare function is *supermodular* (Milgrom and Roberts, 1990) in tariffs: the marginal value of tariff on country *C* increases with tariffs on country *B*.

Indeed, in this model, the external tariff goes down sufficiently to make nonmember countries better off. Recall that, in this segmented-market model with quasilinear preferences and linear production technologies, country *A*'s tariffs on country *B*'s imports do *not* affect the equilibrium pattern of tariffs and consumption in other markets. Thus, changes in country *A*'s tariffs affect country *C*'s welfare only through country *C*'s export profits to country *A*. Substitution of $\tau^F(k)$ into equation (9) yields

$$q_I^F(k) = \frac{\Psi^F(k) + \Gamma(2)}{D^F(k)} \text{ and } q_O^F(k) = \frac{\Psi^F(k)}{D^F(k)}. \tag{16}$$

Denote a nonmember country's export profits to a size-*k* free-trade area by $\pi_O^F(k)$. The following result shows that a nonmember country's volume of exports and export profits to a free-trade area are increasing functions of the size of the free-trade area:

Proposition 1. The formation and expansion of a free-trade area increases a nonmember country's volume of exports, exports profits and welfare.

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country *B*, country 2's firm raises its export price by a smaller amount than the reduction in tariffs. Hence, country *A*'s consumers buy more imports from country *B* and less imports from other countries, once again reducing residual demands for imports from other countries.

Proof. $\dfrac{dq_O^F(k)}{dk} = \dfrac{\gamma\Gamma(2)^2}{\left[D^F(k)\right]^2} > 0$. Since $\pi_O^F(k) = \left[q_O^F(k)\right]^2$, a nonmember country's export profits to a member of a free-trade area increases with the size of the free-trade area.

Q.E.D.

3.2. Comparison: The External Welfare Effects of the Formation of a Customs Union

A member of the size-*k* customs union chooses its external tariffs in order to maximize the *joint* welfare of the members of its customs union. Yi (1996) shows that the joint-welfare maximizing tariff of a size-*k* customs union, which can be denoted by $\tau^C(k)$, is given by

$$\tau^C(k) = \frac{[2-\gamma][2+(k-1)\gamma]}{[4+2(k-2)\gamma-(k-1)\gamma^2][2+(N-1)\gamma]+[2+(k-1)\gamma][2+(k-1)\gamma]}. \qquad (17)$$

A straightforward comparison of $\tau^C(k)$ and $\tau^F(k)$ shows that a member of a size-*k* customs union levies a higher external tariff than does a member of the size-*k* free-trade area:

Lemma 4. $\tau^C(k) > \tau^F(k)$, $k = 2, ..., N$.

This difference in external tariffs results from the fact that members of a customs union considers the effects on other member countries of raising its external tariffs. When country *A* raises its tariffs on imports from country *B*, other countries benefit from the output contraction by country *B*'s firm in country *A*. A member country of a customs union takes into account the positive externality its external tariffs create on other member countries, which a member country of a free-trade area ignores. (Put differently, members of a customs union exercise a bigger monopoly power than members of a free-trade area in setting the world prices of imports from nonmember countries). As a result, member countries of a customs union levy higher external tariffs than do member countries of a free-trade area of the same size.

In this model, this difference in external tariffs is sufficiently large enough to change the sign of external welfare effects. Yi (1996) shows that a nonmember country's volume of exports and export profits to a customs union are *decreasing* functions of the size of the customs union. This result is in sharp contrast to the current paper, where a nonmember country's volume of exports and export profits to a free-trade area are *increasing* functions of the size of the free-trade area.

4. Stable Structures of Free-Trade Areas

4.1. Per-Member Welfare of Free-Trade Areas

Due to the simplicity of preferences and technology, it is possible to obtain a closed-form solution of the per-member welfare of free-trade areas. Suppose that there are m free-trade areas, whose sizes range from n_1 to n_m. This structure of free-trade areas is denoted by $C = \{n_1, n_2, ..., n_m\}$. Denote by $W^F(n_i;C)$ the *per-member* welfare of a size-n_i free-trade areas in the coalition structure $C = \{n_1, n_2, ..., n_m\}$. In the Appendix, I show that

$$W^F(n_i;C) = \frac{1}{2\gamma} - \frac{\Gamma(0)+1}{2\gamma} q_O^F(n_i) + [n_i - 1]\left\{q_I^F(n_i)\right\}^2 + \sum_{j=1, j\neq i}^{m} n_j \left\{q_O^F(n_j)\right\}^2. \quad (18)$$

It is straightforward to see that the *world* welfare is higher under the grand free-trade area than under any other structures of free-trade areas: $NW^F(N;\{N\}) > \sum_{i=1}^{m} n_i W^F\{n_i;C\}$, for all $C = \{n_1, n_2, ..., n_m\}$, $m \geq 2$. This result follows from the fact that world welfare is maximized under global free trade when the only policy tools are import tariffs. (A similar result holds for customs unions: Yi (1996) shows that the world welfare is higher under the grand customs union than under any other customs-union structures.) Given this welfare result, an important question is whether the grand free-trade area is a stable outcome of a noncooperative game of free-trade area formation. As in Yi (1996), I examine stable structures of free-trade areas under the following two membership rules.

4.2. Rule of Free-Trade Area Formation

Simultaneous-Move Open Regionalism Game: Yi and Shin (forthcoming)

In this game, each country announces an "address" simultaneously. The countries that announce the same address belong to the same free-trade area. Formally, each country's strategy space is $A^i = \{a_1, a_2, ..., a_N\}$. For each N-tuple of announcements $\alpha = \{\alpha^1, \alpha^2, ..., \alpha^N\}$ $A \equiv A^1 \times A^2 \times ... \times A^N$, the resulting structure of free-trade areas is $C = \{B_1, B_2, ..., B_m\}$, where country i and j belong to the free-trade area B_k if and only if $\alpha^i = \alpha^j$: they choose the same address.

Infinite-horizon Unanimous Regionalism game: Bloch (1996)

In this game, country 1 first proposes a free-trade area (say, with countries 3, 5, and 6). The potential members of country 1's proposed free-trade area sequentially decide whether to accept or reject country 1's proposal. If any potential member rejects country 1's proposal, then this free-trade are does not form and the first country which rejects country 1's proposal makes a counterproposal. If all potential members of the proposed free-trade area accept country 1's proposal, then this free-trade area forms, and the country with the smallest index among the remaining countries (here, it is country 2) proposes a free-trade area to the rest of the countries, and so on. Bloch [1996] shows that this game yields the same stationary subgame perfect equilibrium coalition structure as the following "Size Announcement" game: country 1 first announces s_1, the size of its free-trade area, and the first s_1 countries form a size-s_1 free-trade area, and then country (s_1 + 1) proposes s_2, and the next s_2 countries form a size-s_2 free-trade area, and so on until country N is reached.

4.3. Stable Structures of Free-Trade Areas

The main result of Yi [1996] shows that the grand custom union is the unique pure-strategy Nash equilibrium outcome of the Open Regionalism game. But the grand customs union is typically not the equilibrium outcome of the Unanimous Regionalism game. Typically, two customs unions of asymmetric sizes form in the unique equilibrium outcome of the Unanimous Regionalism game.

Unlike the case of customs unions, characterizing the equilibrium structure of the free-trade areas under the two membership rules is difficult. This difficulty arises because the per-member welfare function for the case of free-trade areas (given in equation (18)) exhibits different properties from the per-member welfare function for the case of customs unions (given in equation (16) in Yi, 1996). In particular, Yi (1996)'s characterization of the equilibrium coalition structure of the Coalition Unanimity game relies on the *opposite* of Proposition 1 of the current paper. Furthermore, the second part of Proposition 8 of Yi (1996), which is used to show that the global customs union is the unique equilibrium outcome of the Open Regionalism game, may not hold in the case of free-trade areas. As a result, the grand free-trade area is not necessarily an equilibrium outcome of the Open Regionalism game. I illustrate this result for $\gamma = 1$, for which $\Gamma(k) = k + 1$, $\Psi^{F}(k) = 2k - 1$, $D^{F}(k) = (2k - 1)(N + 1) + 3(k + 1)$, $\tau^{F}(k) = \dfrac{3}{[(2k-1)(N+1)+3(k+1)]}$, $q_I^F(k) = \dfrac{2(k+1)}{[(2k-1)(N+1)+3(k+1)]}$, $q_O^F(k) = \dfrac{2k-1}{[(2k-1)(N+1)+3(k+1)]}$, and

$$W^F(n_i;C) = \frac{1}{2} - \frac{2n_i - 1}{[(2n_i-1)(N+1)+3(n_i+1)]} + [n_i - 1]\left\{\frac{2(n_i+1)}{[(2n_i-1)(N+1)+3(n_i+1)]}\right\}^2 + \sum_{j=1, j\neq i}^{m} n_j \left\{\frac{2n_j-1}{[(2n_j-1)(N+1)+3(n_j+1)]}\right\}^2 . \tag{18$'$}$$

Proposition 2. For $\gamma = 1$, the global free-trade area is a pure-strategy Nash equilibrium outcome of the Open Regionalism game if and only if $N \leq 9$.[7]

[7] Even with $\gamma = 1$ (homogeneous products), trade occurs in the current model because exports are driven by *individual* export profit maximization by each country (after tariffs are determined). Also notice that Lemma 3 (supermodularity result) holds for $\gamma = 1$. While the

Proof. See the Appendix.

Proposition 2 reflects potential *free-riding problems* in forming free-trade areas. If one country leaves the global free-trade area, then the deviating country levies its welfare-maximizing tariffs on other countries. The remaining member countries of the (formerly) global free-trade area raises their tariffs on the deviating country, but since they are levying no tariffs on other member countries, their individual welfare-maximizing tariff on the deviating country is not that high, especially when N is big (for the reasons explained in Section 3.1). Hence, the deviating country becomes better off.

The following result characterizes the equilibrium outcome of the Unanimous Regionalism game for $\gamma = 1$ and for $2 \leq N \leq 9$.

Proposition 3. For $\gamma = 1$, the global free-trade area is the unique equilibrium outcome of the Unanimous Regionalism game for $2 \leq N \leq 8$. For $N = 9$, {7,2} is the unique equilibrium outcome.

Proof. See the Appendix.

Notice that the global free-trade area is a stable outcome in both games for $2 \leq N \leq 8$. However, for $N = 9$, the global free-trade area is a stable outcome under the Open Regionalism game but not in the Unanimous Regionalism game.[8] For $N = 9$, we have $W^F(2;\{2,7\}) > W^F(9;\{9\}) > W^F(1;\{8,1\})$. (See the Appendix.) Hence, no country has an *individual* incentive to leave the global free-trade area, but has a *joint* incentive to leave the global free-trade area and form a size-2 free-trade area with another country. The Appendix

love-of-variety effect is absent for $\gamma = 1$, the rent-extraction effect still applies and hence supermodularity holds.

[8] The result that the global free-trade area may not the equilibrium outcome of the Unanimous Regionalism game for a large N is quite robust. For example, a similar proof as in Proposition 3 shows that {7,3} is the equilibrium outcome of the Unanimous Regionalism game for $N = 10$.

shows that the remaining seven countries find it in their self-interest to stick together as a size-7 free-trade area in the Unanimous Regionalism game in which they cannot join the size-2 free-trade area without the consent of its existing member countries. Hence, country 1 forms a size-2 free-trade area (say, with country 2) and the other seven countries form a size-7 free-trade area in the equilibrium of the Coalition Unanimity game.

5. Conclusion

I have examined the welfare effects of the formation of free-trade areas on nonmember countries and compared them to the case of customs unions. I have demonstrated that whether or not member countries of a large trading bloc exploits their monopoly power in setting terms of trade has a profound influence on the welfare of nonmember countries. The formation of a free-trade area (whose members do not exploit their joint power to change terms of trade) makes nonmember countries better off. In contrast, Yi (1996) shows that the formation of a customs union (whose members do exploit their joint monopoly power) makes nonmember countries worse off.

It is instructive to compare the results of the current paper to the classical result by Kemp and Wan (1976). They show that it is *possible* to construct a path of Pareto-improving trading bloc formation all the way to global free trade by adjusting external tariffs appropriately. The current paper shows that the formation of free-trade areas whose member countries maximize their individual welfare *is* a Pareto improvement, because only privately beneficial agreements are signed. However, due to free-riding problems, the endogenous formation of regional free-trade areas does not necessarily lead to global free trade.

I conclude with a remark on the robustness of the model. In order to assume away the income effects of tariffs on non-numeraire goods, I have assumed a quasi-linear utility function. This assumption has enabled me to derive the closed-form solution for the per-member welfare of a free-trade area in an arbitrary coalition structure, because the optimal tariff of a free-trade area depends only on its own size and not on the sizes of other free-trade areas. Extending the analysis to a general-equilibrium model of trade is a non-trivial exercise, because optimal tariffs of a free-trade area in such a model depend on the entire structure of free-trade areas. However, it seems likely that the most important building bloc of the current paper (that is, a member country of a free-trade area has individual incentives to reduce external tariffs when the representative consumer has love-of-variety preferences) would carry over to a general-equilibrium model of trade. It remains to be seen if the external tariffs are reduced sufficiently to raise the welfare of nonmember countries in the general-equilibrium models of trade.

Appendix

1. Proof of Lemma 1[9]

Since

$$v(\mathbf{q}_i) - cQ_i = CS^i + \pi^{ii} + TR^i + \sum_{j\neq i}\pi^{ij}, \qquad \text{(A-1)}$$

we have

$$CS^i + \pi^{ii} + TR^i = Q_i - \frac{\gamma}{2}Q_i^2 - \frac{1-\gamma}{2}\sum_{j=1}^{N} q_{ij}^2 - \sum_{j\neq i} q_{ij}^2. \qquad \text{(A-2)}$$

Country i's optimal tariff on imports on country s satisfies the first-order condition

$$\frac{dW^i}{d\tau_s} = (1 - \gamma Q_i)\frac{dQ_i}{d\tau_s} - (1-\gamma)\sum_{j=1}^{N} q_{ij}\frac{dq_{ij}}{d\tau_s} - 2\sum_{j\neq i} q_{ij}\frac{dq_{ij}}{d\tau_s} = 0, \qquad \text{(A-3)}$$

$s = k + 1, ..., N$. From equations (7) and (9),

$$Q^F(k) = \frac{N-(N-k)\tau^F(k)}{\Gamma(N)},\ q_I^F(k) = \frac{\Gamma(0)+\gamma(N-k)\tau^F(k)}{\Gamma(0)\Gamma(N)},\ q_O^F(k) = \frac{\Gamma(0)-\Gamma(k)\tau^F(k)}{\Gamma(0)\Gamma(N)}. \qquad \text{(A-4)}$$

Substituting equations (11) and (A-4) into (A-3) and rearranging terms yield $\tau^F(k)$.

2. Proof of Lemma 3

Without loss of generality, let $i = 1$, $j = 2$, and $k = 3$. From equation (A-3),

$$\frac{dW^1}{d\tau_2} = (1 - \gamma Q_1)\frac{1}{\Gamma(N)} - (3-\gamma)\sum_{j=1}^{N} q_{1j}\frac{dq_{1j}}{d\tau_2} + 2q_{11}\frac{dq_{11}}{d\tau_2}.$$

Hence,

$$\frac{d^2W^1}{d\tau_2 d\tau_3} = \frac{1}{\Gamma(0)^2\Gamma(N)^2}\left\{2\gamma^2 + (3-\gamma)\gamma\Gamma(N) + \gamma\Gamma(0)\right\} > 0,$$

[9] Full derivations are available from the author upon request.

where I have used equation (10). *Q.E.D.*

3. Derivation of $W^F(n_i;C)$

$$W^F(n_i;C) - \sum_{j=1,\, j\neq i}^{m} n_j\left\{q_O^F(n_j)\right\}^2$$

$$= Q^F(n_i) - \frac{\gamma}{2}\left[Q^F(n_i)\right]^2 - \frac{1-\gamma}{2}\left[n_i\left\{q_I^F(n_i)\right\}^2 + (N-n_i)\left\{q_O^F(n_i)\right\}^2\right] - (N-n_i)\left\{q_O^F(n_i)\right\}^2$$

$$= \frac{1}{2\gamma} - \frac{\Gamma(0)+1}{2\gamma}q_O^F(n_i) + [n_i - 1]\left\{q_I^F(n_i)\right\}^2.$$

4. Proof of Proposition 2

$\{N\}$ is a pure-strategy Nash equilibrium outcome of the Open Regionalism game if and only if $W^F(N;\{N\}) > W^F(1;\{N\text{-}1,1\})$. Now, for $\gamma = 1$, tedious derivations show that

$$W^F(N;\{N\}) - W^F(1;\{N\text{-}1,1\}) = \frac{-24N^7 + 180N^6 + 384N^5 - 312N^4 - 810N^3 - 30N^2 + 450N + 162}{\left[(2N-1)(N+1) + 3(N+1)\right]^2\left[N+7\right]\left[(2N-3)(N+1) + 3N\right]^2}.$$

The numerator of the above expression is positive if and only if $N \leq 9$. *Q.E.D.*

5. Proof of Proposition 3

For notational simplicity, let $\{D\} = C\backslash\{n_i\}$ denote a sub-coalition structure obtained from the coalition structure C by removing the size-n_i coalition. Tedious derivations show:

Lemma A-1. For $\gamma = 1$, **(1)** $W^F(2;\{2, D\}) > W^F(1;\{1,1,D\})$ for $2 \leq N \leq 9$. **(2)** $W^F(3;\{3, D\}) > W^F(k;\{k,3\text{-}k,D\})$ for $k = 1, 2$ and for $3 \leq N \leq 9$. **(3)** $W^F(4;\{4, D\}) > W^F(k;\{k,4\text{-}k,D\})$ for $k =$

1, 2, 3 and for $4 \leq N \leq 9$. **(4)** $W^F(5;\{5, D\}) > W^F(k;\{k,5\text{-}k,D\})$ for k = 1, 3, 4 and for $5 \leq N \leq 9$; and

$W^F(5;\{5, D\}) > W^F(2;\{3,2,D\})$ for $5 \leq N \leq 8$ but $W^F(5;\{5, D\}) < W^F(2;\{3,2,D\})$ for $N = 9$. **(5)** $W^F(6;\{6, D\}) > W^F(k;\{k,6\text{-}k,D\})$ for k = 1, 3, 4, 5 and for $6 \leq N \leq 9$; and $W^F(6;\{6, D\}) > W^F(2;\{4,2,D\})$ for $6 \leq N \leq 7$ but $W^F(6;\{6, D\}) < W^F(2;\{4,2,D\})$ for N = 8, 9. **(6)** $W^F(7;\{7, D\}) > W^F(k;\{k,7\text{-}k,D\})$ for k = 1, 3, 4, 5, 6 and for $7 \leq N \leq 9$; $W^F(7;\{7\}) > W^F(2;\{5,2\})$; $W^F(7;\{7, D\}) < W^F(2;\{5,2,D\})$ for N = 8, 9;and $W^F(7;\{7,D\}) > W^F(2;\{3,2,2,D\})$ for $7 \leq N \leq 9$. **(7)** $W^F(8;\{8, D\}) > W^F(k;\{k,8\text{-}k,D\})$ for k = 1, 3, 4, 5, 6, 7 and for N = 8, 9; and $W^F(8;\{8, D\}) < W^F(2;\{6,2,D\})$ for N = 8, 9. **(8)** $W^F(9;\{9\}) > W^F(k;\{k,9\text{-}k,D\})$ for k = 1, 3 - 8 and $W^F(9;\{9\}) < W^F(2;\{7,2\})$.

Lemma A-2. Consider the case of $\gamma = 1$ and $2 \leq N \leq 9$. Suppose that k countries are left in the Unanimous Regionalism game. Then, regardless of history, the optimal strategy for the current proposer (i.e., the country which is in the cue to choose the size of its free-trade area) is:

(1) If $2 \leq k \leq 4$, then announce "k" for $2 \leq N \leq 9$; **(2)** If $k = 5$, then announce "5" for $5 \leq N \leq 8$ and announce "2" for $N = 9$; **(3)** If $k = 6$, then announce "6" for N = 6, 7 and announce "2" for N = 8, 9; **(4)** If $k = 7$, then announce "7" for N = 7, 9 and announce "2" for $N = 8$; **(5)** If k = 8, then announce "8"; and **(6)** If $k = 9$, announce "2."

Proof. Let $\{D\}$ be the sub-coalition structure which already formed when k countries are left. **(1)** Lemma A-1 shows that for $k = 2$, announcing "2" dominates announcing "1" for the current proposer. Similarly, for $k = 3$, announcing "3" dominates announcing "2" or "1," and for $k = 4$, announcing "4" dominates announcing "3", "2" or "1." **(2)** By (1), announcing "4" or "1" results in $\{4,1,D\}$, and announcing "3" or "2" results in $\{3,2,D\}$. Lemma A-1 shows that the best strategy for the current proposer is to announce "5" for $5 \leq N \leq 8$ and "2" for $N = 9$. **(3) - (6)** can be established as in (1) and (2). *Q.E.D.*

Lemma A-2 shows that for $2 \leq N \leq 8$, the first country announces N. For $N = 9$, the first country announces 2, which is followed by the announcement of 7. *Q.E.D.*

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