Why Are Preferential Trade Agreements Regional?

Increasing Returns, Multinationals and the Geography of Free Trade Agreements

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Abstract: This paper uses a model of horizontal multinational enterprises to explore the relationship between transportation costs and trade policy cooperation. Tariffs have the effect of attracting foreign direct investment to the benefit of consumers in the host country. As transport costs fall, the incentive to impose tariffs falls and the benefits to cooperation rise. Thus, in a repeated game in which cooperation is limited by a self-enforcement constraint, a reduction in transport costs facilitates free trade. This logic is applied to a three-country model to examine cross-sectional relationships. It is found that if any country is too distant from the others, then global free trade is not attainable. Rather, if two of the countries are within a critical distance of each other and distant from the third country, then the unique outcome is an exclusive free trade agreement between the two adjacent countries. Thus, the model predicts a strong regional bias in preferential trade agreements.

Key words: regionalism, trade agreements, multinational enterprises, economic geography.

JEL Codes: F13, F15, F23, R12

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1. Introduction

Of all the various characteristics of countries that might explain (in a statistical sense) why countries enter into preferential trade agreements (PTAs), one variable stands out above all others: proximity. Virtually all PTAs are between geographically contiguous countries. Those that are not are typically based on former imperial relationships, which have been diminishing in importance.[1] Indeed, so strong is the relationship between proximity and PTAs that few economists even bother to make a distinction between preferential trade and "regionalism."[2] Despite this obvious link, however, the theory of PTAs has not produced a compelling argument for why it exists. This paper suggests one.

The approach taken in this paper will be summarized briefly at this point, postponing the details until the next subsections. There is a certain class of international trade models, involving elements of increasing returns and imperfect competition, in which transportation costs (which are closely correlated with distance) provide an argument for trade policy. Perhaps the most transparent model in this class is that of a multinational firm which faces a trade-off between proximity and concentration.[3] By restricting trade, the importing country may induce the multinational firm to engage in local production, which benefits local consumers through lower prices. The desirability of a trade restriction for the importing country, therefore, may increase with the transport cost.

A branch of recent literature has sought to explain the nature of trade agreements by appealing to limitations placed on international cooperation by the absence of outside enforcement (e.g., Bagwell and Staiger, 1990; see Staiger, 1995, for a literature review).

[1] An exception is the US-Israel FTA. Also, Norway and Switzerland are members of the European Free Trade Area (EFTA) but are not contiguous. However, all the countries that lie in between are members of the EU, which has a free trade agreement with the EFTA countries.
[2] See Baldwin and Venables, 1995, for a discussion of this point.
[3] This terminology is borrowed from Brainard, 1993, 1997.

Without a supra-national enforcer, countries must design their trade agreements to be "self-enforcing." In a repeated games framework, this requires that at every point in time a country's one-time incentive to deviate from an agreement must be less than the discounted benefit of future cooperation. Using the simple multinational model described above, this paper shows that the one-time incentive to deviate is lower and the benefit to cooperation greater the lower is the transport cost. Thus, countries separated by low transport costs are more likely to be capable of maintaining a free trade agreement than countries separated by high transport costs.

1.1. An Argument from Standard Preferential Trade Theory

One of the earliest lessons from the standard theory of PTAs (Viner, 1950) is that a PTA is more likely to increase the welfare of its members if it includes the lowest cost suppliers of the goods being traded, as this eliminates the possibility of trade diversion. The cost of transporting goods across distance (as distinct from government-imposed tariffs) is one component of the cost of delivering a product to a foreign market. Other things equal, contiguous countries will be able to deliver goods to each other at lower cost than countries distant from one another. By the same token, a PTA between contiguous countries should be more likely to raise the welfare of its members than a PTA between distant countries.

Krugman (1991a) offers an extreme example. Imagine that transportation costs are zero between countries on the same continent and prohibitive to trade between countries on different continents, even without tariffs. It follows that an inter-continental PTA would offer no benefits at all, while an intra-continental PTA would liberalize all trade that can be liberalized and thus certainly raise the welfare of the continent as a whole. The continent in this example is said to be a "natural" trading bloc.

Although there is some question as to whether the notion of a natural trading bloc generalizes beyond simple examples (see, Frankel, et. al., 1997), the basic idea appears sensible. However, to make use of it as an explanation for the observed regional bias in PTAs,[4] one must make the additional assumption that governments actually enter into those trade agreements that give the highest welfare. While this may not be an objectionable assumption *per se*, it is a treacherous one in this context. If the policy environment in which trade agreements are created is so benign as to enable countries to achieve maximal welfare, then why don't countries simply agree to global free trade and not bother with PTAs? A credible theory must account for the imperfections in domestic or international institutions that give rise to PTAs in the first place.

1.2. A Counter-argument based on Repeated Game Theory

While there are several approaches to modeling the institutional imperfections that give rise to trade policy, the most successful approach in analyzing the character of trade agreements has been that based on the theory of repeated games. In such a model, the limits of cooperation are determined by the balance of the one-time incentive for a country to deviate from an agreement with the discounted benefit of future cooperation (avoiding trade war).

Virtually the only argument in standard trade theory for *not* unilaterally eliminating all tariffs is the one based on monopoly power in trade. The relationship between transport

[4] This is not to suggest that Krugman, or others who have put forth the natural trading bloc idea, have offered it as an explanation for the observed reational bias in PTAs. To the contrary, their focus has been almost entirely normative (i.e., on evaluating the regional bias in PTAs, not explaining it), as was Viner's.

costs and monopoly power is generally ambiguous, but in most cases we would expect it to be negative. In Krugman's example, there is no incentive for a country of any size to unilaterally impose a tariff on inter-continental trade, whereas a large country can expect to benefit from a small tariff on intra-continental trade through improved terms of trade. In other words, while there are greater benefits to intra-continental cooperation, there is a greater incentive to deviate as well. Thus, it certainly cannot be supposed that contiguous countries will be able to agree upon lower tariffs than distant ones, as long as we remain in a conventional constant returns/perfect competition framework.[5]

1.3. *An Argument Based on Economies of Scale*

The literature on trade policy under increasing returns and imperfect competition reveals many new channels by which trade policy can affect welfare, several of which depend on transport costs. Two papers by Venables (1985 and 1987) illustrate important cases. Venables (1985) examines a two-country model of oligopoly with free entry, homogeneous products and segmented markets, while Venables (1987) uses the Dixit-Stiglitz monopolistic competition framework. In each model, because of a transport cost, each firm sells more at home than it exports. A tariff imposed by one country causes firms to enter that country and exit the other. This has the effect of expanding domestic production to the benefit of domestic consumers. Helpman and Krugman (1989) refer to this as the home-market effect. This effect appears in numerous other models as well, such as the geography model of Krugman (1991b).

[5] Bond and Syropoulos (1996) and Bagwell and Staiger (1997a and 1997b) examine preferential trade agreements within perfectly competitive settings, using repeated games to model the limits of cooperation. They are concerned with how a move free trade between a pair of countries affects the trade agreements those counties can reach with outside countries. They do not address the question of which countries are most likely to form PTAs, as the decision to form a PTA is exogenous. There are also no transport costs.

The same effect can arise in models of multinational enterprises; particularly those of "horizontal" direct foreign investment. In such models, the decision to engage in multinational production reflects a trade-off between the firm's desire to be close to foreign markets (because of trade costs) and the desire to concentrate production at home and exploit economies of scale.[6] Such models include Krugman (1983), Smith (1987), Horstmann and Markusen (1992), Motta (1992), Brainard (1993) and others. Trade restrictions can induce firms to engage in multinational production ("tariff-jumping" direct foreign investment) which may benefit consumers in the host country as such production avoids transport costs. All of this points to one general lesson: the incentive to impose trade restrictions may be increasing in the transport cost in models where the home market effect is dominant.

In this paper, this positive relationship is exploited to generate a regional bias in trade agreements. Two cases are studied. The first is a two-country model that serves to illustrate the basic connection between transport costs and trade policy cooperation. It is shown that the benefits of cooperation rise and the incentive to deviate falls as the transport cost is reduced. There is also a discontinuity in the relationship between trade agreements and the transport cost. There is a transport cost threshold that must be crossed before cooperative tariff reductions can occur at all, but once the transport cost falls below this threshold, free trade becomes supportable. The second case is a three-country "triangular" model, in which two countries are adjacent to each other and equidistant from the remote third country. In this case, there is a transport cost threshold in each dimension. Below both of them, global free trade is attainable, as are most forms of preferential agreement.

[6] Brainard, 1997, demonstrates the empirical relevance of this mode of multinational activity and further shows that the share of affiliate sales in the sum of exports an affiliate sales is positively related to trade

Above both of them, no cooperation is possible. If transport costs are low between the adjacent countries and high elsewhere, then the unique outcome is a preferential trade agreement between the adjacent countries. As is typical of repeated games, the less countries discount the future the higher will be the transport cost thresholds, meaning the easier it will be to sustain cooperation.

Taken together our results suggest that free trade will tend to arise between countries that are geographically near one another, and that preferential trade agreements, in particular, will be associated with regions (areas within which transport costs are low and between which transport costs are high). This explanation also requires that trade is based on economies of scale or there is considerable multinational production. This would suggest that the explanation for regional bias offered here would apply best to North-North relationships.

The rest of the paper is organized as follows. Section 2 sets out a simple model of horizontal multinational production, based on Krugman (1983). Section 3 examines the two-country case, introduces the repeated game framework, and demonstrates the relationship between transport costs and cooperation. Section 4 examines the three-country model and establishes the main results regarding preferential trade agreements. Section 4.5 considers the effect of an alternative punishment mechanism. Section 5 concludes.

2. The Model

We consider a world consisting of $m \geq 2$ countries and two sectors, X and Y. There are n firms in each country, each producing a unique, firm-specific variety of good X from

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barriers and transport costs.

at least one plant. Each firm operates a plant in its home country from which it supplies its home market. We take the fixed cost of operating this plant to be zero. The firm may also operate plants in foreign countries. Doing so enables the firm to avoid the trade costs associated with exporting to those markets; however, each new plant incurs a fixed cost of F. The marginal cost of production is constant at c for all plants.

Trade in good X is subject to an iceberg-type transport cost, which causes goods to be lost or destroyed as they are shipped from location to another. Between any two locations i and j, it is assumed that for every unit of good X shipped only $r_{ij} \leq 1$ units actually arrive. We shall refer to r_{ij} as the survival rate of goods shipped between i and j. The survival rate is assumed to be one between a plant and its local market and strictly less than one between different countries.

Trade in X is also subject to *ad valorem* tariffs imposed by the governments. Tariffs are taken to be nonnegative and to apply on the basis of origin (where the good is produced) not ownership (who owns the plant that produces it). This ensures that when a firm locates a plant in a foreign country, the plant faces the same costs as all other plants located in the same country. Tariffs may be discriminatory on the basis of origin, as in the case of a PTA. PTAs are not required to maintain a common external tariff, so the analysis accommodates both customs unions and free trade areas. The structure of the game will be discussed in more detail later, but for now it is assumed that firms take tariffs as given when making their location and production decisions.

The representative consumer has a quasi-linear, separable utility function of the form,

$$U = \sum_{i=1}^{m \cdot n} \theta C_i^{(1/\theta)} + Y, \qquad \theta > 1 \tag{1}$$

where C_i denotes consumption of variety *i* of good *X*, and *Y* represents consumption of the homogeneous, numeraire good *Y*. Each country is assumed to be endowed with an ample quantity of *Y*, and trade in this good is free. Differentiating (1) with respect to C_i gives demand functions $C_i = P_i^{-\varepsilon}$, where P_i denotes consumer price and $\varepsilon \equiv \theta/(\theta - 1)$ is the elasticity of demand.

2.1 Trade Costs and Market Clearing

If a firm wishes to supply a market that is subject to the survival rate *r*, it must produce a quantity 1/*r* times the quantity demanded in the market, so as to compensate for the losses in transit. Also, the consumer price in the market must be (1 + *t*)/*r* times the producer price, reflecting both the survival rate and any tariff rate *t* imposed by the importing government. Thus, to clear a market subject to *r* and *t*, a firm must produce a quantity

$$X(s,t) = (1+t)^{-\varepsilon} P_0^{-\varepsilon}(1-s) \tag{2}$$

where $s \equiv 1 - r^{(\varepsilon-1)}$ and P_0 is the producer price. The variable $s \in [0,1)$ is taken as our measure of the transport cost, and instead of the less intuitive *r*. For a given producer price, *s* measures the percentage reduction in output (and thus profit) caused by losses in transit.

It is evident from (2) that the elasticity of demand is unaffected by the trade costs. Hence, the firm will charge a producer price that is a constant markup over marginal cost and is independent of trade costs. Specifically,

$$P_0 = \theta c \tag{3}$$

The operating profit derived from the production of $X(s,t)$ is therefore

$$\tilde{\pi}(s,t) = (P_0 - c)X(s,t) = \beta(1+t)^{-\varepsilon}(1-s) \tag{4}$$

where $\beta = (\theta - 1)\theta^{-\varepsilon}c^{1-\varepsilon}$. Operating profit is a decreasing function of the transport cost and the tariff rate. It is also decreasing in the marginal cost of production c and the elasticity of demand ε.

Let $v(s,t)$ denote the sum of consumer surplus and tariff revenue derived from the import of any variety subject to transport cost s and tariff t. Using (1), (2) and (3) gives

$$v(s,t) = \theta\beta(1+\varepsilon t)(1+t)^{-\varepsilon}(1-s) \tag{5}$$

This is also decreasing in s, t, c, and ε. The reason $v(s,t)$ is decreasing in the tariff is evident from equation (3). As the producer price is unaffected by trade costs, the imposition of a tariff results in no terms-of-trade improvement for the importing country. This is by design, for we wish to abstract from traditional optimal tariff considerations. Our focus is on the role of trade policy in enabling countries to avoid transport costs. Thus, in this model, the only way a country can benefit from a tariff is to induce foreign firms to engage in multinational production and thereby eliminate s.

2.2. Plant Location

Basically, a firm's decision as to the number and location of its plants reflects a trade-off between trade costs and fixed costs. By locating a plant in a foreign country, the firm incurs F but avoids the trade costs associated with exporting to that market. Complicating this trade-off is the fact that the trade costs connected with exporting to any one market depend on the firm's plant-location choices in other markets, because the firm can export from any of its existing plants. Furthermore, with each new plant, the firm expands the number of sources from which it may export to any country.

Let K be a set of $k \leq m$ countries. A firm with its headquarters in K and a plant located in each of the other members of K receives a maximum total profit of

$$\pi^K(\mathbf{s},\mathbf{t}) = \beta + (k-1)(\beta - F) + \sum_{i \notin K} \max_{j \in K} \tilde{\pi}(s_{ij}, t_{ij}) \tag{6}$$

where s_{ij} (= s_{ji}) is the transport cost between countries i and j, t_{ij} is the tariff imposed by country i on imports from country j. The first term on the right-hand side of (6) is the profit derived from the home market; the second is the profit derived from the other $k - 1$ markets in K; and the third is the profit from exporting to the remaining countries, using the best source plants available in K.

We make two assumptions about plant location. First, if all countries choose zero tariffs, then all firms prefer single-plant production. Second, we assume $\beta > F$, so that it is profitable for a firm to operate a foreign plant. This second assumption is sufficient to imply that there exists a high enough tariff, call it $\bar{t}$, that if any country were to impose $t \geq \bar{t}$ on an MFN basis, then all firms would locate a plant in that country, regardless of the policies of other countries. Such a tariff would maximize the country's consumer surplus, as all products would be locally produced.

Beyond these two extremes, there is very little one can say about the firm's optimal choice of K without a complete specification of the geography and the world configuration of tariffs. The complexity of this problem necessitates the consideration of some simple examples, which are found in the next two sections.

3. The Two-Country Case

In this section we develop the simplest case, that of two countries, *A* and *B*. While this case does not directly address the issue of preferential trade agreements, it serves to illustrate the basic channel through which transport costs affect cooperation on trade policy. As a theory in itself, this model predicts that a decrease in transport costs, due to technological innovation for example, would tend to lower *overall* tariff levels. Whether or not this hypothesis is consistent with the actual time series is an open question.[7] The primary purpose, however, is to take an intermediate step toward establishing that geographical proximity facilitates trade policy cooperation.

With two countries, the plant location decision is binary: the firm either operates a single plant and exports to the other country, or it opens a plant abroad and exports nothing. As all firms in the same country are identical, the total profit of a country facing a foreign tariff of t is given by

$$\Pi(s,t) = n\left\{\beta + \max\left[\tilde{\pi}(s,t), \beta - F\right]\right\} \tag{7}$$

The tariff $\bar{t}$ is determined by $\tilde{\pi}(s,\bar{t}) = \beta - F$, which is where (7) is minimized.

Let $V(s,t)$ be the total consumer surplus plus tariff revenue, summed over the $2n$ goods consumed, for a country that imposes the tariff t. Using (5) and $\bar{t}$ gives,

$$V(s,t) = \begin{cases} n\left[\beta\theta + v(s,t)\right] & \text{for } t < \bar{t} \\ 2n\beta\theta & \text{for } t \geq \bar{t} \end{cases} \tag{8}$$

Combining (7) and (8), the total welfare of a country imposing tariff t and facing a foreign tariff t' is $W(s,t,t') = V(s,t) + \Pi(s,t')$.

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[7] Recently, Hummels (1998) has called into question the conventional wisdom that transportation costs have fallen considerably in the post-war period. However, empirical work in this area is still in its infancy.

Figures 1 and 2 illustrate components of welfare as functions of the tariff. Figure 1 shows total profit as a function of t for two different levels of s ($s < s'$). Total profit declines as the tariff level increases, for $t < \bar{t}$. At $\bar{t}$, the firms switch to multinational production and the tariff has no further effect on profits. Increasing the transport cost reduces the profit of a single-plant firm. This makes firms willing to switch to multinational production for a lower tariff. Thus, the critical tariff $\bar{t}$ falls to $\bar{t}'$.

FIGURE 1

($s < s'$)

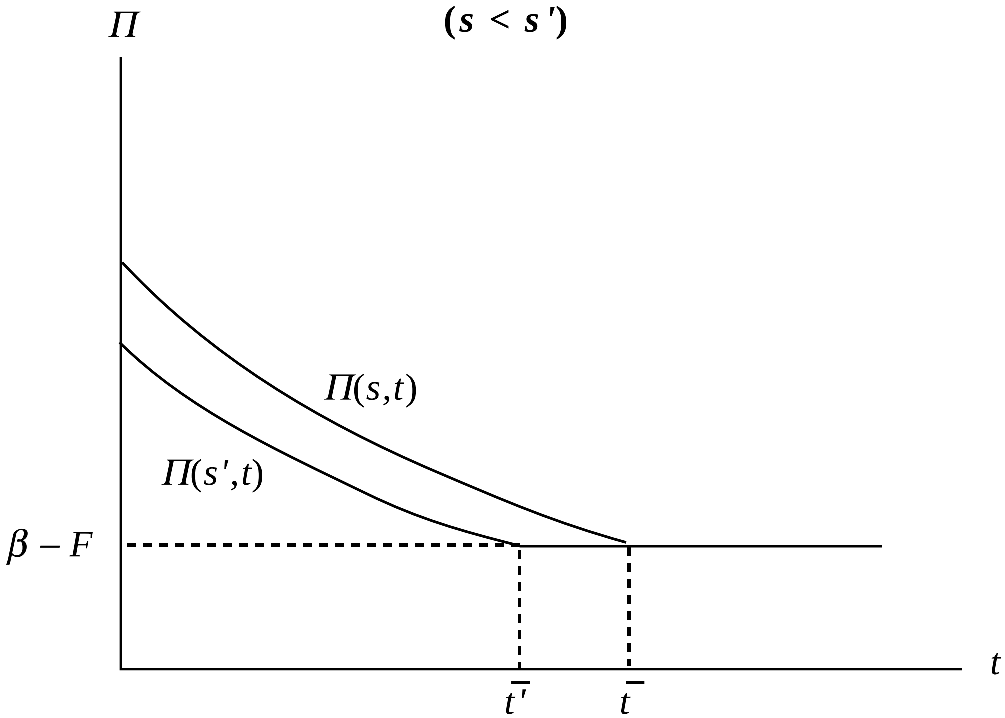
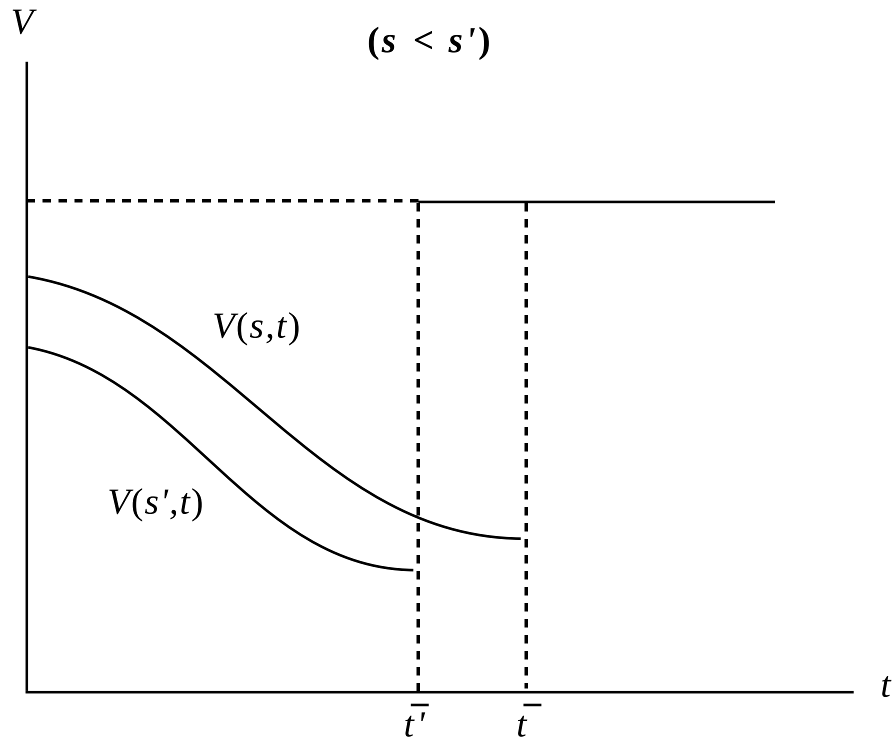


Figure 2 shows $V(s,t)$ as a function of t for the same two levels of s. $V(s,t)$ reaches a local maximum at zero and is declining in t, for all t below $\bar{t}$. Once a country's tariff becomes greater than $\bar{t}$, firms quit exporting to that country and invest in plants to produce locally. This benefits the country's consumers as the consumer price of the affected varieties falls from $(1+t)r^{-1}P_0$ to P_0. As long as the transport cost is positive, the consumers prefer the multinational outcome to free trade. Increasing the transport cost also reduces $V(s,t)$ for $t < \bar{t}$. This makes the incentive for a country to attract foreign investment even greater.

FIGURE 2

($s < s'$)



The fact that both $V(s,t)$ and $\Pi(s,t)$ are decreasing in t for $t < \bar{t}$ means that neither country gains from the imposition of a tariff, unless that tariff is high enough to induce multinational production. At that point the tariff is a beggar-thy-neighbor policy, with home consumers gaining at the expense of foreign firms.

Whether free trade with single-plant firms or no trade with multi-plant firms is better in terms of overall world welfare depends upon parameters. As our interest is in free trade agreements, we assume free trade to be globally efficient, or $W(s,0,0) > W(s,\bar{t},\bar{t})$. Using (7) and (8), the condition for the efficiency of free trade can be written as

$$\frac{F}{\beta} > s(\theta + 1) \tag{9}$$

The left-hand side of (9) is less than 1, otherwise the firms would never find it profitable to establish a second plant. Subject to that, it is clear that the fixed cost of setting up the second firm must be suitably large, or the transport cost suitably small for this condition to hold.

3.1. Self-Enforcing Trade Agreements

In this section, we consider an infinitely repeated game based on the model developed in the previous subsection. Suppose there are an infinite number of discrete time periods, each consisting of a game played in three stages: governments choose tariffs in the first stage; firms make plant and production decisions in the second and third stages, respectively. A strategy is now infinite sequence of functions, one for each period, mapping the history of past play into current actions. Agents discount payoffs in future periods by a factor $\delta < 1$.

In repeated games such as this it is common to find a large set of subgame perfect equilibria. As the purpose of this paper is to explore the limits of trade policy cooperation, however, we shall be interested only in the Pareto frontier of this set, defined with respect to the total welfare levels of the two countries. To construct the set of Pareto efficient (PE) subgame perfect equilibria, we consider first the one-shot version of the game.

In the one-shot game, each government's dominant strategy is to impose a tariff high enough to induce every foreign firm to set up a second plant. Thus, the one-shot equilibrium involves multinational production by all firms and tariffs no less than $\bar{t}$ in each country. Moreover, the welfare received in this equilibrium is the lowest to which any country can be held in any equilibrium. It follows that to construct the complete set of subgame perfect equilibria, one need only look for tariff pairs (t_A, t_B) supportable by the threat that, if any player should deviate, then the one-shot equilibrium would prevail in all future periods.

The tariff pair (t_A, t_B) can be supported as a subgame perfect equilibrium if,

$$(1-\delta)\left[W(\bar{t},t_j)-W(t_i,t_j)\right]\leq\delta\left[W(t_i,t_j)-W(\bar{t},\bar{t})\right],\quad i,j=A,B,\ i\neq j \qquad (10)$$

where the parameter s is suppressed for notation brevity. The left-hand side of condition (10) is country i's temptation to deviate from the equilibrium. It is the one-shot gain from choosing an investment-inducing tariff instead of t_i. The right-hand side is the enforcement. It is loss from switching to the punishment equilibrium in the next and all future periods relative to remaining at (t_A, t_B).

It is useful to decompose (10) into consumer and producer components as follows:

$$V(\bar{t})-V(t_i)\leq\delta\left[\Pi(t_j)-\Pi(\bar{t})\right] \qquad (11)$$

In other words, the gain to consumers associated with multinational production must be less than the discounted loss in firm profits. Recall that the gain to consumers from multinational production (the left-hand side of (11)) is an increasing function of both the tariff rate and the transport cost. The loss to producers (the right-hand side of (11)) is a decreasing function of both the tariff and the transport cost. This has two important implications:

Proposition 1: If any tariffs less than $\bar{t}$ can be supported in equilibrium, then bilateral free trade can also be supported. Thus, zero is the unique PE equilibrium tariff for both countries. Conversely, if free trade is not an equilibrium, then the PE equilibrium tariff is $\bar{t}$ or greater.

The proof of proposition 1 is straightforward. There can be no equilibrium in which one tariff is $\bar{t}$ and the other is less than $\bar{t}$, because this would give the low tariff country a payoff less than $W(\bar{t},\bar{t})$. For tariffs less than $\bar{t}$, free trade gives the maximum enforcement, the minimum temptation, and the highest welfare for both countries. If free trade is not an equilibrium, then we are left with only the one-shot equilibrium (for $t \geq \bar{t}$ both enforcement and temptation are zero).

Proposition 2: The lower the transport cost the larger is the set of discount factors that will support free trade as an equilibrium.

This is because lowering the transport cost increases enforcement and decreases temptation. To be more precise, we substitute equations (7) and (8) into condition (11) and set $t_i = t_j = 0$, yielding the following condition for a free trade equilibrium:

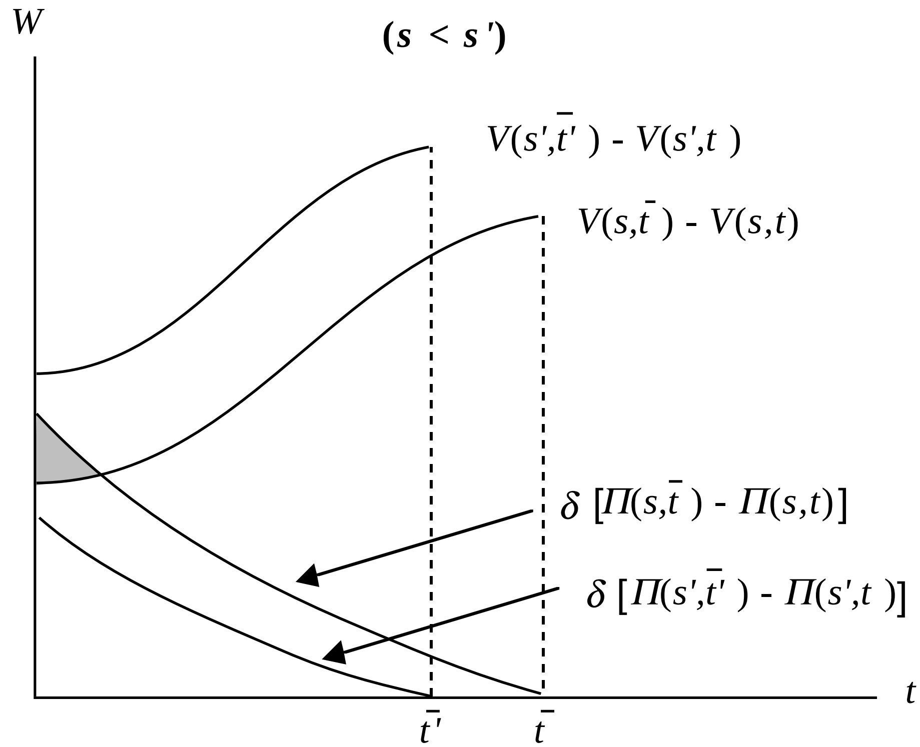
$$\frac{F}{\beta} \geq s\left(\frac{\theta}{\delta}+1\right) \tag{12}$$

The only difference between this and condition (9) (the condition for the efficiency of free trade) is the presence of the discount factor, which increases the right-hand side of (12). From (12) it follows that a larger fixed cost, a higher discount factor or a lower transport cost all favor free trade agreements.

The above results are illustrated in figures 3 and 4. In figure 3, the two sides of condition (11) are drawn separately, as functions of t, for two different levels of s. The shaded area represents the excess of enforcement over temptation. For transport cost s, the shaded region corresponds to an interval of tariffs including zero. Thus, free trade is the

FIGURE 3

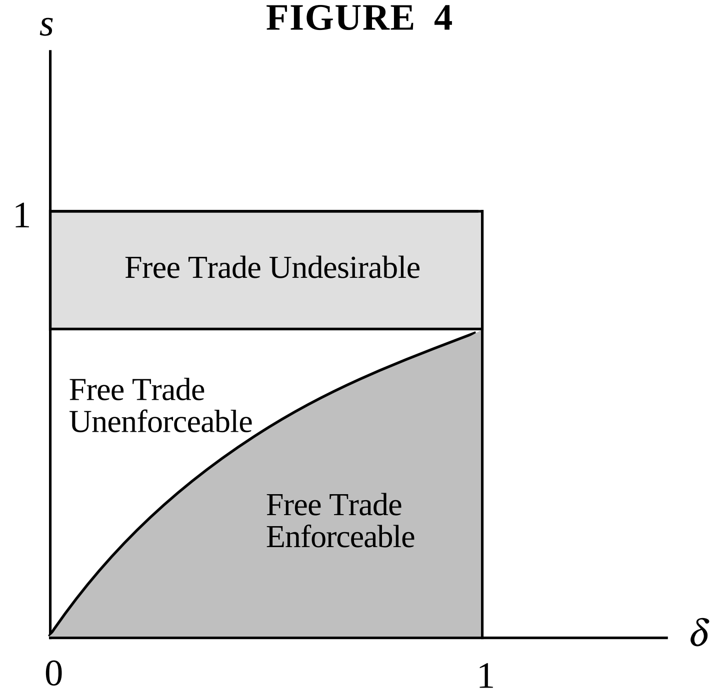
($s < s'$)



PE equilibrium tariff. For the higher transport cost s', free trade is not an equilibrium, as temptation exceeds enforcement for all $t < \bar{t}'$. In this case, the PE equilibrium tariff is $\bar{t}'$. It was noted earlier that $\bar{t}$ is decreasing in s implying that for even higher transport costs (higher than s') the PE equilibrium tariff would be lower. Thus, as the transport cost falls, the PE equilibrium tariff rises until the transport cost reaches a critical level (where (11) is satisfied with equality) at which point the tariff drops to zero and remains there for all lower transport costs.

Figure 4 depicts the equilibria corresponding to different combinations of the discount factor and the transport cost. Above a certain level of *s*, condition (9) is violated

FIGURE 4



and the countries would be better off in the punishment equilibrium. Below this level of *s*, the free trade is enforceable for a high enough discount factor. The minimum discount factor necessary to support free trade increases with *s*.

4. A Triangular Model

We now introduce a third country *C*, which is identical to *A* and *B* in every respect except location. The transport cost between *A* and *B* is *s*, while the transport cost between *A* and *C* and between *B* and *C* is assumed to be $s' > s$. One can think of the three countries as being located at the corners of an isosceles triangle, with *C* being geographically remote but equidistant from its two trading partners. The purpose of this model is to determine whether a preferential trade agreement between neighbors, *A* and *B*, is in some sense more likely than one between separated countries like *A* and *C*. As part of this, we will need to establish that PTAs can occur despite the presence alternatives such a global free trade.

There are three preliminary issues that must be dealt with before we begin the analysis. The first concerns the location of plants when firms are indifferent as to where to locate. In a three-country world, firms no longer face a simple binary plant location choice. Rather, firms must choose whether to operate one, two or three plants, and, if a firm operates two plants, it must decide where to locate the second plant and whether to export from its home plant or from its foreign affiliate. The optimal choice is usually determinate. However, if a firm is headquartered outside of a bilateral FTA, decides to locate a plant within the FTA, and supply both FTA markets from that plant, it will be indifferent as to where in the FTA to locate.

In the aggregate, these choices matter because they affect the distribution of consumer surplus within the FTA. The FTA country receiving the smaller share of investment will have a correspondingly smaller share of FTA consumer surplus and greater tendency to deviate from the FTA. The most resilient FTA therefore will be one in which the investment shares are equal. For this reason and to preserve as much symmetry in the model as possible, we assume that, when outside firms are indifferent, half of them locate in one FTA country and half in the other.

The second issue is that the added dimensionality has the potential to produce a large set of Pareto efficient equilibria. In the two-country case, condition (9) ensures that free trade Pareto dominates any individually rational tariff pair, and thus there is only one efficient equilibrium. This is harder to achieve in higher dimensions. For example, consider a situation where one country imposes a uniform tariff of $\bar{t}$, while all of the other countries have zero tariffs. Such and outcome is better than global free trade (i.e., zero tariffs for all countries) for the tariff-imposing country and is likely to be worse for the other countries. But as long as this outcome is not worse than the punishment equilibrium for any country, it can be supported as an equilibrium for a high enough discount factor. As this illustration suggests, there may be many asymmetric equilibria that are difficult to rule out on grounds of Pareto efficiency.

To limit this complexity (which, combined with added complexity of firm location choice, becomes intractable) and focus on outcomes that resemble actual trade agreements, we restrict attention to equilibria that satisfy a mild form of reciprocity, namely, if $t_{ij} < \bar{t}$ then $t_{ji} < \bar{t}$ (for all $i, j = A, B, C, i \neq j$). That is, a country only reduces its tariff if it receives some tariff reduction from its trade partner in return. This is certainly a conventional if not entirely reasonable requirement for a trade agreement to satisfy.

Finally, we note one important similarity between the two and three country models. Every tariff in a PE equilibrium must be either zero or prohibitive. This was established in Proposition 1 for the two-country case. For the triangular model we have the following lemma:

Lemma 1: In any PE equilibrium, if $t_{ij} > 0$, then exports of X from country j to country i must be zero (for all $i, j = A, B, C$).

Proof in appendix.

The implication of this lemma is that we can restrict attention to equilibria involving only two tariff levels: zero and $\bar{t}$. The intuition is that tariffs are of no benefit to producers or consumers in this model, unless they affect plant location. Thus, an equilibrium in which the tariff matrix contains only zeros and $\bar{t}$s must Pareto dominate any other equilibrium that supports the same configuration of plants. It turns out that there are no equilibrium plant configurations that cannot be reproduced by a matrix of zeros and $\bar{t}$ s. It should be noted that lemma 1 does not depend on reciprocity.

Lemma 1 implies a dramatic reduction in the search for equilibria. In fact, there now are only six cases to be considered, which can be organized into three categories: MFN equilibria; exclusive bilateral agreements; and hub-and-spoke arrangements.

4.1. MFN Equilibria

a) The One-shot Nash Equilibrium

The tariff $\bar{t}$ continues to be determined by $\tilde{\pi}(s,\bar{t}) = \beta - F$, which in this case is equivalent to $\pi^{\{A,C\}} = \pi^{\{A,B,C\}}$. This is the smallest MFN tariff country *B* would need to impose to induce a firm operating in country *A* to open a plant in *B*, given any tariff imposed by *C*. Firms not operating in *A* would be even more inclined open a plant in *B*, as $s' > s$. By imposing $\bar{t}$, a country maximizes its consumer surplus (as all goods come to be produced locally), regardless of the behavior of other governments. Thus, this continues to be the dominant strategy for all countries in the one-shot game. The one-shot equilibrium therefore gives the following payoffs:

$$\overline{V} = 3n\theta\beta \quad \text{and} \quad \overline{\Pi} = n(3\beta - 2F) \tag{13}$$

for all countries. $\overline{V}$ is the surplus from consuming 3*n* goods subject to zero trade costs, while $\overline{\Pi}$ is the profit of a country's *n* firms each operating three plants. $\overline{V} + \overline{\Pi}$ is the lowest welfare any country can experience in any subgame perfect equilibrium, and thus it continues to be the severest possible punishment.

b) Global Free Trade (FT)

With no tariffs, all firms prefer single plant production and export everything from their home plants. A firm in country *A* sells to the *A* market without trade cost, to the *B* market subject to s, and to the *C* market subject to s', yielding a total profit of $\tilde{\pi}(0,0)+\tilde{\pi}(s,0)+\tilde{\pi}(s',0)=\beta(3-s-s')$. Firms in *B* receive the same. A firm in *C* sells to both its export markets at s', yielding $\tilde{\pi}(0,0)+2\tilde{\pi}(s',0)=\beta(3-2s')$. Combining these profits with the corresponding consumer surpluses produces the following payoffs:

$$V_A^{FT}=V_B^{FT}=n\theta\beta(3-s-s') \text{ and } \Pi_A^{FT}=\Pi_B^{FT}=n\beta(3-s-s') \tag{14}$$

$$V_C^{FT}=n\theta\beta(3-2s') \text{ and } \Pi_C^{FT}=n\beta(3-2s') \tag{15}$$

Both producers and consumers in *A* and *B* are better off in *FT* than are their counterparts in country *C*, due to the assumed geography. Thus, *C* is the country most likely to deviate from a global free trade agreement. Using (15) and (13) in (11), the condition for global free trade to be subgame perfect is $\overline{V}-V_C^{FT}\le\delta(\Pi_C^{FT}-\overline{\Pi})$, or

$$\frac{F}{\beta}\ge s'\left(\frac{\theta}{\delta}+1\right) \tag{16}$$

It follows that if country *C* is too far away from *A* and *B*, global free trade will not occur, even if it is Pareto efficient.

4.2. Exclusive Bilateral Agreements

a) FTA between Adjacent Countries (AB)

With free trade between *A* and *B*, and all other tariffs equal to $\bar{t}$, a firm headquartered in *A* or *B* will open a second plant in *C* but continue to supply its FTA partner from its home plant. This yields a profit of $2\tilde{\pi}(0,0)-F+\tilde{\pi}(s,0)=\beta(3-s)-F$. A firm headquartered in *C* opens a second plant either in *A* or *B* and exports from there to the other FTA member. Thus, regardless of where the *C* firm locates its second plant, it receives the same profit as do the *A* and *B* firms.

Using the assumption that half of *C*'s foreign plants locate in each FTA member, the payoffs associated with an FTA between *A* and *B* are

$$V_A^{AB} = V_B^{AB} = n\theta\beta\left(3 - \tfrac{3}{2}s\right) \text{ and } \Pi_A^{AB} = \Pi_B^{AB} = n\beta(3-s) - F \tag{17}$$

$$V_C^{AB} = \overline{V} \text{ and } \Pi_C^{AB} = n\beta(3-s) - F \tag{18}$$

Country *C* is actually better off in the presence of *AB* than are its members. This is because *C* suffers no transport costs on its imports yet benefits from the low trade costs between *A* and *B* on its exports. Thus, *A* and *B* are the countries most likely to deviate. Using (17) in (11), *AB* can be supported as an equilibrium if and only if,

$$\frac{F}{\beta} \geq s\left(\frac{3}{2}\frac{\theta}{\delta} + 1\right) \tag{19}$$

Thus, an FTA between the adjacent countries is a candidate for equilibrium if the transport cost between *A* and *B* is small enough. We shall postpone discussing whether this is a Pareto efficient equilibrium until after we have examined the other cases.

b) FTA between Distant Countries (AC)

This case is the same as *AB* except that the relevant transport cost is s' instead of *s*.

Thus, the payoffs to an FTA between *A* and *C* are

$$V_A^{AC} = V_C^{AC} = n\theta\beta\left(3 - \tfrac{3}{2}s'\right) \text{ and } \Pi_A^{AC} = \Pi_C^{AC} = n\beta(3-s') - F \tag{20}$$

$$V_B^{AC} = \overline{V} \text{ and } \Pi_B^{AC} = n\beta(3-s') - F \tag{21}$$

and this can be supported as an equilibrium if and only if,

$$\frac{F}{\beta} \geq s'\left(\frac{3}{2}\frac{\theta}{\delta}+1\right) \tag{22}$$

Comparing condition (22) with (16) it is evident that if global free trade fails to be an equilibrium than so also does the FTA between distant countries.

4.3. Hub and Spoke Arrangements

If bilateral trade agreements were restricted to being customs unions, rather than free trade areas (the difference being that customs unions require a common external tariff), then the foregoing cases would be exhaustive. However, if members of a bilateral agreement are permitted to have different external tariffs, then it is possible for one member of an FTA to sign a second FTA without including its partner from the first. This is known as a hub and spoke arrangement[8] – the country that is a member of both agreements is the hub, while the other two countries are spokes. There are two generic cases of this.

a) Country A as the Hub (AH)

If country *A* is the hub, firms headquartered in *A* enjoy tariff-free access to *B* and *C* and thus receive the same profit as under *FT*. Firms headquartered in *B* locate a plant in *C* in order to serve that market, and export to *A* from their home plants. This produces the same profit as under *AB*. A firm headquartered in *C* locates a plant in either *A* or *B* and exports from there, also generating the same profit as under *AB*. The payoffs are therefore,

$$V_A^{AH} = V_A^{AB} \text{ and } \Pi_A^{AH} = \Pi_A^{FT}$$

[8] See Wonnacott (1990) uses this terminology.

$$V_B^{AH} = V_B^{AB} \text{ and } \Pi_B^{AH} = \Pi_B^{AB}$$

$$V_C^{AH} = n\theta\beta(3 - s') \text{ and } \Pi_C^{AH} = \Pi_C^{AB}$$

The only difference between this and *AB* is that now *A*'s proft is greater and *C*'s consumer surplus is lower. In other words, *A* saves from having to invest in *C* at the expense *C*'s consumers. One implication of this is that if both *AB* and *AH* exist as equilibria, then neither one Pareto dominates the other.

Whether *B* or *C* is the country more likely to deviate from *AH* depends on the transport costs. For high values of s', consumer surplus in *C* will be low and thus *C* will be the more likely to deviate. Otherwise, *B* is the potential deviator, and since *B* receives the same payoff in *AH* as in *AB*, the existence condition for this equilibrium is the same for *AB*. The condition for the existence of *AH* is therefore

$$\frac{F}{\beta} \geq \max\left[s\left(\frac{3}{2}\frac{\theta}{\delta}+1\right),\left(s'\frac{\theta}{\delta}+s\right)\right] \tag{23}$$

b) Country C as the Hub (CH)

Finally, there is the possibility that country *C* is the hub, maintaining bilateral free trade agreements with *A* and *B*. Firms headquartered in *C* receive the same profit as under *FT*. Firms headquartered in *B* locate a plant in either *A* or *C* and export from there, generating the same profit as under *AC*. Firms headquartered in *A* behave symmetrically and thus receive the same profit as firms headquartered in *B*. Thus, the payoffs to *CH* are

$$V_A^{CH} = V_B^{CH} = V_A^{AC} \text{ and } \Pi_A^{CH} = \Pi_B^{CH} = \Pi_A^{AC}$$

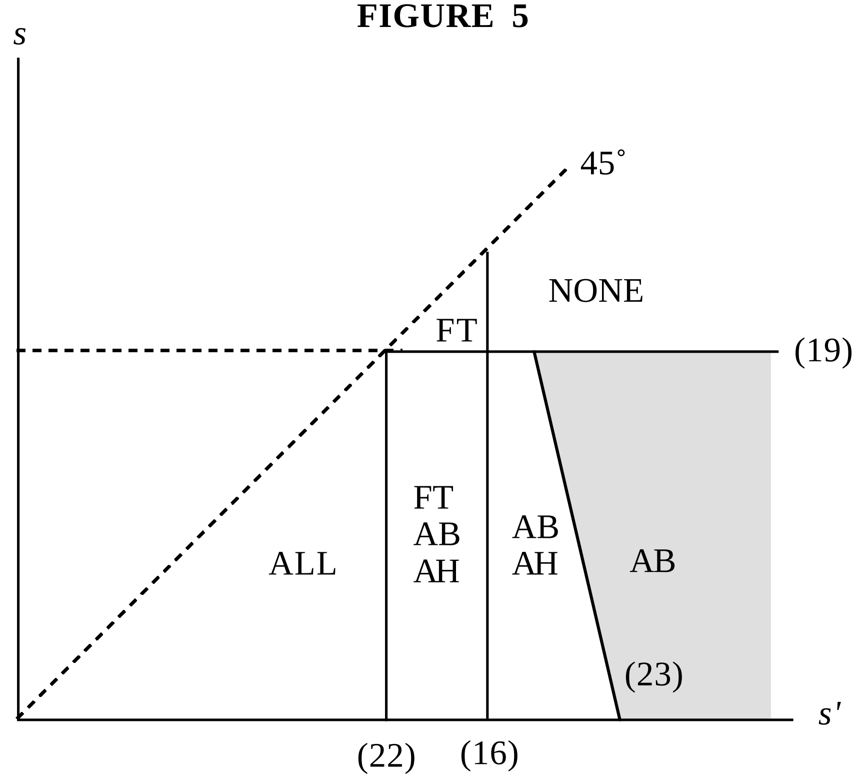
$$V_C^{CH} = V_C^{AH} \text{ and } \Pi_C^{CH} = \Pi_C^{FT}$$

and existence condition for this equilibrium is identical to that of *AC*. As with the previous hub-and-spoke arrangement, if both *AC* and *CH* exist as equilibria, then neither one Pareto dominates the other.

4.4. Results

A comparison of the existence conditions for the six cases described above is found in figure 5. Figure 5 shows the different trade agreements that exist for every combination of s and s' such that $s < s'$. The boundaries separating the various sets are the combinations of s and s' that satisfy the equilibrium conditions with equality, and are labeled according the corresponding equation numbers.

FIGURE 5



One conclusion that can be drawn immediately from figure 5 is that if s is below the threshold (19) that permits a preferential agreement between A and B, then an exclusive bilateral FTA between A and B is the only equilibrium (other than the punishment equilibrium) to survive a high enough s'. This is shown by the shaded region is figure 5. The next proposition states the result formally.

Proposition 3: For all $s \leq \frac{F}{\beta}\left(\frac{2\delta}{2\delta+3\theta}\right)$ and $s' > \left(\frac{F}{\beta}-s\right)\frac{\delta}{\theta}$, *AB* is the unique PE equilibrium.

Proposition 3 is the central result of the paper. It establishes that if two countries have low transport costs between them and high transport costs in relation to the rest of the world, then those two countries must have an exclusive bilateral FTA. This is strongly indicative of a regional bias in PTAs.

If s is above the threshold (19), then either FT is the outcome (for low s') or no cooperation is possible (for high s'). This is same as in the two-country model.

For all other transport costs, there are multiple trade agreements that satisfy the subgame perfection requirement, and thus we must apply the Pareto criterion to refine the equilibrium set any further. We have already noted that when both *AB* and *AH* exist, neither Pareto dominates the other, so we focus the remainder of this section on cases in which (16) and (19) are both satisfied [i.e., points in Figure 5 below (19) and left of (16)].

Proposition 4: If (16) and (19) are both satisfied, then

a) *FT* and *AH* are PE equilibria

b) *AB* is a PE equilibrium if and only if, $s \leq 2(\theta+1)s' - (F/\beta)$.

Proof in appendix.

Proposition 4b implies that it is possible for *AB* to be ruled out on grounds of Pareto efficiency. This will occur whenever *C* prefers *FT* to *AB* (the condition stated in proposition 4b is the converse). If the cost of shipping goods from *C* is low relative to the fixed cost of setting up a new plant, then *C*'s firms benefit from global free trade (relative to *AB*) by more than *C*'s consumers benefit (relative to *FT*) from having foreign goods locally produced. Thus, a low s' relative to *F* and *s* will tend to promote global free trade.

Finally, consider the only two cases (other than the punishment equilibrium) in which countries *A* and *B* do not have free trade between them. These are *AC* and *CH*. Condition (22) must be satisfied for these equilibria to exist [i.e., points to the left of (22) in figure 5]. The next proposition states the conditions under which they are Pareto efficient.

Proposition 5: If (22) is satisfied, then

a) *AC* is a PE equilibrium if and only if, $s \geq \frac{(F/\beta) - \theta s'}{1+\theta}$

b) *CH* is a PE equilibrium if and only if, $s \geq (\theta + 2)s' - (F/\beta)$

c) If $\delta \leq 3/4$, then *CH* is a PE equilibrium and *AC* is not.

Proof in appendix.

Proposition 5 suggests that *AC* is an unlikely equilibrium. It is ruled out for discount factors less than three fourths (5c). When $\delta > 3/4$, *AC* can only survive for high values of *s* and s', corresponding to the upper corner of the triangular region of figure 5 in which all agreements are PE equilibria. The condition in proposition 5a is the condition for country *B* to prefer *AC* to *FT*.

The hub and spoke arrangement *CH* is more robust. When it exists it is likely to be Pareto efficient, because the hub country *C* enjoys free trade for its exports to both *A* and *B*, while receiving investment from those *A* and *B* firms that locate in *C* so as to export to the other spoke.

The main conclusion to be drawn from propositions 4 and 5 is that if transport costs are fairly low across the board, then we can expect to see agreements involving country *C*. These will typically be *in addition to* free trade between *A* and *B*, as in the cases of *FT* and *AH*. But they may occur instead of free trade between *A* and *B*, as in the cases of *AC* and *CH*. Thus, it is not necessarily the case that, if all three countries are relatively close to each other, free trade will occur between the two closest countries. Empirically, therefore, we should expect to see a slightly weaker correlation between tariffs and transport costs (or distance) within well-defined regions than between them.

4.5 Targeted Punishment

The previous sections operated under the assumption that defection from an equilibrium would result in worldwide trade war. The value of this assumption was that it enabled us to find the largest possible set of supportable trade agreements. Despite its effectiveness, however, complete trade war is not necessarily the most reasonable punishment, particularly in cases where other, less draconian, punishments can produce efficient outcomes as well.

In this section, we consider an alternative form of punishment that applies to trade agreements involving more than two countries. If one country defects from a three-country trade agreement, it may be considered undesirable that the non-defecting countries should raise tariffs against each other for no other reason than to punish the defector. Instead, suppose the non-defecting countries target their tariff increases, applying $\bar{t}$ only to imports from the defecting country, while maintaining tariffs toward each other at pre-defection levels, provided this is equilibrium behavior. If this is not equilibrium behavior, then countries revert to generalized trade war.

The most obvious effect of using targeted instead of generalized punishment is that hub-and-spoke arrangements are now ruled out as equilibria. The explanation is simple. We saw in the previous section that if *AH* is an equilibrium under generalized punishment, then so is *AB*, and country *C* always prefers *AB* to *AH*. Thus, country *C* would always defect from *AH* in favor of the targeted punishment equilibrium *AB*, for any discount factor. Likewise, if *CH* is an equilibrium under generalized punishment, then so is *AC*, and country *B* always prefers *AC* to *CH*. Again, *B* would defect from *CH* in favor of the targeted punishment equilibrium *AC*, for any discount factor. In sum, at least one of the spokes would always defect from a hub-and-spoke arrangement.

The next issue is to determine when free trade can be supported by targeted punishment. If condition (19) (the existence condition for *AB*) is violated, then free trade continues to be an equilibrium for low enough s'. If condition (19) is satisfied, then free trade is an equilibrium provided *C* would not prefer to defect in favor of *AB*, and *B* would not would not prefer to defect in favor of *AC*. It can be shown that the first of these conditions obviates the second, and thus we only need to ensure *C* would not defect. This condition is,

$$\frac{F}{\beta} \geq 2s'\left(\frac{\theta}{\delta}+1\right)-s \tag{24}$$

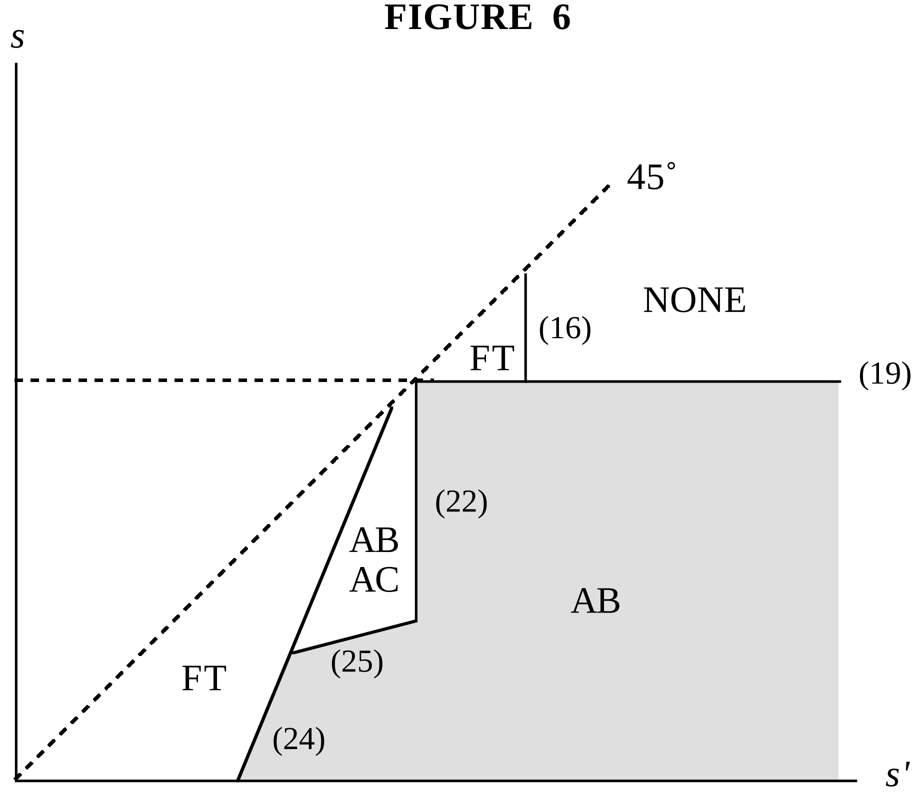
This is just the reverse of the condition in 4b discounted by δ. If (24) is satisfied, then *FT* is the unique equilibrium, because *FT* satisfies subgame perfection and Pareto dominates both *AB* and *AC*.

The only remaining issue is whether *AB* Pareto dominates *AC* or not, when (24) is violated. The country most likely to prefer *AC* to *AB* is *B*. Country *B* prefers *AB* to *AC* if and only if,

$$s' > s\left(\frac{3}{2}\theta + 1\right) \tag{25}$$

This condition depends only on transport costs, not on the fixed cost, because firms headquartered in *B* operate two plants in either case. In *AB*, *B* trades only with *A*, subject to *s*. In equilibrium *AC*, *B*'s firms export between *A* and *C* through foreign affiliates,

FIGURE 6



subject to s'. Thus, high s' or low s will tend to make B prefer AB to AC.

Figure 6 summarizes the equilibrium set for the targeted punishment case. The overall results are similar: AB is the unique equilibrium for low s and high s'; FT is an equilibrium for low values of both s and s', as well as for a small range of high s and low s'; if s and s' are both high, no cooperation is possible. The effect of the targeted punishment is to significantly increase range of parameters in which AB is the unique equilibrium, to eliminate hub-and-spoke arrangements, and to reduce the set of parameters in which global free trade can occur. Thus, targeted punishment strengthens the regional bias of PTAs.

5. Conclusions

The strong empirical relationship that seems to exist between proximity and preferential trade is an issue worthy of the attention of economists interested in economic geography and commercial policy. It is not easily explained using standard trade theory, even when account is taken of trade agreement imperfections due to limited enforceability. This paper uses a simple model of horizontal multinational enterprises, which when combined limited enforceability, produces a strong inverse relationship between physical transport costs and trade policy cooperation. In the three-country model, this produces a regional bias in PTAs.

This paper does not claim to have the definitive explanation for why PTAs are regional, for there is still much to be done. This paper has highlighted the possible role of multinationals; however, it may be that multinational activity alone may be too small in relation to total trade flows to account for the geography of PTAs. Thus, it would be useful to extend the analysis to other models of trade that exhibit the home market effect. Some progress has been made using the oligopoly and monopolistic competition models of Venables (1985 and 1987). Though the analytics of these cases are rather untidy, numerical simulations have produced results similar to those presented here.

Even among models of multinational enterprises, the model presented in this paper is special. For example, the multinational model used here does not allow for competition between the firms. We might do well to reexamine our results in the context of a model such as Hostmann and Markusen (1992).

Another worthwhile next step in this research would be to increase the number of countries. Our results seem to suggest that trade blocs may come in clusters, and there may be a maximum geographic size of an bloc. It is likely that this maximum size would grow as the transport cost falls

Mindful of its limitations, this paper is an encouraging first step toward understanding the geography of trade agreements. The model features transport costs, economies of scale, and imperfect competition – the same recipe that has proven successful in the economic geography literature in explaining a wide variety of geographic phenomena. It also uses the repeated games approach which has been used extensively in the commercial policy literature to explain aspects of international trade agreements. This paper shows the potential of linking these two traditions for modeling the geography of trade agreements.

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7. APPENDIX

Proof of Lemma: Suppose there exists an efficient equilibrium in which $t_{ij} > 0$ and exports from j to i are positive. Consider the effect of reducing t_{ij} to $t'_{ij} \in (0, t_{ij})$. There are two cases to consider.

(1) Suppose the reduction has no effect on the location of plants. Since $\tilde{\pi}$ and v are both decreasing in the tariff, the reduction in t_{ij} raises the consumer welfare in i and profits in j and causes no decrease in any component of any country's welfare. Thus, t'_{ij} represents a pareto improvement and it is also an equililbrium, as $\bar{V} - V$ does not rise and $\Pi - \overline{\Pi}$ does not fall for any country.

(2) Suppose the reduction in t_{ij} affects plant location. The firms that alter their plant location must be those headquartered in country $k \neq i, j$. Firms headquartered in i are entirely unaffected by a reduction in t_{ij}. By construction, firms headquartered in j export to country i from their home plants in the original equilibrium, a decision that is only reinforced by a reduction in t_{ij}. Thus, any alteration in plant location must be in the form of country k firms opening new plants in j so as to export from there to i. If such firms previously had no foreign plants, then the move raises profits in k and increases consumer welfare in i and j. Again t'_{ij} represents a pareto improvement and it is consistent with equililbrium. The only other possibility is that country k firms have plants in i in the orignial equilbirum but abandon them for plants in j, when t_{ij} is reduced. This would only occur if $t'_{ij} \leq t_{ji}$, but what is t_{ji}? There are two possibilities:

a) There are positive exports from i to j in the original equilibrium. If this is so, then t_{ji} must be zero, because any lowering of t_{ji} does not affect plant location and is thus pareto improving and consistent with equilibrium.

b) There are no exports from i to j in the original equilibrium. If this is true, then there are also no exports from i to k. But this must be pareto dominated by an equilibrium in which $t_{ki} = \bar{t}$, $t_{ji} = 0$ and there are positive exports from i to j.

The consequence of a) and b) is that because the original equilibrium is pareto efficient, t_{ji} must be zero. It follows that for any $t_{ij} > 0$, there exists $t'_{ij} \in (0, t_{ij})$ that pareto dominates t_{ij} and is consistent with equilibrium. This contracts our original supposition.

QED

Proof of Proposition 4:

Comparing (14) and (17), we have $W_A^{FT} > W_A^{AB}$ if and only if $F/B > s'(\theta+1) - s(\theta/2)$. But (19) guarantees that $\dfrac{F}{\beta} > s'\left(\dfrac{\theta}{\delta}+1\right) > s'(\theta+1) - s\left(\dfrac{\theta}{2}\right)$, and so, $W_A^{FT} > W_A^{AB}$ whenever (19) is satisfied. Thus, we can rank the payoffs to country A, as follows:

$$W_A^{AH} > W_A^{FT} > W_A^{AB} > W_A^{AC} = W_A^{CH} \tag{A1}$$

As $W_A^{FT} = W_B^{FT}$ and $W_A^{AB} = W_B^{AB}$, we can partially rank the payoffs for country B:

$$W_B^{FT} > W_B^{AB} = W_B^{AH} > W_A^{CH} \tag{A2}$$

From A1 and A2, we see that *FT* and *AH* cannot be Pareto dominated. This establishes proposition 4a. Also, *FT* (and only *FT*) is better than *AB* for both *A* and *B*. Thus, *AB* is Pareto dominated if and only if $W_C^{FT} > W_C^{AB}$. Subtracting (18) from (15), a little algebra produces the condition: $s \le 2(\theta + 1)s' - (F/\beta)$. This establishes 4b. QED

Proof of Proposition 5:

For all paramters W_C^{AC} is the lowest payoff (other than the punishment equilibrium) for country C. Thus, considering A1, *AC* must be Pareto dominated unless $W_B^{AC} > W_B^{FT}$. Subtracting (20) from (14), a little algebra produces the condition: $s \ge \frac{(F/\beta) - \theta s'}{1+\theta}$. This establishes 5a.

A1,.A2, and the fact that $W_B^{AC} > W_B^{CH}$ for all paramters imply that CH is the worst outcome for *A* and *B*. Thus, CH is Pareto dominated unless it is the best outcome for C. For all parameters it is the case that $W_C^{CH} > W_C^{FT}$ and $W_C^{AB} > W_C^{AH} > W_C^{AC}$. Thus the CH is best for C if and only if $W_C^{CH} > W_C^{AB}$, which if produces the condition: $s \ge (\theta + 2)s' - (F/\beta)$. This establishes 5b.

Finally, we note that condition (22) depends on the discount factor. In particular if $\delta \le 3/4$, then

$$\frac{F}{\beta} \ge s'\left(\frac{3}{2}\frac{\theta}{\delta} + 1\right) \ge s'(2\theta + 1) \tag{A3}$$

Recalling that $\theta > 1$, and $s < s'$, A3 ensures the condition in 5b is satisfied and that in 5a is violated. Thus, *CH* is a PE equilibrium and *AC* is not. QED