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Multi-lateral trade negotiations and the Most Favored Nation clause

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Abstract

This paper considers the interaction between private information and the Most Favored Nation clause in trade negotiations. It demonstrates that by aggregating uncertainty over a number of trading partners, the Most Favored Nation clause may offer a welfare improvement over a set of bilateral trade negotiations. This improvement is shown to be most pronounced when a large number of countries are involved in negotiations.

Keywords: Economic integration; Private information; Most Favored Nation

JEL classification: F13; F15

1. Introduction

The recent proliferation of preferential trade agreements (PTAs) has renewed the debate over their desirability, especially in relation to efforts to liberalize at the multi-lateral level. A number of papers have now documented the potentially negative impact that PTAs may have on the multi-lateral process of trade negotiations.[1] However, one issue that has been neglected in this literature has

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[1] See Bhagwati and Panagariya (1996) for a recent survey, along with Levy (1997), Krishna (1998), Bagwell and Staiger (1997a,b).

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been the problems associated with multi-lateral trade negotiations (MTN).[2] Indeed, if one looks at the analysis of why the US pursued its regional trade initiatives since 1980, a recurring theme is that they were undertaken to circumvent problems with pursuing liberalization at the multi-lateral level.[3]

Misgivings over the efficiency of MTN generally stem from concerns over the prominent role that the Most Favored Nation (MFN) clause plays in GATT negotiations. This clause requires that exports of one country be treated no less favorably than exports of any other country. Consequently, when a trade concession is granted to one member of the GATT, all other members are automatically extended the same privilege. This creates the possibility of the benefits of liberalization spilling over to GATT members who have not offered an appropriate reciprocating concession (i.e. free riders). These free riders are said to undermine the efficiency of MFN negotiations as countries become reluctant to offer concessions.[4]

Despite these problems the MFN clause is also said to have a number of potential benefits, such as avoiding transaction costs and counteracting imbalances in negotiating strength. Indeed as Caplin and Krishna (1988) point out:

> ''There is a simple observation which illustrates the difficulties in providing a general bargaining-theoretic rationale for MFN. There is a grand utility possibility frontier available to countries using all the commercial trading instruments at their disposal, such as tariffs. If we view the bargaining process as yielding efficient outcomes, as for example with the Nash bargaining solution, then MFN simply limits the tools available to different countries, shifting in the utility possibility frontier. Hence the most positive aspects of MFN can only be illustrated when the bargaining process absent-MFN yields inefficient outcomes''.[5]

Therefore, the challenge is not to quantify how poorly the MFN clause performs in a first best environment, but rather consider the potential advantages and disadvantages it may have compared to other institutions in a world where negotiations encounter frictions. The friction that this paper considers is the extent to which an individual country's valuation of a trade agreement is private information.[6]

Uncertainty surrounding the potential benefits from a trade agreement can arise

[2]The papers of Bagwell and Staiger (1997a,b) are exceptions. They assume that multi-lateral trade negotiations are inefficient due to a lack of enforcement power.

[3]The Caribbean Basin Initiative, the US–Israel FTA and Canada–US FTA were all set in motion at a time when the US could not get a new round of MTN started, while NAFTA was conceptualized when the Uruguay round looked to have stalled.

[4]See, for example, Conybeare (1987).

[5]As quoted in Staiger (1995).

[6]See Ludema (1991) for an analysis of the MFN clause in a setting of complete information.

from a number of sources. Most obviously the estimates generated from computable general equilibrium models depend crucially on assumptions relating to market structure, returns to scale, intersectoral mobility of factors, coverage of countries and industries as well as notoriously imprecise estimates of trade elasticities. It is not uncommon for the range of estimated benefits to vary by more than a factor of four.[7] In addition to quantifying the actual size of benefits, there may also be significant uncertainty surrounding how a policy maker evaluates the distribution of gains and losses across different groups in society. These types of considerations imply that trade negotiations are often conducted in the knowledge that gains exist, but with considerable uncertainty over the size and distribution of these gains among countries.

The role that private information has played in the operation of trade policy has been analyzed from a number of perspectives — non-cooperative trade policy has been analyzed be Jensen and Thursby (1990), while the operation of trade policy in more co-operative settings has been studied by Feenstra and Lewis (1991), Riezman (1991) and Bac and Raff (1997). However, the interaction between different trade negotiation institutions and private information has not been considered. In particular, an interesting question relates to the relative merits of the way information is processed under different institutions. In this paper the operation of the MFN clause is compared to the negotiation of a set of bilateral trade agreements. Under bilateral negotiations, attention is focused on the uncertainty of the payoff of one trading partner with an associated tendency to sort countries into high and low valuation groups, with liberalization only viable for the high valuation group. In contrast, MFN negotiations aggregate the uncertainty over a number of trading partners and shift the focus to the aggregate valuation of these partners. Depending on the expected size of the aggregate valuation, the outcome under MFN negotiations may either be global free trade or a global trade war. Therefore a comparison of these two institutions sets up a tension between widespread, but not complete liberalization, under a bilateral regime, and some possibility of global free trade but also some possibility of a trade war under MFN negotiations.

This comparison can be clarified by examining the efficiency of each institution as the number of countries involved in negotiations is increased. This exercise has a real world analogue as the membership of the GATT/WTO has increased from 23 when it was founded in 1947 to now be over 130. Variation in the number of countries does not influence the terms of a trade agreement under a bilateral regime, and hence the problems associated with attempts to liberalize on a bilateral basis remain. However, under MFN negotiations the probability of free trade increases with the number of countries involved in negotiations. The intuition for this result follows from the emphasis the MFN clause puts on the aggregate

[7] See Francois et al. (1996) for the impact of increasing returns to scale, McKibbin and Salvatore (1995) for dynamic effects and Klenow and Rodriguez-Clare (1997) for the effect of variety gains.

valuation of an agreement and the fact that uncertainty surrounding the aggregate valuation diminishes as the number of countries involved in negotiations increases. Despite the resolution of aggregate uncertainty, individual uncertainty remains under MFN negotiations. Therefore, while a large country may be able to hold an agreement 'hostage' when dealing with a small number of trading partners, using the probability of an agreement to extract concessions, its capacity to act in this way is diminished as the number of countries involved in negotiations is increased. One consequence of this counterbalancing of negotiating power is that the probability of a trade agreement increases. A second consequence is that the reduction in the rent extracting ability of a large country implies that such a country will most desire bilateral negotiations as the number of countries involved in MFN negotiations increases. Hence, despite the global desirability of MFN negotiations when there are a large number of countries involved in negotiations, these are the very conditions when a large country will be tempted to pursue bilateral initiatives. This prediction goes some way to explaining the behavior of the US and the EU, both of which have showed interest in pursuing further preferential trade agreements despite the successful conclusion of the Uruguay Round and the creation of the WTO.

To establish these results the paper proceeds as follows. Section 2 constructs a simple Ricardian model with trade between a large country and many small countries and characterizes the outcomes both under free trade and a trade war. Section 3 examines the benchmark case of bilateral trade negotiations. Section 4 considers the design of a multi-lateral trade agreement under the constraint of an MFN clause and characterizes its efficiency by considering the scope for free-riding. Section 5 looks at how the terms of an agreement to implement free trade are influenced by the number of countries involved in negotiations and makes welfare comparisons.

2. Trade model

The objective of this section is to construct a simple model of multi-lateral trade that can form the basis of a model of trade negotiations. The general structure of the model considers an arbitrary number of countries that are initially operating in autarky.[8] Given that gains from trade exist, these countries come together to negotiate the nature of trade. The underlying rationale for these negotiations is that at least one country has monopoly power in world markets and therefore has an incentive to impose an optimal tariff in order to extract a terms of trade benefit.

This paper addresses the likely outcome of these negotiations when countries

[8] Since the model is constructed in such a way as to ensure that the tariffs imposed in a trade war are not a function of private information, this initial period can also be thought of as characterized by a trade war.

have private information about the benefits that they receive from a trade agreement. It is clear that information revealed during the negotiation process can be used in setting the terms of any trade agreement. Likewise, any information revealed can also be used if a trade agreement is not reached and a trade war occurs. To keep the framework simple, this last possibility is ruled out by constructing a model that ensures the tariffs imposed in a trade war are not a function of the private information.[9] In order to accommodate these requirements, the model analyzed has a Ricardian structure. In addition, it is assumed that only one country will be large enough to have an incentive to set an optimal tariff.

2.1. Technology

Consider a world economy with two goods (x and m), one large country and N small countries. Each country has Ricardian technology, with the properties of each country's technology assumed to be common knowledge.

The large country is assumed to possess the following technology and resource constraint (where L^B is the large country's endowment of labor and L_j is the labor devoted to the production of good j, $j \in \{x, m\}$):

$$x = \alpha L_x, \quad 0 < \alpha < 1, \quad m = L_m, \quad L_m + L_x = L^B.$$

Each small country is assumed to have labor endowments of the same size,[10] L, and each possesses a common technology that exhibits a technological comparative advantage in x relative to the large country:

$$x_i = L_{xi}, \quad m_i = L_{mi}, \quad L_{xi} + L_{mi} = L \quad i \in \{1, \ldots, n\}$$

The assumption that all the small countries have the same technology rules out the possibility of trade diversion from a preferential trade agreement.[11] The advantage of this setup is that it allows the impact of the MFN clause to be clearly appraised

[9]The model can be extended to allow for this possibility. What this amounts to is allowing the individual rationality constraints to be a function of information revealed in the negotiation process. Under this more general formulation the outcome of the Nash tariff game depends on the beliefs of the large country over the type the small country can be. This would allow the large country to make inferences about the small country's type if negotiations fail, thereby altering the outcome of the tariff setting game. Such a possibility can be accommodated in a consistent way by employing the concept of ratifiability described in Cramton and Palfrey (1990). However, such a generalization only endows the large country with a greater ability to extract rents but does not qualitatively alter the results.

[10]The assumption that all small countries have the same labor endowment is not important for the results derived in this paper. It is straight forward to allow for labor endowments of different sizes.

[11]Allowing the possibility of trade diversion does not alter the results of this paper. The main impact of trade diversion is to increase the rent extracting ability of the large country. In addition incorporating trade diversion would decrease the welfare associated bilateral negotiations and therefore strengthen the results derived in Section 5.

since the only externalities that exist in negotiations are associated with the MFN clause.

2.2. Preferences

It is assumed to be common knowledge that each small country's preferences are drawn independently from a restricted set of CES preferences, with the restriction that the elasticity of substitution lies between zero and one.

Assumption 1. $U_i(C_x, C_m) = \left[C_x^{-\rho_i} + C_m^{-\rho_i}\right]^{-1/\rho_i}$ where $\rho_i \equiv (1/\sigma_i - 1)$ and it is assumed that $\sigma_i \in [0, 1]$ implying $\rho_i \in [0, \infty)$.

The private information in this model is assumed to be related to a small country's σ_i, with the value of this elasticity of substitution known only by small country *i*. This preference structure has two useful properties. First, in conjunction with the common autarky prices, these preferences imply that each small country has the same consumption and expenditure patterns in autarky. Therefore, autarky consumption and expenditure patterns reveal no information about a small country's preferences to the large country. Second, the restriction on the elasticity of substitution ensures that the offer curves of each small country are inelastic at world prices other than their autarky prices.[12] This implies that the equilibrium of a non-cooperative tariff setting game has the property that the large country's Nash tariff is solely a function of the common technology of the small countries, a variable that is known by the large country. As will be shown in Section 2.4, this means that the Nash outcome yields autarky welfare for each small country.

2.3. Free trade

Two further assumptions are made in order to ensure that the free trade equilibrium is unique:

Assumption 2. The large country's consumption of good *x* in autarky is at least as large as $nL/2$.

Assumption 3. The large country has preferences such that both good *x* and good *m* are normal goods.

Together these two assumptions imply a restriction on the size of the large country relative to the size of the small countries considered in aggregate of $L^B > nL/2$.

[12]The assumption that the elasticity of substitution is less than or equal to one can be relaxed. However, doing so would imply a restriction on the relative size of α for the Nash equilibrium to have the desired characteristics, see McLaren (1997) for details.

These assumptions also ensure that the small countries taken as a whole do not have the power to influence the terms of trade. By holding the relative market power of the large country constant, this allows the role that the MFN clause plays in negotiations to be the central focus, especially in Section 5 when the number of small countries is increased.

Due to the assumptions on preferences, technologies and size asymmetries, a characteristic of free trade is that the equilibrium prices coincide with the autarky prices of the large country. Therefore, the large country does not gain from trade in the free trade equilibrium, but all the small countries benefit from free trade with the large country. It is assumed that if a trade agreement is negotiated, then free trade will be implemented.[13]

2.4. Tariff setting

If a trade agreement fails to be negotiated then a non-cooperative tariff game is assumed to occur. In this tariff game each country simultaneously announces ad valorem tariffs on its imports, with any resulting tariff revenue assumed to be distributed among domestic consumers in the form of a lump sum transfer.

The tariff-distorted offer curves can be derived by following Bhagwati and Srinivasan (1983). The large country will demand positive imports of good x only if the terms of trade are less than $1/\alpha(1+\tau)$, where τ is the tariff imposed by the large country. Similarly, a small country will demand positive imports of good m only if the terms of trade are above $(1+\tau_i)$, where τ_i is the tariff imposed by small country i. However, regardless of the tariffs imposed by the other countries, the optimal tariff for a small country is zero (since a tariff imposed by a small country does not effect the terms of trade but is associated with a consumption distortion). Consequently, the reaction curve of any small country is simply its free trade offer curve.

On the other hand, the optimal tariff for the large country is not zero. When the large country imposes a tariff it rotates down and pulls in its offer curve, which influences the terms of trade. The optimal tariff for the large country must satisfy $1/\alpha(1+\tau)=1$, which implies $\tau=(1-\alpha)/\alpha$. Therefore, a Nash equilibrium of this tariff game is the vector $(\tau,\ \tau_1,\ldots,\ \tau_n)=((1-\alpha)/\alpha,\ 0,\ldots,\ 0)$.[14] A characteristic of this equilibrium is that the optimal tariff for the large country depends only on the common technology, and not on the preferences of a small country. Furthermore, in this equilibrium the terms of trade reflect the relative

[13] Including partial liberalization as a negotiating option will not alter the results of this paper. Under bilateral negotiations it can only serve to increase the rent extracting ability of the large country, and the outcome will still be inefficient from a global perspective. Under MFN negotiations, it will still be the case that the probability of free trade goes to one as the number of countries increases.

[14] It should be noted that other Nash equilibria exist which result in no trade, however we concentrate on the trade equilibrium since all other equilibria are built on weakly dominated strategies.

prices faced by a small country in autarky. Thus, the small countries do not gain from trade in the Nash tariff equilibrium. However, by imposing an optimal tariff the large country improves its terms of trade and captures some gains from trade.

The benefit for the large country from imposing Nash Tariffs is an increase in real income. The real income prior to the imposition of an optimal tariff is L^B, while the real income after the imposition of an optimal tariff is $L^B + nL(1-\alpha)/2\alpha$. Therefore, the gain from the optimal tariff is $nL(1-\alpha)/2\alpha$.[15] Since the same tariff revenue is extracted from each small country, define $r = L(1-\alpha)/2\alpha$ as the terms of trade benefit the large country derives from each small country as a result of its Nash equilibrium trade policy.

2.5. Gains from a trade agreement

Tariffs can only act as an efficient international transfer scheme when the income gain to the large country is equal to the income loss of the small country. Given the assumption on preferences, the only situation in which tariffs have this property is when the small country has an elasticity of substitution equal to zero (i.e. Leontief preferences). In this case, the Nash tariff does not distort the consumption or production decisions of the small country. Therefore, the Nash tariff generates a pure income transfer of $L(1-\alpha)/2\alpha$ from the small country to the large country. If a small country possesses preferences other than Leontief preferences, then it will experience a distortion in consumption. Hence, the Nash tariff will cause the income loss to the small country to be greater than the income gain to the large country. It is the removal of this inefficiency that generates a surplus that can be realized through the negotiation of a trade agreement.

3. Designing a trade agreement

Despite not knowing the preferences of an individual small country, the large country knows that its valuation of free trade must lie within the range set by Leontief and Cobb Douglas preferences. To determine the limits of this range, define a small country's valuation of free trade to be the increase in real income associated with the move from the Nash tariff equilibrium to free trade. For a Leontief small country, the increase in real income is $a = L(1-\alpha)/2\alpha = r$. For a Cobb–Douglas country, the increase in real income is $b = (1/\alpha - (1/\alpha)^{1/2})L > r$. Therefore, the large country knows that small country i's valuation of free trade, v_i, must lie between a and b, i.e. $v_i \in [a, b] \equiv d$.

The large country's uncertainty about country i's valuation of free trade is assumed to be described by a continuous probability distribution over this interval.

[15] Since the large country's domestic prices do not change with the imposition of a tariff, the terms of trade gain is also equal to tariff revenue.

Let $f: d \to \Re_+$ be the probability density function for small country i's valuation of free trade. In addition, assume that $f(v_i) > 0$ for all $v_i \in d$; and that $f(.)$ is a continuous function on d. Let $F: d \to [0, 1]$ denote the distribution function corresponding to the density function $f(.)$ so that $F(v_i) = \int_{[a,\ vi]} f(s)\, ds$. Thus, $F(v_i)$ is the large country's assessment of the probability that small country i has a valuation of v_i or less. Note also that $F(.)$ is not indexed by i. Hence, the large country is assumed to view each small country's valuation as being identically distributed. Let D denote the set of all possible combinations of valuations of the small countries:

$D \equiv d^n = [a, b]^n$. It is assumed that the valuations of the n small countries are stochastically independent random variables. Thus, the joint density function of D for the vector $v \equiv (v_1, \ldots, v_n)$ of small country valuations is: $f(v) \equiv \Pi_i\ f(v_i)$. For any small country i let D_{-i} denote the set of all possible combinations of valuations which might be held by small countries other than i; that is: $D_{-i} \equiv [a, b]^{n-1}$. Of course, each small country knows their own valuation of free trade. However, it is assumed that small country i assesses the probability distribution of the other small countries valuations in the same way the large country does. That is, both the large country and small country i assess the joint density function on D_{-i} for the vector $v_{-i} \equiv (v_1, \ldots, v_{i-1}, v_{i+1}, \ldots, v_n)$ of valuations for all small countries other than i to be $f_{-i}(v_{-i}) = \Pi_{j \neq i} f(v_j)$. Finally, it is assumed that the cost to the large country of moving from the Nash tariff equilibrium to multi-lateral free trade, $nL(1 - \alpha)/2\alpha \equiv R = nr$, is known by all countries.

3.1. Benchmark case: bilateral trade negotiations

To ensure a trade agreement under complete information, the large country need only seek a contribution that leaves a small country indifferent between free and impeded trade. In this situation the large country is indifferent between negotiating on a bilateral or multi-lateral basis. However, under incomplete information the large country no longer knows the size of the benefit a small country will get from trade liberalization, complicating the process of trade negotiations for the large country. If it asks for too much, then no agreement will be struck. If it asks for too little, free trade will prevail but at terms that are less advantageous than the large country might have desired.

To get a feel for how negotiations proceed when one side has private information, the benchmark case of bilateral trade negotiations will be analyzed. Since the large country has the ability to impose optimal tariffs, it will also be assumed that it sets the terms of the trade agreement. The question is then, when confronted with a single small country, what terms will maximize the expected surplus of the large country? This paper treats this question as a mechanism design problem.

In this bilateral setting a mechanism is described by a pair of outcome functions

that map the reported valuation of the small country, y_i, into a probability of free trade and the required bribe/transfer:

$p(y_i):[a, b] \rightarrow [0, 1]$, maps any reported valuation, y_i, into a probability of free trade.

$t(y_i):[a, b] \rightarrow \Re_+$, maps any reported valuation into a bribe/transfer.

The use of transfers in this model represents a simplification from the reciprocal trade liberalization that is usually associated with trade agreements. One interpretation is that the transfers serve as a proxy for the trade liberalization that a small country might undertake (see Park, 2000). It is also the case that a number of side agreements have been negotiated as part of both preferential trade agreements and multilateral agreements. These side agreements are significant and have been interpreted as implicit transfer between countries. For example Whalley (1998) sees the commitment that Canada made in relation to energy and investment policy as way of inducing the US to limit the application of safeguard measures.[16] At the multilateral level the agreement on the trade related aspects of intellectual property rights (TRIPs) is seen as having important implications for the distribution of the benefits of trade liberalization between the members of the WTO. Estimates show that the implied transfers between countries due to the TRIPs agreement result in a large net benefit for the US while reducing the gains from increased market access to most of the other members of the WTO (see McCalman, forthcoming).

In seeking to describe such mechanisms, this paper focuses on direct revelation mechanisms in which the probability of free trade and the transfer from the small country are determined as functions of the small country's valuations of free trade, v_i. By the revelation principle, the restriction to direct revelation mechanisms is without loss of generality; any outcome associated with an equilibrium of some process (game) will also be an equilibrium outcome of some revelation mechanism in which the small countries report their private information truthfully.

The mechanism chosen by the large country is subject to three constraints. First, each small country type must have an incentive to negotiate, and so a small country must expect non-negative utility from the negotiations. Therefore, the following individual rationality constraint is imposed:

$$p(v_i)[v_i - t(v_i)] \geq 0 \text{ for all } v_i \in [a, b] \quad \text{(IR)}$$

Second, a small country must be induced to report their valuation truthfully. Therefore, a small country must not be able to favorably manipulate its expected outcome by lying. Therefore, the following incentive compatibility constraint is imposed:

$$p(v_i)[v_i - t(v_i)] \geq p(y_i)[v_i - t(y_i)] \text{ for all } v_i, y_i \in [a, b] \quad \text{(IC)}$$

[16] See Fernandez and Portes (1998) for further examples.

Finally, the constraint that the probability of bilateral free trade lies between zero and one is imposed.

Taking account of these constraints, the large country attempts to maximize its ex ante expected surplus from a trade agreement. The large country's problem can be formalized as follows:

$$\max_{\{p(.)\ t(.)\}} \int_{[a,\ b]} p(v_i)[t(v_i) - r]\, f(v_i)\, \mathrm{d}v_i \tag{1}$$

subject to:

$$p(v_i)[v_i - t(v_i)] \geq 0 \text{ for all } v_i \in [a, b] \tag{IR}$$

$$p(v_i)[v_i - t(v_i)] \geq p(y_i)[v_i - t(y_i)] \text{ for all } v_i,\ y_i \in [a, b] \tag{IC}$$

$$p(v_i) \in [0, 1], \text{ for all } v_i \in [a, b] \tag{PR}$$

The incentive compatibility constraint implies that the large country can not choose $p(.)$ and $t(.)$ independently.[17] Therefore, using standard techniques,[18] the problem can be transformed into one that involves a single choice variable:

$$\max_{p(.)} \int_{[a,\ b]} p(v_i)\{v_i - [1 - F(v_i)]/f(v_i) - r\} f(v_i)\, \mathrm{d}v_i \tag{2}$$

subject to:

$$p(v_i) \text{ is non-decreasing} \tag{M}$$

$$p(v_i) \in [0, 1], \text{ for all } v_i \in [a, b] \tag{PR}$$

Note that the transfers can be recovered from: $p(v_i)t(v_i) = p(v_i)v_i - \int_{[a,\ vi]} p(s)\, \mathrm{d}s$.

While the objective function described by (2) may look complicated, Bulow and Roberts (1989) have shown that problems of this type have a very familiar interpretation. Examining the terms in parentheses, Bulow and Roberts point out that these are analogous to the marginal revenue and marginal cost terms of a standard third degree monopoly pricing problem. The first two terms, $v_i - [1 - F(v_i)]/f(v_i)$, are equivalent to the marginal revenue term, with v_i the gain in revenue from lowering the price to sell to the marginal consumer and $[1 - F(v_i)]/f(v_i)$ the loss of revenue on the infra-marginal units from lowering the price. Similarly, the last term, r, can be interpreted as the marginal cost. Continuing with the monopolist analogy, the large country will only liberalize with small country types whose marginal revenue from liberalization is greater than the tariff revenue foregone. To complete the analogy, assume that the marginal revenue function is

[17] In contrast to the complete information case where $p(.) = 1$ independently of the transfer.

[18] See Appendix A for details and Fudenberg and Tirole (1991) for a more general treatment.

downward sloping (i.e. $v_i - [1 - F(v_i)]/f(v_i)$ is strictly increasing). Then the following represents an optimal mechanism for the large country:

$$p^*(v_i) = \begin{cases} 1 & \text{if } v_i - [1 - F(v_i)]/f(v_i) > r \\ 0 & \text{otherwise.} \end{cases} \tag{3}$$

$$t^*(v_i) = \begin{cases} v^* & \text{if } v_i - [1 - F(v_i)]/f(v_i) > r \\ 0 & \text{otherwise.} \end{cases}$$

Where v^* is defined as the solution to $v^* = [1 - F(v^*)]/f(v^*) + r$.

Note that these optimal rules imply that only countries with valuations above v^* will be able to achieve free trade, and by design this excludes the low valuation countries. The need to exclude low valuation types follows from the fact that the only thing that the large country can use to induce truthful revelation is the probability of free trade. If a large country were to always grant free trade, then it would never get a small country to admit to having a valuation greater than the lowest valuation. Hence, a bilateral approach to liberalization can not guarantee free trade as the large country uses the possibility of impeded trade to extract rents from high valuation countries, with the most effective way to back this threat being not to liberalize with low valuation countries.

This benchmark case can be generalized to describe the large country's dealings with an arbitrary number of small countries. This analysis can be extended to two or more small countries because the trade volume of any single small country is independent of the trade volumes of any other country. Therefore, the large country will offer each small country the same terms for liberalization. Since the inefficiencies identified above are retained in each individual set of negotiations, it follows that a series of bilateral negotiations can not be relied upon as a path to global free trade.

An example illustrates the operation of these optimal policies. Assume there are two small countries each with a labor endowment of 2. In addition assume that $\alpha = 1/4$, which implies an optimal tariff of 3 and an associated tariff revenue of 3 from each small country. The technology parameter and labor endowment assumptions imply that each small country has a valuation of free trade that lies between 3 and 4. Assume that the valuation of free trade is uniformly distributed over this interval. Combining the distributional assumptions with the optimal policies described by (3) yields:

$$p^*(v_i) = \begin{cases} 1 & \text{if } v_i > 7/2 \\ 0 & \text{otherwise.} \end{cases}$$

$$t^*(v_i) = \begin{cases} 7/2 & \text{if } v_i > 7/2 \\ 0 & \text{otherwise.} \end{cases}$$

The optimal policy is for the large country to demand a transfer of $7/2$ in order to liberalize trade with a country. It follows that all small countries with a valuation

of free trade above 7/2 will pay the transfer, while the exports of the lower valuation countries will be subject to the optimal tariff.

The welfare implications of this example can also be quantified. The expected surplus accruing to the large country from this policy is 1/2 (calculated by substituting the optimal policies into (1), and summing over the two small countries), while the expected surplus captured by a small country is 1/8 (calculated by substituting the optimal policies into a small country's payoff function and averaging with respect to priors). Therefore, the average realized surplus from this policy is 3/4, which is below the ex ante potential surplus from implementing unconditional free trade of 1.[19]

The message of both this example and this section is clear: even without the negative affects of trade diversion, attempts to achieve global free trade through a series of bilateral negotiations will not be successful in the presence of private information. Even though these negotiations may generate widespread trade liberalization, bilateral negotiations can not be relied upon as a path to global free trade. This can be expressed directly through Proposition 1:

Proposition 1. *Under preferential trade negotiations, the terms of trade liberalization are set independently of the number of countries seeking an agreement, and these terms exclude countries since the equilibrium transfer, v^*, is greater than the minimum valuation, a. Consequently, the average realized surplus from a set of bilateral trade negotiations is always strictly less than ex ante potential surplus of unconditional free trade.*

4. The Most Favored Nation clause

By documenting the inefficiency of bilateral negotiations, this paper further contributes to the negative image of PTA's as a means of achieving global free trade. However, in order to make a judgment about the comparative value of PTA's it is also important to evaluate the efficiency of multi-lateral trade negotiations, especially the role that the MFN clause plays. The MFN clause requires members of the GATT/WTO to grant every member the most favorable treatment, which it grants to any country with respect to imports and exports.[20] While the MFN clause is viewed predominantly as a principle of non-discrimination, ensuring equal treatment among GATT/WTO members, it also influences the way that countries approach trade negotiations. With an MFN clause, any concession offered to one country is automatically extended to all members. All negotiations effectively become multi-lateral.

In the model, the MFN clause requires the large country to grant free trade to all

[19]Since each small country's valuation of free trade is uniformly distributed over an interval of 1.
[20]See Jackson (1989) for a discussion of the MFN clause and its role in trade negotiations.

countries if it grants free trade to any country. This interdependence of outcomes transforms the nature of the mechanism design problem from one in which the large country conditions its decision regarding free trade on the valuation of a single country, into one where the large country conditions on the aggregate valuation (i.e. the sum of the individual valuations). Reflecting this change, the mechanism the large country selects is now described by a pair of outcome functions with the following range and domain:

$p:[a, b]^n \to [0, 1]$ probability of global free trade is a function of all reported valuations;

$t:[a, b]^n \to \Re_+^n$ specifies transfers for each small country as a function of all reported valuations.

Facing the mechanism chosen by the large country, each small country must simultaneously report a valuation of free trade, $y_i \in [a, b]$. Since the mechanism is set before the small countries move, any small country has the option of misrepresenting its actual gain from free trade. Therefore, it can manipulate both the probability of multi-lateral free trade and the transfer it pays to the large country. To ensure that a small country has an incentive to report truthfully and is a willing participant in the trade agreement, two constraints are placed on the class of mechanisms the large country can choose:

(1) The incentive compatibility constraint (IC) requires that truth telling be a Bayesian equilibrium of the revelation game played by the N small countries. Fix a mechanism (p, t) and let $u(v_i, p, t)$ denote country i's payoff when its true benefit and reported benefit is v_i:[21]

$$u(v_i, p, t) \equiv \int_{D-i} p(v)[v_i - t_i(v)] f_{-i}(v_{-i})\, dv_{-i}$$

Recall that v is the vector of v_i's, so $p(v)$ reflects the probability of global free trade conditional on all reported valuations. Hence, the expected payoff for a small country is calculated with respect to the distribution of the valuations of the other small countries. The dependence of a small country's expected payoff on the valuations of the other small countries highlights the notion that MFN negotiations admit spill-over effects.

When country i misrepresents its actual gain from free trade (i.e. reports $y_i \neq v_i$), the expected contribution for country i becomes $t_i(y_i|v_{-i})$ and the probability of global free trade becomes $p(y_i|v_{-i})$. Therefore (IC) requires:

[21]The notation used in this section is set out at the beginning of Section 3.

$$\int_{D-i} p(v)[v_i - t_i(v)] f_{-i}(v_{-i})\, \mathrm{d}v_{-i} \geq \int_{D-i} p(y_i|v_{-i})[v_i - t_i(y_i|v_{-i})] f_{-i}(v_{-i})\, \mathrm{d}v_{-i} \text{ for all } i \text{ and } v_i, y_i \in d\,.$$

(2) The individual rationality constraint (IR), requires that a small country can not be forced to participate in the trade agreement (i.e. $u(v_i) \geq 0$ for all i).

The large country's problem can now be formalized as one where it attempts to maximize its ex ante expected surplus subject to the incentive compatibility and individual rationality constraints:

$$\max_{\{p(.)\ t(.)\}} \int_D p(v)\Big[\sum t_i(v) - R\Big] f(v)\, \mathrm{d}v \tag{4}$$

Subject to

$$u(v_i) \geq 0 \text{ for all } i \text{ and for all } v_i \in d. \tag{IR}$$

$$u(v_i) \geq u(y_i|v_i) \text{ for all } i \text{ and for all } v_i, y_i \in d. \tag{IC}$$

$$p(v) \in [0, 1], \text{ for all } v \in D. \tag{PR}$$

Once again this problem can be simplified into one involving a single choice variable for the large country by using standard techniques.

$$\max_{p(.)} \int_D p(v)\Big\{\sum\nolimits_i [v_{\ i} - (1 - F(v_i))/f(v_i)] - R\Big\} f(v)\, \mathrm{d}v \tag{5}$$

subject to:

$$p(v_i|v_{-i}) \text{ is non-decreasing} \tag{M}$$

$$p(v) \in [0, 1], \text{ for all } v \in D. \tag{PR}$$

Note that the transfers can be recovered from the following function: $T_i(v) = p(v_i|v_{-i})v_i - \int_{[a,\ vi]} p(s|v_{-i})\ \mathrm{ds}$.[22]

Recalling the assumption that $v_i - (1 - F(v_{\ i}))/f(v_i)$ is strictly increasing in v_i, then the following is an optimal scheme:

$$p^*(v) = \begin{cases} 1 & \text{if } \sum_i [v_i - (1 - F(v_i))/f(v_i)] > R \\ 0 & \text{otherwise.} \end{cases} \tag{6}$$

[22] See Appendix A for definition of $T_i(v)$.

$$t_i^*(v) = \begin{cases} v_i' & \text{if } \sum_i [v_i - (1 - F(v_i))/f(v_i)] > R \\ 0 & \text{otherwise.} \end{cases}$$

Where v_i' is defined as the solution to $v_i' = R - \Sigma_{j \neq i} [v_j - (1 - F(v_j))/f(v_j)] + (1 - F(v_i'))/f(v_i')$ (i.e. the valuation of the pivotal type from i's perspective).

As with the bilateral negotiations, this solution also has a monopoly analogy. Employing the same marginal cost and marginal revenue interpretation as in Section 3, a trade agreement is reached only when the sum of the marginal revenues (i.e. $\Sigma_i [v_i - (1 - F(v_i))/f(v_i)]$) is greater than the sum of the marginal costs (i.e. $R = nr$).

This interpretation can also be used to highlight the existence of spill-over effects from imposing an MFN clause. By implementing free trade whenever the sum of the marginal revenues is greater than the sum of the marginal costs, the large country ignores whether the difference between marginal cost and marginal revenue is positive or negative for an individual country. This focus on the sum of marginal revenues leads to the possibility of small countries free riding on trade negotiations. A free rider on a trade agreement is defined as a country whose marginal revenue from free trade, $v_i - (1 - F(v_i))/f(v_i)$, is less than the tariff revenue the large country foregoes from liberalizing with it, r. Thus, countries are free riding on a trade agreement whenever:

$$\sum_i [v_i - (1 - F(v_i))/f(v_i)] > R \text{ (i.e. MFN free trade occurs)} \tag{a}$$

and

$$v_i - (1 - F(v_i))/f(v_i) < r \text{ for some } i. \tag{b}$$

Under these circumstances any country i, for which condition (b) holds, is defined as a free-rider on an MFN trade agreement. In particular, such a country is characterized by an inability to achieve free trade under bilateral negotiations with the large country. Also note that when condition (a) is violated it must be the case that the low valuation countries have imposed a negative externality on the high valuation countries. This negative externality arises since the high valuation countries achieve free trade with probability one under preferential trade negotiations, but under MFN negotiations this probability is less than one.

The existence of these spill-over effects also has implications for the expected surplus of the large country. To see this compare the objective functions under MFN and preferential trade agreements. Under preferential trade negotiations the objective function is given by $\Sigma_i \int_d p(v_i)\{v_i - (1 - F(v_i))/f(v_i) - r\} f(v_i)\, dv_i$ while the objective function under MFN negotiations is given by $\int_D p(v)\{\Sigma_i [v_i - (1 - F(v_i))/f(v_i)] - R\} f(v)\, dv$. The main difference between these two objective functions is that under MFN negotiations the probability of free trade is constrained to be a joint probability while under preferential trade negotiations no such constraint is imposed. To see the impact on the expected surplus of the large

country start by considering the preferential trade agreement objective function. In this case the expected surplus is maximized by putting as much weight as possible on situations when $v_i - (1 - F(v_i))/f(v_i) - r$ is positive and putting as little weight as possible on situations when this term is negative. The maximum weight possible is given by setting $p(v_i) = 1$, while the least weight is obtained by setting $p(v_i) = 0$. By following this rule the expected surplus is maximized. Now consider the impact of the MFN constraint. Once again to maximize the expected surplus the large country sets the joint probability equal to one when $\Sigma_i[v_i - (1 - F(v_i))/f(v_i)] - R$ is positive and zero when it is negative.

Does this raise or lower expected surplus for the large country? Having a joint probability is one option available under preferential trade negotiations but it would not be adopted since the valuations are independent. Therefore the MFN policy is available under preferential trade negotiations but is not chosen. To see why note that the expected surplus under MFN can be written as $\Sigma_i \int_d [p(v_i|v_{-i})\{v_i - (1 - F(v_i))/f(v_i)\} - r] f(v_i)\, dv_i$, while the expected surplus under preferential negotiations is $\Sigma_i \int_d [p(v_i)\{v_i - (1 - F(v_i))/f(v_i)\} - r] f(v_i)\, dv_i$. The difference between these functions is $\Sigma_i \int_d [(p(v_i|v_{-i}) - p(v_i))\{v_i - (1 - F(v_i))/f(v_i)\} - r] f(v_i)\, dv_i$, where $(p(v_i|v_{-i}) - p(v_i))$ can be positive when $\{v_i - (1 - F(v_i))/f(v_i)\} - r < 0$, and $(p(v_i|v_{-i}) - p(v_i))$ can be negative when $\{v_i - (1 - F(v_i))/f(v_i)\} - r > 0$. Both of these situations illustrate how free riding and the negative externality can reduce the expected payoff of the large country under MFN negotiations compared preferential negotiations.

To develop some intuition for the working of the optimal mechanism, the example from Section 3 can be solved for the MFN case. Using (6), the optimal policies in the uniform distribution case are:

$$p^*(v) = \begin{cases} 1 & \text{if } v_1 + v_2 > 7 \\ 0 & \text{otherwise.} \end{cases}$$

$$t_i^*(v) = \begin{cases} 7 - v_j & \text{if } v_1 + v_2 > 7 \\ 0 & \text{otherwise.} \end{cases}$$

Therefore, the optimal policy for the large country is to only liberalize when the aggregate reported valuation is greater than 7, and when this occurs the large country demands a payment from country i of $7 - v_j$. These policies generate an expected surplus of $1/3$ for the large country (calculated by substituting the optimal policies into (4)) and an expected surplus of $1/6$ for a small country. Consequently, the average realized surplus is $2/3$, which is less than both the average realized surplus generated by preferential trade agreements and the ex ante potential surplus from unconditional free trade.

The results of this section can be summarized in the following proposition.

Proposition 2. *(a) Under MFN negotiations it is possible for some countries to*

'free ride' in equilibrium, thus generalizing the benefits of liberalization to include low valuation countries.

(b) Under MFN negotiations it is possible for low valuation countries to impose a negative externality on high valuation countries, lowering the probability of free trade for these countries.

(c) Since MFN negotiations admit the possibility of 'free riders' and negative externalities, the expected surplus of the large country is always lower under MFN negotiations than under preferential trade negotiations.

5. Welfare comparison — large number of small countries[23]

Since both negotiating regimes generate inefficient outcomes, it is natural to ask whether one approach is inherently more efficient and thus dominates the other. The above example provides some insight by showing that there exists situations in which preferential trade agreements achieve a higher average realized surplus than MFN negotiations. However, a more comprehensive answer to this question can be given by examining the share of potential surplus realized[24] under each regime as the number of countries seeking an agreement increases.

Consider first bilateral trade negotiations and recall how the terms offered to each country were independent of the number of countries seeking a trade agreement. This implies that the ratio of the average realized surplus to potential surplus is not a function of the number of countries seeking a trade agreement, with this ratio always strictly less than one (see Proposition 1).

In contrast, it is unclear a priori how MFN negotiations perform as the number of countries involved in negotiations is increased, although the common conjecture is that a large number of countries seeking an MFN trade agreement undermines its effectiveness. In order to clarify this relationship, the share of potential surplus realized under MFN negotiations can be defined as:

$$\frac{\int_D p^*(v)\left[\sum_i v_i - nr\right] f(v)\,\mathrm{d}v}{\int_D \left[\sum_i v_i - nr\right] f(v)\,\mathrm{d}v}.$$

Therefore the share of potential surplus realized is directly related to the probability of MFN free trade. By characterizing the relationship between the probability of MFN free trade and the number of countries, we also characterize

[23] Papers by Rob (1989) and Mailath and Postlewaite (1990) use similar techniques to those adopted in this section.

[24] Share of potential surplus realized is defined as the ratio of average realized surplus to ex ante potential surplus.

the relationship between the share of potential surplus realized by MFN negotiations and the number of countries seeking a trade agreement.

In order to setup the calculations it is useful to evaluate the following quantity. Let $k_i = (1 - F(v_i))/f(v_i)$. Then,

$$\begin{aligned} E(v_i - k_i) &= \int_d (v_i - (1 - F(v_i))/f(v_i))f(v_i)\,\mathrm{d}v_i \\ &= \int_d v_i f(v_i)\,\mathrm{d}v_i - \int_d (1 - F(v_i))\,\mathrm{d}v_i \\ &= \int_d v_i f(v_i)\,\mathrm{d}v_i + a - \int_d v_i f(v_i)\,\mathrm{d}v_i \quad \text{(after integrating by parts)} \\ &= a \end{aligned} \tag{7}$$

In addition by assuming that $E[k_i^2] < \infty$, the variance of $v_i - k_i$ can be calculated as:

$$q^2 \equiv \mathrm{var}(v_i - k_i) = \int_d [(v_i - k_i) - a]^2 f(v_i)\,\mathrm{d}v_i.$$

From (6) we know that the large country will find it optimal to implement MFN free trade whenever:

$$\sum_i v_i - \frac{1 - F(v_i)}{f(v_i)} > nr \text{ or } \sum_i (v_i - k_i) > nr$$

Therefore the probability of MFN free trade for n small countries is defined as:

$$\mathrm{prob}\left(\sum_i (v_i - k_i) > nr\right) \equiv g_n.$$

It turns out that the lower bound of a small country's valuation of market access, a, plays an important role in determining the probability of an MFN trade agreement as the number of small countries, n, gets large. Therefore, it is important to be clear about the nature of efficiency gains that arise from liberalizing with a country having the lowest valuation of market access. Since tariffs are seen as an inefficient method of transferring income between countries (in general tariffs are associated with both consumption and production distortions), it will be assumed that trade liberalization is always associated with an increase in global welfare. Specifically, it is assumed that $a > r$ (i.e. the lowest valuation of market access is strictly greater than the tariff revenue the large country derives from a small country). This assumption requires that the elasticity of substitution be bounded away from zero, since such a small country does not experience a consumption distortion (i.e. $a = r$ for the Leontief case of $\sigma_i = 0$). Now the lower bound on the distribution of valuations is defined as $a = r + c$,

where c represents the minimum efficiency gain from liberalization and is assumed to be strictly greater than zero. With an arbitrarily small constant, c, the probability of MFN free trade now becomes:

$$\begin{aligned} g_n &= \text{prob}\left(\textstyle\sum_i (v_i - k_i) > nr\right) \\ &= \text{prob}\left(\textstyle\sum_i (v_i - k_i) - \sum_i E(v_i - k_i) > nr - \sum_i E(v_i - k_i)\right) \\ &= \text{prob}\left(\textstyle\sum_i (v_i - k_i) - na > nr - n(r + c)\right) \\ &= \text{prob}(\bar{v}_n - \bar{k}_n - a > -c) \quad \text{(where } \bar{v}_n - \bar{k}_n \text{ is the sample mean)} \\ &\geq \text{prob}(|\bar{v}_n - \bar{k}_n - a| < c) \\ &\geq 1 - \frac{q^2}{nc^2} \quad \text{(by Chebyshev's Inequality)} \end{aligned}$$

This implies that: $\text{Lim}_{n\to\infty}\ g_n = 1$. Hence, the large country always finds it optimal to implement multi-lateral free trade when the number of small countries involved in negotiations is large.[25]

To understand this result, recall that the large country employs a pivot type mechanism to extract truthful revelation. With a large number of small countries the likelihood of small country i being pivotal (i.e. changing the probability of an MFN trade agreement by misrepresenting its valuation) is very low. With a continuum of small countries it is zero. Since small country i can not effect the probability of an MFN trade agreement, its objective then becomes to minimize the transfer it must pay to the large country. In this situation the incentive compatibility constraint implies that each small country must face the same transfer. Furthermore, this transfer can not exceed the lower bound of the distribution, a, since this would violate individual rationality. By setting the transfer equal to the lower bound for each small country, the large country will make a gain of c from each small country. Hence, in aggregate, this scheme generates greater income than the optimal tariff, and the large country has an incentive to conclude a trade agreement.

The positive relationship between the probability of an MFN trade agreement and the number of small countries has important implications for which negotiating regime is likely to realize the highest expected surplus. In the example considered in the last section, the bilateral approach was superior to MFN negotiations. However, as the number of countries involved in negotiations is increased, the probability of global free trade arising out of MFN negotiations also

[25]Note that this result is the opposite of that derived by Rob (1989) and Mailath and Postlewaite (1990) who consider the related problem of the provision of a public good under asymmetric information. The different results can be attributed to different assumptions about the extent of ambiguity of efficiency gains for individuals involved in negotiations. Here I have assumed that there are unambiguous efficiency gains from liberalizing with countries of *all* types (i.e. $a > r$). In contrast, the above papers assume that efficiency gains do not exist for all types (i.e. $r > a$).

increases, as indicated by the approximation above. It follows that beyond some point, the higher probability of global free trade will come to dominate the gains that are available from the limited amount of liberalization generated by the bilateral approach.[26] Therefore, MFN negotiations yield higher welfare than bilateral negotiations when a sufficiently large number of countries are involved. These insights underlie Proposition 3.

Proposition 3. *(a) If the efficiency gains from trade liberalization are strictly positive for each country involved in negotiations, then the probability of global free trade under MFN negotiations has a limit of one as the number of countries seeking an agreement goes to infinity.*

(b) There always exists an n such that average realized surplus under MFN negotiations is strictly greater than the average realized surplus from preferential trade agreements.

(c) The large country always prefers preferential negotiations over MFN negotiations, and this preference is strongest in the limit as the number of countries involved in negotiations tends to infinity.[27]

Therefore, the large country will most desire bilateral negotiations as the number of countries involved in MFN negotiations grows, but this is exactly when the world would be better off pursuing MFN negotiations.

6. Conclusion

This paper considers the interaction between private information and the Most Favored Nation clause in trade negotiations. Three results are established. First, bilateral negotiations will result in liberalization for some countries but global free trade can not be attained through such a regional approach. The main stumbling block is the terms on which members are admitted to a regional agreement, with these terms set to exclude low valuation countries in order to extract rents from high valuation countries. This undermines the ability of a regional approach to achieve global free trade. Second, multi-lateral trade negotiations conducted under a MFN clause allow some countries to free-ride in equilibrium, which in turn undermines the likelihood of achieving global free trade. Finally, the comparative welfare implications of both approaches are clarified by examining the probability of achieving global free trade as the number of countries party to negotiations is increased. Contrary to the general presumption, it is shown that the probability of

[26] In terms of the example, with $a=3$ and $b=4$, setting $r=149/50$ to ensure that $a>r$, MFN negotiations generate a higher realized surplus whenever there are more than 16 small countries involved in negotiations.

[27] See Appendix A for a proof.

an MFN agreement increases with the number of participants. This occurs as long as there exists efficiency gains from liberalizing with every country that is party to MFN negotiations. Since the terms of regional free trade are not influenced by the number of potential members, the ability of regional agreements to generate widespread liberalization remains limited. Therefore, MFN negotiations yield higher welfare than bilateral negotiations when there are a large number of countries involved. The greater efficiency of MFN negotiations is due to a reduced capacity of the large country to hold an agreement hostage in order to extract rents. This implies that the large country will most desire bilateral negotiations as the number of countries involved in MFN negotiations grows, and this is exactly when the world would be better off under MFN.

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Appendix

A.1. Bilateral negotiations

The large country's problem is:

$$\max_{\{p(.)\ t(.)\}} \int_{[a,\ b]} p(v_i)[t(v_i) - r]\, f(v_i)\, \mathrm{d}v_i$$

subject to:

$$p(v_i)[v_i - t(v_i)] \geq 0 \text{ for all } v_i \in [a, b] \tag{IR}$$

$$p(v_i)[v_i - t(v_i)] \geq p(y_i)[v_i - t(y_i)] \text{ for all } v_{i,yi} \in [a, b] \tag{IC}$$

$$p(v_i) \in [0, 1], \text{ for all } v_i \in [a, b]. \tag{PR}$$

To simplify the problem, define $T(v_i) = p(v_i)t(v_i)$. Therefore the problem can be restated as:

$$\max_{\{p(.)\ t(.)\}} \int_{[a,\ b]} [T(v_i) - p(v_i)r]\, f(v_i)\, \mathrm{d}v_i$$

subject to:

$$p(v_i)v_i - T(v_i) \geq 0 \text{ for all } v_i \in [a, b] \quad \text{(IR)}$$

$$p(v_i)v_i - T(v_i) \geq p(y_i)v_i - T(y_i) \text{ for all } v_i, y_i \in [a, b] \quad \text{(IC)}$$

$$p(v_i) \in [0, 1], \text{ for all } v_i \in [a, b]. \quad \text{(PR)}$$

Furthermore, let $u(v_i)$ be defined by

$$u(v_i) = p(v_i)v_i - T(v_i)$$

The problem now conforms to the set up considered in Mas Colell et al. (1995), so Proposition 23.D.2 can be applied which states that the (IC) is equivalent to:

$$p(v_i) \text{ is non-decreasing} \quad \text{(M)}$$

$$u(v_i) = u(a) + \int_{[a,\, vi]} p(s)\, \mathrm{d}s. \quad \text{(E)}$$

Which implies

$$T(v_i) = p(v_i)v_i - u(v_i) = p(v_i)v_i - u(a) - \int_{[a,\, vi]} p(s)\, \mathrm{d}s$$

Substitution into the objective function gives:

$$\max_{\{p(.)\}} \int_{[a,\, b]} \left[p(v_i)v_i - \int_{[a,\, vi} p(s)\, \mathrm{d}s - p(v_i)r \right] f(v_i)\, \mathrm{d}v_i - u(a)$$

subject to: (IR), (M) and (PR). Noting that the optimal solution will involve setting $U(a) = 0$, and integrating the objective function by parts yields:

$$\max_{p(.)} \int_{[a,\, b]} p(v_i)[v_i - [1 - F(v_i)]/f(v_i) - r] f(v_i)\, \mathrm{d}v_i$$

subject to: (M) and (PR).

A.2. MFN negotiations

The large country's problem is:

$$\max_{\{p(.)\ t(.)\}} \int_D p(v)\left[\sum t_i(v) - R\right] f(v)\, \mathrm{d}v$$

Subject to

$$\int_{D-i} p(v)[v_i - t_i(v)]\, f_{-i}(v_{-i})\, \mathrm{d}v_{-i} \geq 0 \text{ for all } i \text{ and for all } v_i \in D_i \quad \text{(IR)}$$

$$\int_{D-i} p(v)[v_i - t_i(v)] f_{-i}(v_{-i})\, \mathrm{d}v_{-i} \geq \int_{D-i} p(y_i|v_{-i})[v_i - t_i(y_i|v_{-i})] f_{-i}(v_{-i})\, \mathrm{d}v_{-i} \text{ for all } i \text{ and } v_i\ y_i \in D_i \quad \text{(IC)}$$

$$p(v) \in [0, 1], \text{ for all } v \in D \quad \text{(PR)}$$

To simplify things, make the following transformations:

$$T_i(v_i) = \int_{D-i} p(v) t_i(v) f_{-i}(v_{-i})\, \mathrm{d}v_{-i}$$

$$p(v_i\,|v_{-i}) = \int_{D-i} p(v) f_{-i}(v_{-i})\, \mathrm{d}v_{-i}$$

Furthermore, let $u(v_i)$ be defined by

$$u(v_i) = p(v_i\,|v_{-i})v_i - T_i(v_i)$$

Once again employing Proposition 23.D.2 from Mas Colell et al. (1995) to restate the (IC) as:

$$p(v_i|v_{-i}) \text{ is non-decreasing} \quad \text{(M)}$$

$$u(v_i) = u(a) + \int_{[a,\, vi]} p(s\,|v_{-i})\, \mathrm{d}s. \quad \text{(E)}$$

Which implies

$$T_i(v_i) = p(v_i|v_{-i})v_i - u(v_i) = p(v_i|v_{-i})v_i - u(a) - \int_{[a,\, vi]} p(s)\, \mathrm{d}s.$$

Substitution into the objective function gives:

$$\max_{\{p(.)\}} \int_D \left[\sum_i \left\{ p(v_i|v_{-i})v_i - \int_{[a,\, vi]} p(s\,|v_{-i})\, \mathrm{d}s \right\} - p(v)R \right] f(v)\, \mathrm{d}v - \sum_i U(a)$$

subject to: (IR), (M) and (PR). Noting that the optimal solution will involve setting transfers such that $U(a) = 0$, and integrating the objective function by parts yields:

$$\max_{p(.)} \int_D \left[p(v_i\,|v_{-i}) \sum_i \{v_i - (1 - F(v_i))/f(v_i)\} - p(v)R \right] f(v)\, \mathrm{d}v$$

subject to (M) and (PR). Finally, by recalling the definition of $p(v_i\ |v_{-i})$, the objective function can be written as:

$$\max_{p(.)} \int_D p(v) \left\{ \sum_i [v_i - (1 - F(v_i))/f(v_i) - R] \right\} f(v)\, \mathrm{d}v$$

subject to (M) and (PR).

Proof of Proposition 3c. Expected surplus of the large country per small country under MFN is given by:

$$\int_D^1 \left(\left\{\sum_i [v_i - (1 - F(v_i))/f(v_i)] - R\right\}/n\right) f(v)\,\mathrm{d}v \left(\text{where } D^1 = \left\{v \in [a, b]^n \middle| \sum_i [v_i - (1 - F(v_i))/f(v_i)] > nr\right\}\right)$$

$$= \int_D^1 \left\{\sum_i [v_i - (1 - F(v_i))/f(v_i)]/n\right\} f(v)\,\mathrm{d}v - r\,\mathrm{prob}\left(\sum_i [v_i - (1 - F(v_i))/f(v_i)]/n > r\right)$$

$$= \int_D^1 \left\{\sum_i [v_i - k_i]/n - a\right\} f(v)\,\mathrm{d}v + (a - r)\,\mathrm{prob}\left(\sum_i [v_i - k_i]/n - a > r - a\right)$$

$$= \int_D^1 \left\{\left(\sum_i [v_i - k_i]/n - a\right)\sqrt{n}/q\right\} f(v)\,\mathrm{d}v(q/\sqrt{n}) + (a - r)\,\mathrm{prob}\left(\left(\sum_i [v_i - k_i]/n - a\right)\sqrt{n}/q > -c\sqrt{n}/q\right).$$

Let $z = (\Sigma_i [v_i - k_i]/n - a)\sqrt{n}/q$

$$= \int_D^1 z f(z)\,\mathrm{d}z(q/\sqrt{n}) + c[\mathrm{prob}(z - c\sqrt{n}/q)]$$

using the Central Limit Theorem

$$\approx \int z\phi(z)\,\mathrm{d}z(q/\sqrt{n}) + c[1 - \Phi(-c\sqrt{n}/q)]$$

where $\phi(.)$ is the pdf of the standard normal and $\Phi(.)$ is the cdf of the standard normal and $z \in (-c\sqrt{n}/q, \infty)$.

Note that this has a limit of c as n tends to ∞, which is the lowest expected surplus for the large country.

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