Do Countries Free Ride on MFN?

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July 2005

Abstract: The Most-Favored Nation (MFN) clause has long been suspected of creating a free rider problem in multilateral trade negotiations. To address this issue, we model multilateral negotiations as a mechanism design problem with voluntary participation. We show that an optimal mechanism induces only the largest exporters to participate in negotiations over any product, thus providing a rationalization for the Principal supplier rule. We also show that, through this channel, equilibrium tariffs vary according to the Herfindahl index of export shares: higher concentration in a sector reduces free riding and thus causes a lower tariff. Estimation of our model using sector-level tariff data for the U.S. provides strong support for this relationship.

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We especially thank Bruce Blonigen, Chad Bown, Brian Copeland, Peter Debaere, Nuno Limão and Robert Staiger for helpful comments on earlier drafts, and we thank seminar participants at KU Leuven, University of British Columbia, University of Oregon, Georgetown University, CEPR ERWIT Conference in Rotterdam, Inter-American Development Bank, and the Midwest International Economics conference.

I. Introduction

The Most-Favored Nation (MFN) clause has been a central element of international trade agreements for over a hundred years[1] and is widely acknowledged as one of the "pillars" of the GATT/WTO system. Found in almost all WTO agreements, the MFN clause requires that each member give equal treatment to the goods or services of all other members in the application of its trade policy. In practice, MFN implies that every time a country lowers a trade barrier or opens up a market, it must do so for the same goods or services from all its WTO trading partners. Despite the prominence of MFN, its actual effect on the progress of trade liberalization within the multilateral system remains largely unknown.

A spate of recent theoretical literature has pointed to several potential benefits of the MFN clause, deriving mainly from its ability to curb opportunistic behavior by governments that might otherwise undermine trade agreements.[2] This paper does not address these arguments; rather, we focus on the most notable and long-standing concern about MFN, which is that it opens the possibility of countries "free riding" on the trade negotiations of others. This concern stems from the fact that whenever a few WTO members mutually exchange trade-barrier reductions, they must extend those reductions to all other WTO members under MFN, even if the latter do not reciprocate. To the extent that non-reciprocating countries benefit from improved market access to liberalizing countries (the so-called MFN externality), two related incentive problems emerge: countries may avoid entering into negotiations in hopes of free riding on the

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[1] See Caplin and Krishna (1988) for a detailed history of MFN.
[2] Examples include, Choi (1995), Either (2004), Ludema and Cebi (2002), Bagwell and Staiger (2002, Ch.5), Ederington and McCalman (2003), Saggi (2003); see Horn and Mavroidis (2001) for a survey.

liberalization of others; and countries that do enter negotiations may reach inefficient agreements, as they do not fully internalize the benefits of their liberalization.

The purpose of this paper is to assess the empirical relevance of the MFN free rider problem. We argue that free riding arises out of two basic constraints (besides MFN itself): countries are free to choose whether or not to participate in trade negotiations on any given product; and participants cannot precommit to punishing free riders. We show that any system of trade negotiations that is optimal (i.e., maximizes world welfare) subject to these constraints induces the participation of only a subset of countries: the importer (there is only one in our model) and the largest exporters of each product. This accords with the WTO negotiating convention known as the principal supplier rule. The model also allows us to establish a negative relationship between exporter concentration, as measured by the Herfindahl index of export shares, and the importer's tariff, on a good-by-good basis. We derive an estimating equation similar to Goldberg and Maggi (1999) and Gawande and Bandyopadhyay (2000), suitable for explaining cross-sector trade protection. Using US MFN tariff rates for both 1983 and 1989-1999, we find evidence of a significant free-rider effect.

II. Assessing the MFN Free-Rider Argument

Although policymakers have been concerned about the MFN free rider problem for centuries,[3] Johnson (1965) was the first to model the effect of free riders on bilateral

[3] Viner (1924) cites John Jay, who in a 1787 report to Congress concerning the U.S.-Netherlands Treaty of 1782, expressed the U.S. position on MFN: "it would certainly be inconsistent with the most obvious principles of justice and fair construction, that because France purchases, at a great price, a privilege of the United States, that therefore the Dutch shall immediately insist, not on having the like privileges for the like price, but without any price at all." The U.S. would not fully embrace unconditional MFN in trade treaties until 1923.

reciprocal tariff reductions under MFN. Caplin and Krishna (1988) extended the result to a formal bargaining model, in which pairs of countries simultaneously negotiate bilateral agreements (subject to MFN). The result is that each pair chooses inefficiently high tariffs, due to the MFN externality. In both of these papers, the authors assume a setting in which the MFN externality exists and negotiations take place on a bilateral basis.

Others have cast doubt on these assumptions. Viner (1931) noted that countries often try to minimize the MFN externality by defining products so narrowly as to make MFN nonbinding.[4] In the extreme, if products are defined in such a way that no product is imported from more than one country, then the MFN externality cannot exist. In practice, manipulation of product classification is limited under the harmonized classification system, and we know from the data that the vast majority of imported products into the U.S. are supplied by more than one country at the relevant level of aggregation. Nevertheless, it remains an open question how effective creative product definition has been in limiting the MFN externality.

More recently, Bagwell and Staiger (2002, Ch.5) have argued that the MFN externality can be suppressed by reciprocity, defined as bilateral liberalization (subject to MFN) aimed at holding constant world relative prices. To see this point, consider the pattern of trade depicted in figure 1(a), involving three countries, A, B and C, and two goods, 1, and 2. If country A lowers its tariff on imports of good 1 on an MFN basis, it improves the terms of trade of both B and C. If B cuts its tariff on good 2 in exchange, it worsens the terms of trade of C, thereby mitigating the MFN externality. However, if we

[4] The oft-cited example is the German-Swiss treaty of 1904 in which tariffs were reduced on "large dapple mountain cattle or brown cattle reared at a spot at least 300 metres above sea level and having at least one month's grazing each year at a spot at least 800 metres above sea level" (Viner, 1931 p. 101, as quoted in Caplin and Krishna, 1988, p269.)

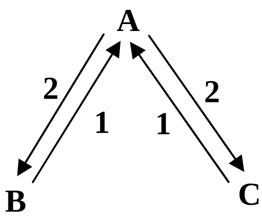

Figure 1(a)

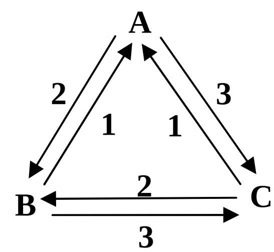

Figure 1(b)

consider the alternative pattern of trade with three goods, depicted in figure 1(b), bilateral exchange of tariff concessions does not suppress the MFN externality. The effect of A's tariff cut is the same as in 1(a), but now B's tariff cut improves C's terms of trade as well, thereby magnifying the MFN externality.

Figure 1(b) actually says less about the pattern of trade *per se* than it does about the set of trade policy instruments available to affect reciprocity. If instead of cutting its tariff on good 2, B subsidizes its exports of good 1, the suppression result goes through. Thus, whether or not the MFN externality can be controlled through reciprocity depends on having the requisite policy instruments available to hold constant the outsider's terms of trade. In actual practice, the GATT bans export subsidies in general, as well as many other trade policies. In light of such restrictions, it remains an open question how effective reciprocity has been in limiting the MFN externality.

Finally, there is reason to question whether countries actually do free ride. Much of the literature takes free riding, i.e., the existence of countries that do not participate in the tariff cutting exercise, as exogenous. However, Ludema (1991) puts forth a model of multilateral bargaining, in which countries have the option of free riding but choose not to do so in equilibrium. This occurs because free riding by one country triggers a temporary breakdown in negotiations, which amounts to an effective punishment of free riders. Thus, in this model, the structure of the multilateral negotiations causes the MFN externality to be internalized.

Recent theoretical literature on the effect of MFN on multi-country bargaining has focused on sequential bilateral bargaining (Bagwell and Staiger, 2003; Bond, Ching, and Lai, 2000) and asymmetric information (McCalman, 2002; Ludema and Cebi, 2002). In each case, the MFN externality continues to exert an effect, though not always in the form of free riding.[5]

As an empirical matter there is ample evidence that not all countries fully participate in trade negotiations on all goods, even during multilateral negotiating rounds.[6] Finger (1979) provides evidence that this lack of participation affected US tariff concessions in the first six GATT rounds (1947-1967). He found that the share of imports originating in participating countries of goods on which the US granted tariff cuts was consistently larger than those countries' share in total US imports. His interpretation is that US selected goods for tariff cuts so as to internalize the benefits to the participants. Examining a cross-section of U.S. pre-Tokyo tariffs, Lavergne (1983) finds higher tariffs on goods exported predominantly by LDCs, controlling for various domestic political factors. He offers an MFN interpretation of this finding as well.

In summary, the theory of trade negotiations under MFN is inconclusive about the importance of free riding, and the empirical evidence is thin. Our purpose in this paper is

[5] In Bagwell and Staiger (2003), for example, countries negotiating early in a sequence hold back on liberalization to prevent free riding on the negotiations by countries later in the sequence ("forward manipulation"), but later negotiators also steal some of the benefits of early negotiations ("backward stealing"). In McCalman (2002), the MFN externality raises the cost to a large country of inducing privately-informed small countries to join an agreement, resulting in inefficient outcomes.

[6] Horn and Mavroidis (2000) note that "...In the WTO, negotiations for the most part take place between subsets of Member countries. Sometimes this is 'officially sanctioned,' as in the case of Principal Supplier negotiations. But also in seemingly multilateral negotiations, the 'actual' negotiations occur between a very limited number of countries..." (Horn and Mavroidis, 2000, p. 34).

to provide what is sorely lacking in this literature: an empirical assessment based on theory. In section III, we construct a model of MFN free riding. We assume a set-up in which the MFN externality exists, meaning that free riders do stand to benefit from the tariff reductions of others. We also assume a negotiating set-up in which countries have the option to free ride, but participants (i.e., non-free-riders) have only limited ability to punish free riders. In particular, we impose two constraints on the negotiations: 1) voluntary participation – no country can be compelled to "pay" for a tariff concession made by another; 2) Pareto efficiency for participants – the bargaining that takes place among participants is efficient. These constraints are equivalent to those used by Dixit and Olsen (2000) to study free riding in the provision of public goods.

Beyond these constraints, we attempt to remain as general as possible in modeling the interactions between countries. Thus, we treat the allocation of gains from the multilateral trade negotiations as a mechanism design problem. We define an optimal mechanism to be one that maximizes world payoffs (participants and non-participants), subject to these constraints.

In Section III.A, we derive the tariff that is Pareto efficient for participants. We find this tariff depends on the usual political and economic characteristics of the industry (e.g., see Grossman and Helpman, 1995) and is a decreasing function of the market share of participants. Section III.B considers the participation decision itself. We find that, in general, not all countries can be induced to participate. Full participation (i.e., no free riding) can only occur when the degree of exporter concentration, as measured by a Herfindahl index of export market shares, is sufficiently high.

Section III.C discusses the relationship between the optimal mechanisms and the principal supplier rule. The principal supplier rule is a key, albeit informal, aspect of the item-by-item, request-and-offer method that has been GATT's most common form of negotiation over the years.[7] It basically mandates that a country's tariff on each product be negotiated with the exporters having a "principal supplying interest" in the country's market for that product. Normally this is taken to mean the largest exporter, or group of exporters, as measured by market share.[8] We show that such a rule is an optimal response to the MFN free rider problem. In a situation where full participation is not possible, it is beneficial to have the countries that do participate be principal suppliers as this minimizes the MFN externality, thereby producing the lowest negotiated tariffs. Note that this principal supplier rule emerges from the optimality of the mechanism rather than being imposed from the start.

In Section III.D we bring together the above results to derive a relationship between the Herfindahl index of export market shares and the tariff implemented by the optimal mechanism. General comparative statics are elusive, because the tariff depends on the entire distribution of market shares. However, if any two distributions can be ranked according to first-order stochastic dominance, the one with the higher Herfindahl

[7] In the Uruguay round, the US used the item-by-item approach. On the other hand, the Kennedy and Tokyo Rounds were characterized by a formula approach, whereby each country cuts tariffs across-the-board according to a certain formula agreed to at the outset. In fact, however, countries deviated considerably from the formula cuts on an item-by-item basis, and many countries ignored the formula entirely (Hoda, 2001, pp. 30-32). Negotiations over these deviations took place on an item-by-item basis between principal suppliers. According to Hoda (2001, p. 47), "Thus a linear or formula approach did not obviate the need for bilateral negotiations: they only gave the participants an additional tool to employ in the bargaining process."

[8] This rule is not clearly spelled out in the GATT agreement, except in the case of renegotiation. According to Article XXIII, when a country wishes to modify or withdraw a concession previously granted, it must negotiate compensation with, 1) those countries with which the concession was originally negotiated, and 2) those countries with a principal supplying interest, defined as having market share larger than any country in category 1) or as otherwise determined by the Ministerial Conference (Hoda, 2001, p. 14). Thus, Article XXIII implies that the country granting the original concession becomes liable to compensate principal suppliers for modifications or withdraw.

index also produces the lower tariff. Section III.E provides a simple example. Section III.F extends the model to include exogenous preferential trade agreements.

In Section IV, we empirically assess the importance of the free rider problem for U.S. tariffs. Using a panel of US MFN tariff rates at the 4-digit ISIC level from 1989-1999, we find a strong negative correlation between tariffs and the Herfindahl index of exporter concentration that is quite consistent over time. This relationship survives the inclusion of variables that proxy for domestic political-economy determinants of trade barriers. We also estimate a complete Goldberg-Maggi type model for 1983 with the same result (e.g., Goldberg and Maggi, 1999; Gawande and Bandyopadhyay, 2000). In particular, estimates using 1983 U.S. tariff levels show a significant and negative impact of exporter concentration. Estimates using U.S. non-tariff barriers do not. Considering that many non-tariff barriers are exempt from MFN, we take this as evidence of an MFN-related free rider problem in tariffs. Section V concludes.

III. The Model

There are $N + 1$ countries, indexed by $i = 0, \ldots, N$, and two goods, X and Y, produced under constant returns to scale and perfect competition.[9] Good Y is the numeraire and employs only labor, while X employs both labor and a sector-specific factor K, according to the production function $X = g(K, L)$. Preferences are identical across countries, according to the quasi-linear per capita utility function, $U = c_Y + u(c_X)$, where $u' > 0$, $u'' < 0$. The endowments of country i are given by L_i and K_i, and let

[9] For simplicity, we consider X to be a single good, though the model could be extended to make X a vector of goods without weakening the results.

$k_i \equiv K_i / L_i$. We assume endowments are such that country 0 is the natural importer of good *X* and the other *N* countries are natural exporters.

Each government seeks to maximize a weighted welfare function, with weight λ reflecting the greater importance of specific-factor owners in its domestic political process. Letting *S* denote per capita consumer surplus, π the return to the specific factor, and *M* net imports, the government welfare functions are given by,

$$w_0 = L_0\left[1 + S(p) + (1+\lambda_0)\pi(p)k_0\right] + (p - p^*)M_0(p) \tag{1}$$

$$w_i = L_i[1 + S(p^*) + (1+\lambda_i)\pi(p^*)k_i] \ \text{ for } \ i = 1,\ldots,N \tag{2}$$

The domestic and foreign prices are *p* and p^*, respectively.

Although not essential for our results, it is convenient for exposition to impose a degree of symmetry on the exporters. Let $k_i = k^*$ and $\lambda_i = \lambda^*$ for all *i* = 1,…,*N*. This enables us to write (2) as $w_i = \theta_i w^*$, where $w^* = \Sigma_{j=1}^N w_j$ and $\theta_i = L_i / \Sigma_{j=1}^N L_j$. We refer to θ_i as the export market share of exporter *i*, as it equals *i*'s share of world exports of product X to the importing country. Thus, an exporter's welfare is proportional to its market share and market shares are independent of world price.[10]

The importer imposes an *ad valorem* tariff on *X* and offers tariff reductions in exchange for transfers of good *Y* from the exporting countries. All countries are assumed to be members of the WTO and are therefore entitled to MFN treatment. That is, the importer must charge a single, uniform tariff on all imports of *X*, irrespective of the

[10] Without the symmetry assumptions, it would still be the case that the *change* in an exporter's welfare is proportional to θ_i, i.e., $w_i' = \theta_i w^{*\prime}$, which is the important point. However, θ_i would differ from simple market share, becoming $\theta_i \equiv (-M_i + \lambda_i X_i)/\Sigma_{j\in N}(-M_j + \lambda_j X_j)$, and would vary with the world price. None our theoretical results would change, as long as the price elasticity of θ_i is not too large. In our empirical work, we use simple market shares as a proxy for θ_i, since we lack data on the political weights of the exporting countries. Thus, there is ultimately no benefit to using the more general, more complicated, specification.

identity of, or transfer received from, any exporter.[11] Our assumption that exporters use transfers to reciprocate a tariff reduction means that the MFN externality is neither suppressed nor magnified by reciprocity.[12]

To determine the tariff and transfers, we need a model of multilateral trade negotiations. One approach is to construct a bargaining game embodying the multitude of rules found in actual WTO negotiations. Given the complexity of actual WTO negotiations, however, this is a monumental task, not mention a risky one, considering the sensitivity to specification displayed in previous literature. The approach we take here is based on mechanism design theory. We begin by positing a hypothetical center, or principal, which we refer to simply as the WTO. The WTO's objective is to maximize the joint welfare of its members. It does this by designing a game, or mechanism, through which the members interact. The mechanism has a general form: $\Gamma = \{\Sigma_0, \Sigma_1, ..., \Sigma_N, \tau(\cdot), t(\cdot)\}$, where Σ_i is the message space of country *i*, $\tau : \Sigma_0 \times ... \times \Sigma_N \to \Re$ is a tariff function, and $t : \Sigma_0 \times ... \times \Sigma_N \to \Re^N$ is a transfer function. Each country "sends" a (pure strategy) message $\sigma_i \in \Sigma_i$. The functions $\tau(\cdot)$ and $t(\cdot)$ map the resulting message profile $\sigma = (\sigma_0, \sigma_1, ..., \sigma_N)$ into a tariff τ, measured as one plus the *ad valorem* tariff rate, and a transfer profile $t = (t_1, t_2, ..., t_N)$, respectively. A mechanism Γ is said to implement the outcome $(\tilde{\tau}, \tilde{t}) \in \Re^{N+1}$ if there exists a Nash equilibrium σ of Γ such that $\tau(\sigma) = \tilde{\tau}$ and $t(\sigma) = \tilde{t}$.

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[11] At this point, we abstract from preferential trade agreements as permitted under Article XXIV. These are dealt with in section IIIF.

[12] In actual practice, countries typically exchange trade barrier reductions of all kinds, some presumably suppress the externality, while others may magnify it. Transfers provide a convenient, tractable way of summarizing these reductions by the exporters, as they imply no effect on the externality.

With no restrictions on the set of mechanisms, the WTO could always implement a fully efficient outcome by simply choosing $\tau(\cdot)$ to equal the world optimal tariff for all message profiles. However, we shall restrict attention to mechanisms satisfying the following two conditions:

(*V*) *Voluntary Participation*: each country is endowed with a "withdraw" message. If exporter *i* withdraws, then $t_i = 0$, regardless of the others' messages, while if the importer withdraws, then $t_i = 0$ for all *i* and τ is set at its unilaterally optimal level $\bar{\tau}$.

(*P*) *Pareto Efficiency for Participants*: for all σ, $\tau(\sigma)$ maximizes the joint welfare of all countries that do not withdraw.

The first assumption is that no country can be forced from its *status quo*. The exporters cannot be forced to make positive transfers, and the importer cannot be forced to reduce its tariff. This assumption can be justified by appealing to national sovereignty. The second assumption is that participants will always negotiate an efficient outcome for themselves. Importantly, this means that the participants cannot be made to take part in any scheme to punish free riders with an inefficient (for participants) tariff. One possible justification for this might be renegotiation: if participants were permitted to renegotiate the tariff-transfer package after the fact, then no inefficient agreement would survive. In light of these restrictions, we can partition the message space into withdraw and not withdraw (i.e., participate) without loss of generality.

An example of a class of games satisfying *V* and *P* are the voluntary participation games of Palfrey and Rosenthal (1982), Saijo and Yamato (1999) and Dixit and Olson (2000). While these authors study the provision of public goods, the application to our context is immediate. They posit a two-stage process, where, in the first stage, agents decide non-cooperatively whether or not to participate. Participants are assumed to share the cost of providing the public good, according to some sharing rule, while non-participants pay nothing (*V*). In the second stage, participants engage in efficient bargaining over the level of the public good (*P*). It can be shown that any outcome that is implementable under *V* and *P* is an equilibrium of a voluntary participation game for some sharing rule. In this paper, we endogenize the sharing rule (i.e., the transfer function), by way of the optimal mechanism, and we are unique in considering heterogeneous agents.

A. The Efficient Tariff

In this section, we solve for the efficient tariff for any set of participants, including the importing country. Let *N* refer to the set of all exporting countries (as well as number of countries in *N*), and consider the set $A \subseteq N$. Assuming the importing country and all members of *A* participate, we can find the efficient tariff by maximizing $w_0(\tau) + \Sigma_{i \in A} w_i(\tau)$ with respect to τ. The first-order condition is,

$$w_0' + \sum_{i \in A} w_i' = 0 \tag{3}$$

Defining $\Delta \equiv -\left[w_0'' + \Sigma_{i \in A} w_i''\right]^{-1}$, the second-order condition is $\Delta > 0$.

Differentiating (1) and (2) gives,

$$w_0' = \left[\lambda_0 X_0 + (p - p^*) \frac{dM_0}{dp} \right] \frac{dp}{d\tau} - M_0 \frac{dp^*}{d\tau} \tag{4}$$

$$\sum_{i \in A} w_i' = \Theta_A \left(M_0 + \lambda^* X^* \right) \frac{dp^*}{d\tau} \tag{5}$$

where $X^* \equiv \Sigma_{i \in N} X_i$ is aggregate exporter output, and $\Theta_A \equiv \Sigma_{i \in A} \theta_i$ is the cumulative market share of participating exporters. World market clearing implies, $-\mu \frac{dp}{p} = \xi^* \frac{dp^*}{p^*}$, where μ and ξ^* are the elasticities of import demand and total export supply, respectively. Combining this relationship with (3), (4) and (5) produces an expression for the efficient tariff,

$$\tau^e(A) = \frac{1 + \left[1 - \Theta_A \left(1 + \lambda^* \frac{X^*}{M_0} \right) \right] \frac{1}{\xi^*}}{\left(1 - \frac{\lambda_0}{\mu} \frac{X_0}{M_0} \right)} \tag{6}$$

The efficient tariff (6) can be seen as a generalization of the equilibrium tariffs found in Grossman and Helpman (1995). In their two-country framework (N = 1), the only possible values for Θ_A are zero and one. When $\Theta_A = 0$, we obtain the unilateral tariff,

$$\bar{\tau} \equiv \tau^e(\varnothing) = \left(1 + \frac{1}{\xi^*} \right) \Big/ \left(1 - \frac{\lambda_0}{\mu} \frac{X_0}{M_0} \right). \tag{7}$$

If we let $\lambda_0 = \dfrac{I_L - \alpha_L}{a + \alpha_L}$, where I_L is an indicator of the political organization of the sector-specific factor, α_L is the fraction of voters represented by a lobby, and a is the government's preference for social welfare relative to lobbying contributions, then (7) is identical to the "trade war" equilibrium of Grossman and Helpman (1995). Similarly, when $\Theta_A = 1$, we obtain the world optimal tariff,

$$\tau^w \equiv \tau^e(N) = \left(1 - \frac{\lambda^*}{\xi^*}\frac{X^*}{M_0}\right) \Big/ \left(1 - \frac{\lambda_0}{\mu}\frac{X_0}{M_0}\right), \tag{8}$$

which is the same as Grossman and Helpman's "trade talks" equilibrium.[13]

The efficient tariff declines as countries are added to the set of participants. This is confirmed by noting that the addition of a country to *A* increases Θ_A, and by total differentiation of (3), $d\tau^e / d\Theta_A = w^{*\prime}\Delta < 0$. This is driven by the terms-of-trade effect of the tariff. The more the terms-of-trade cost of the tariff falls on the participating exporters, as opposed to free riders, the more the total welfare cost of the tariff is internalized in the tariff setting exercise. As the cost to any exporter is proportional to its market share, the share of the total cost that falls on participating exporters is Θ_A. Thus, the larger is the cumulative market share of the participating exporters the less beneficial is a tariff to the participant group and the smaller is the efficient tariff.

B. Voluntary Participation

Having found the efficient tariff for any given set of participants, we consider next which countries would choose to participate. Suppose *A* is an equilibrium set of participating exporters. For country *i* to be a member of this set, the net benefit it receives from participation must exceed the payoff it would receive by withdrawing, given the behavior of all other countries. This means that the transfer *i* pays must satisfy,

$$t_i \leq w_i(\tau^e(A)) - w_i(\tau^e(A \setminus i)). \tag{9}$$

The right-hand side of (9) is the loss in gross welfare exporter *i* would experience by withdrawing from *A*. This loss is due to an increase in the efficient tariff from $\tau^e(A)$ to

[13] In addition, if there is no domestic political pressure ($\lambda_0 = \lambda^* = 0$), the efficient tariff in (7) is equal to the optimum tariff for a large open economy, while the efficient tariff in (8) is equal to 1 (free trade).

$\tau^e(A \setminus i)$ resulting from i's withdrawal. We can think of the right-hand side of (9) as the amount exporter *i* would be willing to pay to participate.

If i's market share is fairly small, the right-hand side of (9) can be approximated by its differential $(\theta_i w^{*\prime})^2 \Delta$, evaluated at $\tau^e(A)$. Thus, an exporter's willingness to pay is proportional to its squared market share. This is because a country's welfare loss from a small increase in the tariff is proportional to its market share, and so is its impact on the efficient tariff.

To ensure the participation of the importing country, the sum total of the transfers must be large enough for the importer to forgo its unilateral tariff:

$$w_0(\tau^e(A)) + \sum_{i \in A} t_i \geq w_0(\bar{\tau}), \tag{10}$$

Combining (9) and (10), we see that there exists a profile of transfers that supports A as an equilibrium set of participants, if and only if,

$$\Omega(A) \equiv \sum_{i \in A} w_i(\tau^e(A)) - w_i(\tau^e(A \setminus i)) - \left[w_0(\bar{\tau}) - w_0(\tau^e(A))\right] \geq 0 \tag{11}$$

The function $\Omega(A)$ measures the difference between the total willingness to pay of the participating exporters and the opportunity cost to the importing country of imposing the efficient tariff instead of its unilateral tariff. It follows that a tariff τ can be implemented if and only if $\tau = \tau^e(A)$ and $\Omega(A) \geq 0$ for some $A \subset N$.

For the remainder of this section, we examine some of the properties of $\Omega(A)$. Consider the effect on $\Omega(A)$ of adding an exporter to the set of participants. The change in Ω is given by,

$$
\begin{aligned}
\Omega(A\cup i)-\Omega(A) = {} & w_i(\tau^e(A\cup i))-w_i(\tau^e(A)) \\
& -\sum_{j\in A}\left[w_j(\tau^e(A))+w_0(\tau^e(A))-w_j(\tau^e(A\cup i))-w_0(\tau^e(A\cup i))\right] \qquad (12)\\
& -\sum_{j\in A}\left[w_j(\tau^e(A\cup i\setminus j))-w_j(\tau^e(A\setminus j))\right]
\end{aligned}
$$

The first term in (12) is the willingness-to-pay of the new entrant, which is positive. The second term is the loss of welfare to existing participants and the importer from changing the tariff from $\tau^e(A)$ to $\tau^e(A\cup i)$. The last term is the increase in the withdraw payoffs of the existing participating exporters. Each of the terms in brackets above is positive. Thus, the change in Ω is more likely to be positive when the exporter being added is large relative to the set of countries already in *A*.[14]

Two results follow immediately. One is that the first exporter to be included in the set of participants always increases Ω. This is verified by noting that for a single participating exporter, maximization of joint surplus implies that, for all *i*, $\Omega(i)=w_i(\tau^e(i))+w_0(\tau^e(i))-(w_i(\overline{\tau})+w_0(\overline{\tau}))\geq 0$. In other words, it is always possible to find a set of transfers consistent with the participation of any single exporter.

Second, the Herfindahl index of exporter concentration for the entire market is a key determinant of whether the world optimal tariff τ^w can be implemented. The Herfindahl index, defined as $H\equiv\Sigma_{i\in N}\theta_i^2$, ranges from 1 (one exporter has the entire market) to $1/N$ (each exporter has equal market share). In the case of $H = 1$, we have already seen that any single-exporter participation set is an equilibrium, so by choosing the exporter with the entire market, τ^w can be implemented. As *H* declines, however, this

[14] In particular, the first term in (12) is proportional to the market share of the entrant; the second term is near zero, because of the envelope theorem; the third term is roughly proportional to the sum of market shares of the existing participants. Thus the larger is the market share of the entrant relative to that of the existing participants, the more likely ΔΩ will be positive.

becomes less likely. To see this, note that if market shares are fairly small, our earlier approximation of the willingness to pay implies:

$$\Omega(A) \approx \sum_{i \in A} \theta_i^2 [w^{*\prime}(\tau^e(A))]^2 \Delta - \left[w_0(\overline{\tau}) - w_0(\tau^e(A))\right] \tag{13}$$

Evaluating this at $A = N$, we have, $\Omega(N) \approx H[w^{*\prime}(\tau^w)]^2 \Delta - [w_0(\overline{\tau}) - w_0(\tau^w)]$. As the terms $[w^{*\prime}(\tau^w)]^2 \Delta$ and $[w_0(\overline{\tau}) - w_0(\tau^w)]$ are positive and invariant to H, $\Omega(N)$ decreases as H decreases. In the extreme case of $H = 1/N$, $\Omega(N)$ becomes negative (and the approximation becomes exact) as N gets large. If $\Omega(N) < 0$, full participation is not an equilibrium, and τ^w cannot be implemented. We summarize these conclusions in the following proposition:

Proposition 1: If the Herfindahl index of exporter concentration is sufficiently high (low), the world optimal tariff can (cannot) be implemented.

C. Optimal Mechanisms and the Principal Supplier Rule

We defined an optimal mechanism to be one that maximizes world welfare, subject to V and P. Hence, such a mechanism must induce the participation of a set of countries A that minimizes $\tau^e(A)$, subject to $\Omega(A) \geq 0$. Because the domain of this problem (the power set of N) is discrete, it makes for a rather difficult nonlinear integer programming problem. In this section, we show that this problem can be simplified considerably, with minimal loss of generality, by restricting attention to sets of participants obeying the principal supplier rule, defined as follows:

Definition: A set of participants A obeys the *principal supplier rule* (PSR), if and only if there exists a critical exporter $i' \in A$ such that $\theta_i \geq \theta_{i'}$ for all $i \in A$, and $\theta_i \leq \theta_{i'}$ for all $i \notin A$.

In other words, under the principal supplier rule, only the exporters above a certain size participate.

Two special cases follow immediately from our analysis of the previous section. If $\Omega(A) \geq 0$ is satisfied for at most one exporter, then the optimal mechanism would select as a participant the largest exporter as measured by market share. If $\Omega(N) \geq 0$, then it is clear that an optimal mechanism yields full participation and the corresponding tariff τ^w. In both of these cases, the optimal mechanism produces a set of participants satisfying the principal supplier rule.

Beyond these special cases, the virtue of the principal supplier rule can be seen by comparing any two sets A and B, that are *equivalent* in the sense that $\Theta_A = \Theta_B$, but where B obeys PSR while A does not. Because they have the same cumulative market share, these two sets produce the same efficient tariff. However, it can be shown (see proof of the next proposition) that $\Omega(B) \geq \Omega(A)$. Thus, any non-PSR set having an equivalent PSR set can be thrown out of consideration in our search for an optimal mechanism.

The reason $\Omega(B) \geq \Omega(A)$ is evident from (13). Total willingness to pay is an increasing function of the sum of the squared market shares of participants. For any given cumulative market share, the sum of the squared market shares is maximized by choosing the largest exporters. Intuitively, a small group of large exporters has a greater total willingness to pay than a large group of small exporters (even though they have the same cumulative market share), because each of the large exporters has larger impact on the tariff than any of the small exporters.

Can we eliminate all non-PSR sets from consideration? No, because not all non-PSR sets have an equivalent PSR set. This too is a consequence of the discreteness of the countries. If there were many exporters each with small market share, this problem would evaporate. Nevertheless, for any non-PSR set A having no equivalent PSR set, there is a PSR set C that is slightly smaller ($\Theta_C < \Theta_A$) and another PSR set D, obtained by adding the next largest country to C, that is slightly larger ($\Theta_D > \Theta_A$). We can show that $\Omega(C) \geq \Omega(A)$, provided a mild regularity condition holds.[15] If as well, $\Omega(D) \geq \Omega(A)$, then we can throw out A. Otherwise, it is possible that A is part of an optimal mechanism. Even in this case, however, PSR sets are useful, as C and D provide bounds for locating the tariff implemented by this mechanism. Moreover, with small market shares, the gap between C and D is small, so there is minimal loss of generality by focusing exclusively on PSR sets.

As the focus of our empirical work is on tariffs, it is useful to express the above results in terms of tariffs instead of sets of participants. To that end, we define:

- A tariff τ is *feasible under PSR*, if there exists a PSR set A such that $\tau^e(A) = \tau$.
- Let $\hat{A}$ be the largest PSR set satisfying $\Omega(\hat{A}) \geq 0$. Thus, $\hat{\tau} = \tau^e(\hat{A})$ is the smallest tariff *implementable under PSR.*
- Let $\hat{A}^+$ be the next largest PSR set, with $\hat{\tau}^+ = \tau^e(\hat{A}^+)$. The set $\hat{A}^+$ is obtained by $\hat{A} \cup \hat{i}^+$, where $\hat{i}^+$ is the largest exporter not a member of $\hat{A}$.

[15] We assume $[\Omega(A \cup i) - \Omega(A)]/\theta_i$ is non-decreasing in θ_i. This "convexity" property always holds for small enough θ_i, so the assumption here is that convexity extends to discrete changes as well.

We can now state a precise relationship between optimal mechanisms and the principal supplier rule.

Proposition 2: Let $\tilde{\tau}$ be the tariff implemented by the optimal mechanism, and let $\hat{\tau}$ be the smallest tariff implementable under PSR. If $\tilde{\tau}$ is feasible under PSR, then $\tilde{\tau} = \hat{\tau}$. Otherwise, $\tilde{\tau} \in (\hat{\tau}^{+}, \hat{\tau}]$, and $\tilde{\tau} \to \hat{\tau}$ as $\theta_{\hat{i}^{+}} \to 0$.

Proposition 2 states that the smallest tariff implementable under PSR is either optimal or nearly so, and it establishes an upper bound on the error. The smaller is the market share of the largest non-participant the smaller the error. In the limit the error is zero.

There are three reasons to appreciate Proposition 2. First, it greatly simplifies the search for optimal mechanisms. To find the largest PSR set satisfying $\Omega \geq 0$, one simply adds countries to the set of participants in rank order until the constraint binds. To go the extra mile of finding $\tilde{\tau}$, one need only search for sets with efficient tariffs between $\hat{\tau}$ and $\hat{\tau}^{+}$ and check if they satisfy $\Omega \geq 0$. Second, as we shall see in the next section, the simplicity afforded by focusing on PSR sets allows us to obtain comparative statics on $\hat{\tau}$. Proposition 2 tells us that results concerning $\hat{\tau}$ should carry over to $\tilde{\tau}$ with only a small amount of potential error. We rely on this fact for our empirical estimation. Finally, as a theoretical result on its own, the optimality (or near-optimality) of PSR sets helps to rationalize the principal supplier rule itself. A protocol under which negotiations take place on given product only if the principal suppliers participate is actually part of an optimal response to the MFN free rider problem.

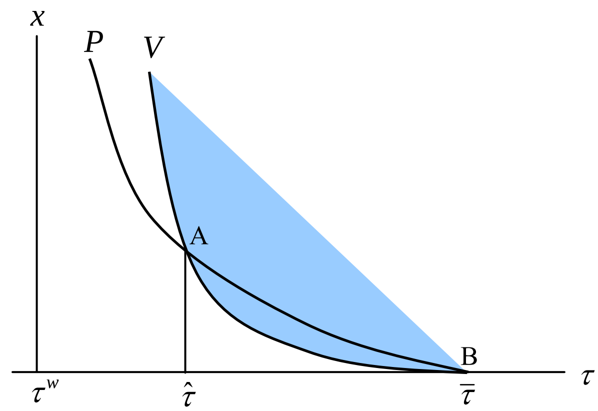

FIGURE 2: *All points along AB can be implemented. Point A is optimal.*

D. The Effect of Exporter Concentration with Many Exporters

In this section, we explore further the large N case with a view to understanding the relationship between the optimal mechanism and the underlying distribution of market shares. In view of Proposition 2, we restrict attention to mechanisms satisfying the principal supplier rule. It is convenient to order our exporters with $z = 1,\ldots, N$, where z is the rank of each country, in terms of market share. Let $f(z)$ be the market share of z, which is a monotonically declining function of z, and let $F(x) = \Sigma_{z=1}^{x} f(z)$ be the cumulative market share of the top x exporters.

An outcome $(x,\ \tau)$ satisfying conditions V, P and PSR solves the system,

$$w_0'(\tau) + F(x)w^{*\prime}(\tau) = 0 \tag{14}$$

$$h(x)w^{*\prime}(\tau)^2\Delta \geq \overline{w}_0 - w_0(\tau) \tag{15}$$

where $h(x) = \Sigma_{z=1}^{x} f(z)^2$ is the Herfindahl index of market concentration *of participants.* This is illustrated in Figure 2. The curve P shows the efficient tariff for each x, as determined by equation (14). The shaded area above and including V shows all values of

x and τ satisfying (15). Every outcome on the arc *AB* can be implemented. The optimal mechanism implements point *A*, which is the outcome with the lowest tariff.

At this point, provided (15) holds with equality, the importer's payoff is $w_0(\overline{\tau})$, which represents no gain relative to the status quo. Each free rider gains by $\theta_i[w^*(\hat{\tau}) - w^*(\overline{\tau})],\ i \notin A$, due to improved market access. Each participating exporter gains by $\theta_i[w^*(\tau^e(\hat{A}/i)) - w^*(\overline{\tau})],\ i \in A$. Relative to market share, this is less than the gain to free riders, because participants must compensate the importer for its terms of trade loss. However, in absolute terms, it may be larger as the participants are larger.

Inspection of (15) makes it clear the participants' willingness to pay for the tariff depends on the degree of market concentration of participants as measured by $h(x)$. To see how concentration matters, consider an initial density f_0, with a corresponding optimal outcome $(\hat{x}_0, \hat{\tau}_0)$, and suppose we replace f_0 with a new density f_1, such that $F_0(\hat{x}_0) = F_1(\hat{x}_0)$ but $h_0(\hat{x}_0) < h_1(\hat{x}_0)$. In other words, all else equal, the Herfindahl index of participants is higher under the new density. What happens to the optimal outcome? The answer can be seen in Figure 3a. By construction, the P schedule does not shift in the neighborhood of point A. Thus, the new density does not, by itself, change the efficient tariff. However, under the new density, the total willingness to pay of participants is higher. This is reflected by a downward shift in the *V* schedule at point A. This means that total willingness to pay under f_1 exceeds the cost of the initial tariff to the importer. This being the case, the optimal mechanism would call for an increase in participation and lower efficient tariff. Thus, the larger the Herfindahl index of participants *ceteris paribus* the lower is the tariff. This is summarized in the next proposition.

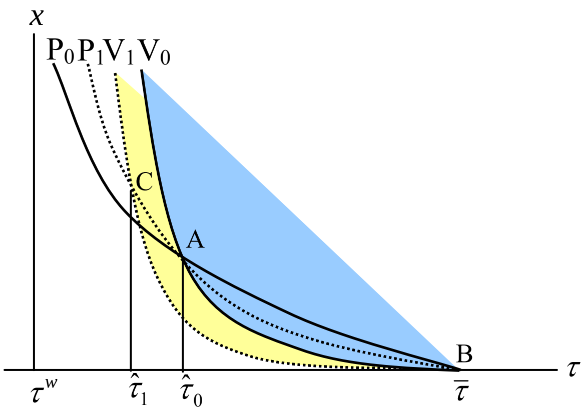

Figure 3a: *The effect of an increase in concentration, holding Θ constant at A.*

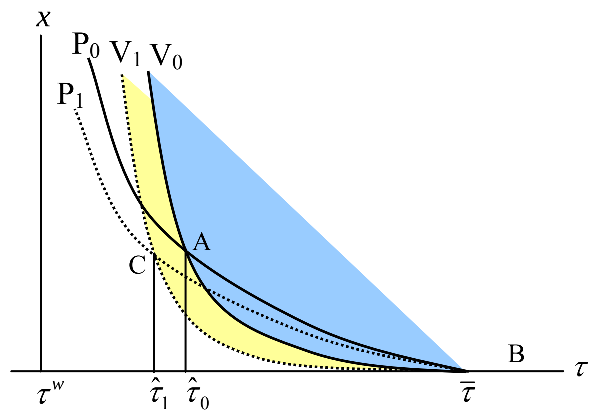

Figure 3b: *The effect of an increase in concentration, according to FSD.*

Proposition 3: Consider any two densities f_0 and f_1 with interior solutions $(\hat{x}_0, \hat{\tau}_0)$ and $(\hat{x}_1, \hat{\tau}_1)$, respectively, such that $F_0(\hat{x}_0) = F_1(\hat{x}_0)$. If $h_0(\hat{x}_0) < h_1(\hat{x}_0)$, then $\hat{\tau}_0 > \hat{\tau}_1$.

Proposition 3 establishes the connection between the Herfindahl index of participants and the tariff, holding all else constant. The empirical usefulness of this proposition is limited, however, because we are not able to measure the Herfindahl index of participants, without knowing the critical exporter. This is endogenous and usually unobservable (to the econometrician).

There are two ways to proceed. One is to impose some structure on the distribution of market shares that will enable us to establish a connection between the Herfindahl index of participants $h(x)$ and the Herfindahl index of the whole market H. It turns out that if two distributions of market shares can be ranked according to first-order stochastic dominance (FSD), there is a tight connection indeed.

Proposition 4: If f_0 and f_1 are densities such that $F_0(x) > F_1(x)$ for all x, and both admit interior solutions, then the equilibrium market share of participants is higher, and the tariff is lower, under f_0 than under f_1. Moreover, $H_0 > H_1$, i.e., the overall market

Herfindahl index is higher under f_0 than under f_1.

Proof in appendix.

Proposition 4 is illustrated in Figure 3b. The *P* schedule shifts to the left, because under the new distribution, the cumulative market share is higher for all *x*, and thus the efficient tariff is lower for all *x*. The *V* schedule shifts down because, for all *x* the Herfindahl index is now higher, meaning that the willingness-to-pay threshold for each τ is reached for a smaller *x*. The proof of the proposition shows that the shift in *V* is greater than the shift in *P*, and thus the new equilibrium C is left of A.

As an example of Proposition 4, assume that market shares have a geometric density, $f(z) = q(1-q)^{z-1}$ for $0 < q < 1$ (this density assumes a countably infinite number of countries). In this case, the Herfindahl index of any set of participants becomes,

$$h(x) = H\left[1-(1-F(x))^2\right] \tag{16}$$

where $H = q^2/[1-(1-q)^2]$. It is easy to see from (16) that an increase in *H*, holding constant the market share of participants, increases the Herfindahl index of participants. Just as in the discussion of Proposition 3, an increase in Herfindahl index of participants relaxes the participation constraint enabling an increase in the market share of participants and a decrease in the tariff.

Corollary: If market shares are distributed geometrically, then any increase in the Herfindahl index of the whole market increases the market share of participants and decreases the tariff.

The second way to proceed would be to assume parametric forms for the fundamentals of the underlying economy. This would enable us to solve for the optimal set of participants, given any distribution of market shares, and thereby deduce the corresponding cumulative market share of participants and efficient tariff. Below we consider the special case of Leontief technology and linear demand.

E. A Linear Example

Assume X is produced with Leontief technology, $g = \min[K, L]$, and preferences are quadratic, $u = \frac{1}{b}(ac_X - \frac{1}{2}c_X^2)$. Thus, each country has inelastic supply, $X_i = k_i L_i$, and linear demand. We also normalize $\Sigma_{i=1}^{N} L_i$ to unity. These assumptions imply that government objective functions are quadratic in the tariff. We can write them generically as,

$$w_0 = \delta_0 + \delta_1 \tau - \delta_2 \tau^2 \tag{17}$$

$$w(z) = f(z)\left(\gamma_0 - \gamma_1 \tau + \gamma_2 \tau^2\right) \tag{18}$$

where δ's and γ's are all positive parameters, constructed from the underlying model parameters, a, b, k^*, k_0 λ^*, λ_0 and L_0. The efficient tariff is,

$$\tau^e(x) = \frac{1}{2}\frac{\delta_1 - \gamma_1 F(x)}{\delta_2 - \gamma_2 F(x)}, \tag{19}$$

This is decreasing in F, under reasonable parameter restrictions.[16] The equilibrium set of participants is determined by,

$$h(x) = \frac{1}{2}F(x)^2\left(1 - \frac{\gamma_2}{\delta_2}F(x)\right). \tag{20}$$

[16] The condition $\lambda_0 < (k^* - k_0)/\ k_0$ is necessary to ensure that imports are non-negative at the unilaterally optimal tariff. This condition is also sufficient for the efficient tariff to decline with the market share of participants.

Finally, we note that the coefficient γ_2/δ_2 appearing in equation (20) is equal to $L_0/(1+2L_0)$, which is increasing in L_0. Thus, in this example, the optimal set of participants is determined only by the distribution of market shares and the relative size of the importing country. Its does not depend on outputs, demand parameters or political parameters. An increase in the relative size of the importing country reduces the left-hand side of (20), leading to a higher optimal *x* and lower tariff. Equation (20) can be solved for any distribution including an empirical one.

If we further assume that *F* is geometric, we can combine (16) and (20) to produce a closed-form relationship between the market share of participants and the overall Herfindahl index:

$$F(x)=\frac{1}{2}\frac{\delta_2}{\gamma_2}\left[2H+1-\sqrt{(2H+1)^2-16\frac{\gamma_2}{\delta_2}H}\right] \tag{21}$$

The right-hand side is monotonically increasing in *H*. Although (21) relies on very strong assumptions, it is useful in that *H* is readily observable.

F. Free Trade Agreements

Before moving ahead to the empirics, there is one extension of the model that is necessary to make it applicable to a real-world setting: we need to account for preferential trade agreements. We do not consider the endogenous formation of PTAs, because we believe such decisions involve factors well outside the scope of this paper. For the most part, the introduction of exogenous PTAs requires little change in our model beyond reinterpretation. For example, if two or more of the exporters are members of a customs union (CU), we treat them as a single exporter, and if an exporter is part of a CU with the importer, we treat the pair as the importer. The interesting case is when the importer and an exporter (henceforth, the "partner") form a free trade area (FTA). In this case, the partner's incentives differ from those of the other exporters: the partner prefers a higher tariff to be imposed on the other exporters.

We assume that the partner does not participate directly in the negotiations but allow for the possibility that the importer takes into account the effect of its tariff on the partner.[17] Also, to simplify, suppose $\lambda^* = 0$. Thus, the objective of the importer is,

$$w_0 + \phi w_{FTA} = L_0\left[1 + S(p) + (1+\lambda_0)\pi(p)k_0\right] + (p - p^*)E_R(p^*) \\ + \phi L_{FTA}\left[1 + S(p) + \pi(p)k_{FTA}\right]$$

where w_{FTA} is the welfare of the partner, ϕ measures the importer's concern for the partner, and E_R denotes total exports of those countries that are *not* members of the FTA. This gives rise to a modified efficient tariff of,

$$\tau^e(A) = \frac{1 + \frac{1}{\xi_R}(1-\Theta_{AR})}{1 - \frac{1}{\mu + \xi_{FTA}\Theta_{FTA}}\left(\lambda_0 \frac{X_0}{M_0} - (1-\phi)\Theta_{FTA}\right)} \qquad (22)$$

where Θ_{FTA} refers to the partner's share of the total home imports, and Θ_{AR} refers to the market share of non-FTA participants *as a fraction of* E_R.

There are three notable features of (22). First, our previous results concerning the effects of concentration on the tariff are unchanged; however, here they apply to the Herfindahl index of non-FTA countries only. Second, the relevant import elasticity is now $\mu + \xi_{FTA}\Theta_{FTA}$, which is the import elasticity of the FTA as a whole. Other things

[17] This might be justified by assuming the importer and FTA partner engage in ongoing bilateral negotiations over non-trade policies, as in Limão (2002). In such a model, increases in partner welfare due to increases in the importer's external tariff are partially extracted by the importer through negotiations, with ϕ reflecting the importer's bargaining share. This would suggest that ϕ lies between 0 and 1. However, if the external tariff also affects the threat point of the negotiations, as is assumed by Limão, then ϕ could in effect exceed 1.

equal, this is increasing in the FTA share. Finally, note that the tariff is increasing in ϕ and decreasing in the partner's market share, for $\phi < 1$.

IV. Empirical strategy and results

In this section we empirically analyze the impact of MFN-related free-riding on MFN tariff rates. Our analysis focuses on the United States and is based on two data sets: the first one is a panel covering the years between 1989 and 1999; the second data set only includes information for the year 1983, but on a greater number of variables than the first one.

Here is our plan of attack. We first show that a preliminary examination of the data, in both periods, produces evidence consistent with the predictions of the model: a higher sector concentration, as measured by the Herfindahl index over export market shares, is associated with lower U.S. MFN tariff rates. However, these are only *correlation* patterns. We next worry about identification issues. We address them using an empirical specification which is closely related to the model predictions. In particular, our theoretical results point out that both domestic political-economy factors and MFN-related free riding affect MFN tariff rates. We need to control for the first set of variables, as they might be correlated with sector concentration and give rise to an omitted variable bias. Using the first data set, we account for domestic political-economy factors *indirectly*, by allowing the coefficient on the inverse import-penetration ratio to vary by industry.[18] When we use the second data set, which focuses on a single year (1983), we

[18] Industries are defined at a higher level of aggregation (3-digit ISIC codes) than sectors (4-digit ISIC codes). We use the terms sectors, products and goods interchangeably throughout this section: they all refer to 4-digit ISIC codes.

have access to a larger number of variables, for example political contributions by sector. This allows us to control *directly* for domestic political-economy factors.

To apply the theoretical model to the data, we assume that the tariff on each product k is the outcome of an independent negotiation. While it is fairly standard to assume a separable utility function, so as to obtain independence across optimal tariffs, our assumption also requires that countries make their participation decisions on a good-by-good basis. A second assumption is $\lambda^* = 0$, i.e., exporting governments care only about welfare. Given that the U.S. has FTA partners during the sample period, the relevant equation for the efficient tariff is (22). This equals 1 (free trade) if there is full participation, no domestic political pressure and negligible FTA share. Taking a first-order Taylor approximation of (22) around this point, and adding an error term, we obtain the following estimating equation:

$$\tau_k - 1 = \frac{1}{\xi_k^*}\left(1 - \Theta_{AR,k}\right) + \frac{\lambda_k}{\mu_k}\frac{X_k}{M_k} - \frac{1-\phi}{\mu_k}\Theta_{FTA,k} + \varepsilon_k . \tag{24}$$

The variables we directly observe in the data are, $\tau_k - 1$, X_k / M_k, and $\Theta_{FTA,k}$, which measure, respectively, the MFN tariff rate, the inverse import-penetration ratio, and imports from FTA partners as a share of total imports, in sector *k*. In addition, the 1983 dataset contains estimates of the elasticity of import demand[19] μ_k and domestic political contributions, which affect I_{Lk}, the latter being the variable component of Grossman and Helpman (1994) term, $\lambda_k = (I_{Lk} - \alpha_L)/(a + \alpha_L)$. We lack data on all other variables and thus treat them as parameters to be estimated.

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[19] Note that the import demand elasticity μ_k appears in equation (24) instead of the FTA-augmented elasticity found in (22). This is because our approximation occurs around the point of zero FTA share, where the two elasticities are the same.

To estimate the MFN free-rider effect, the key variable is $\Theta_{AR,k}$, which measures U.S. imports from participants in GATT/WTO negotiations with the U.S. over product *k* as a fraction of U.S. imports from all countries that are entitled to MFN treatment and are not U.S. FTA partners. Although we know the market share of each exporting country, we do not observe which countries participate in the negotiations over which good. Dealing with this problem was the ultimate purpose of Propositions 1 and 4. They tell us that we should focus on the Herfindahl index (for the entire market). Proposition 1 says that $\Theta_{AR,k} < 1$ if *H* is low enough, and $\Theta_{AR,k} = 1$ if it is high enough. Moreover, if the conditions of Theorem 4 are met, $\Theta_{AR,k}$ is a monotonically increasing function of *H*.

Thus, the main prediction of the model is that, controlling for domestic political-economy determinants and FTA market share, the MFN tariff rate is negatively affected by the Herfindahl index. We measure the Herfindahl index as,

$$H_k = \frac{\sum_{i \in GATT} M_{ik}^2}{\left(\sum_{i \in MFN} M_{ik}\right)^2} \tag{25}$$

where MFN is the set of all non-FTA countries that export product *k* to the U.S. and are granted MFN treatment by the U.S., while $GATT$ is the subset of MFN consisting of members of the GATT/WTO (and are therefore potential participants in the multilateral negotiations). M_{ik} is the value of U.S. imports of product *k* from country *i*. Thus the Herfindahl index so defined equals the sum of squared shares of exports to the U.S. over *all* potential (non-FTA) participants.

A. Results 1989 - 1999

Our first set of results is based on data for the years between 1989 and 1999 (excluding 1994, for which tariff data is not available in our data set). The period of time covered by the panel includes the final years of the Uruguay round – which took place in 1986-1994 – and its implementation period. We use the World Bank's Trade and Production Database (Nicita and Olarreaga 2001), which includes data on MFN tariffs, trade flows and production for 81 manufacturing industries at the 4-digit level of the International Standard Industrial Classification (ISIC Rev. 2).[20] We obtain information on GATT/WTO membership from Rose (2004) and on MFN treatment from the U.S. Harmonized Tariff Schedule.[21]

Table 1 presents summary statistics of the main variables used in the 1989-1999 analysis. The U.S. MFN tariff rate is characterized by a downward trend over the period, decreasing by 1.75 percentage points between 1989 and 1999.[22] Coinciding with this is a steady decline in the inverse import-penetration ratio. The Herfindahl index shows no clear pattern, except for an upward jump that occurs in 1995. The FTA share increases over the period and also jumps up in 1995. FTA countries include Israel and Canada for

[20] This dataset derives from several sources: the UNCTAD Trains, UN Comtrade, and UNIDO Industrial Statistics databases are the sources of MFN tariffs, trade flows and production data, respectively. Tariffs are MFN simple averages at the 4 digit level of the ISIC classification.

[21] From 1996 onwards, the only non-MFN countries were Afghanistan, Cuba, Laos, North Korea, Vietnam, Serbia and Montenegro. Before then, the US granted unconditional MFN to all countries, except Communist countries. Communist countries began receiving MFN treatment in the nineties.

[22] It might be surprising that the MFN tariff rate kept decreasing over time after the end of the Uruguay round. There are a few explanations for this pattern. The tariffs in the World Bank data set are applied rates (the tariffs importers actually pay) rather than bound rates (the tariff ceilings countries agree to). While bound rates remain fixed between negotiating rounds, applied rates can and do vary from year to year. Countries have discretion over applied tariffs below bound rates. The other major source of intertemporal variation in applied rates is the transition from one set of bound rates to another, in the years following the conclusion of a round (the Uruguay Round phase-in period was 1995-1999). In addition, countries exercise some discretion in whether tariff reductions negotiated in a round are implemented on schedule. Finally, another source of tariff changes are renegotiations that occur between rounds, as allowed by Article XXVIII, but these are not common.

the whole period (1989-1999), and Mexico from 1994.[23] Thus, the jumps are most likely due to Mexico being removed from the Herfindahl index and added to the FTA share after 1994, as removal of a country near the middle of the market share distribution generally increases the Herfindahl index.

A first pass through the data shows that, in 1993, the U.S. MFN tariff rate is indeed negatively related to the Herfindahl index (Figure 1). Every 10 percentage points difference in the Herfindahl index across sectors is associated, on average, with a 0.6 percentage points (negative) difference in the MFN tariff rate (significant at the 1% level, see Table 3).[24]

The previous result is robust to changes in the year considered, as shown in Tables 2 and 3, where we regress the U.S. MFN tariff rate on the Herfindahl index, year by year. We estimate a negative and significant coefficient on sector concentration for each year between 1989 and 1999. Given the importance of the European Community (EC) as a trading partner of the U.S., we check the robustness of our results to two alternatives. In Table 2 we consider each European country separately, while in Table 3 we think of the EC as constituting one negotiating block.[25] The results in the two tables are consistent with each other and with the theoretical predictions. Interestingly, the

[23] We use the strict definition of Article XXIV to determine FTA status. Countries that may have received preferential treatment through other means, such as the Generalized System of Preferences, are treated as MFN not FTA countries. We take this approach mainly because of the inconsistent coverage and conditional nature of these preferences.
[24] All our regressions (Tables 2 to 8) use robust standard errors to address heteroskedasticity. In Table 6 we also cluster standard errors by industry to account for correlation in the error term introduced by the 2-stage estimation procedure. Outliers (observations with tariffs higher than 50) are excluded from the analysis in Tables 2 to 6.
[25] When we consider the European-Community (EC) countries as one block, we take into account when each country joined the EC (date in parentheses): Belgium (1958), Luxembourg (1958), Netherlands (1958), Germany (1958), France (1958), Italy (1958), Denmark (1973), Ireland (1973), United Kingdom (1973), Cyprus (1973), Greece (1981), Portugal (1986), Spain (1986) were part of the EC in 1989; Austria, Finland, and Sweden joined it in 1995; Turkey joined it in 1996.

estimates in the regressions where European countries are considered separately are larger in absolute value.[26]

From (24) we expect FTA market share to have a negative effect on the MFN tariff rate. The intuition behind this result is that, the larger the export market share of FTA partners, the smaller the terms-of-trade gain for the U.S. from setting a high tariff (as the price of goods coming from FTA partners equals the domestic price) and, therefore, the lower the MFN tariff rate. We find evidence consistent with this prediction in the yearly regressions of Table 4.

In Tables 2, 3 and 4 the estimated effect of the Herfindahl index drops (in absolute value) after the end of the Uruguay round. In addition, for the same years, when we regress the MFN tariff rate on both the contemporaneous Herfindahl index and the 1993 Herfindahl index, we estimate a negative and significant coefficient on the latter variable and an insignificant coefficient on the former variable (results not shown). These results are consistent with our model, as the free-riding effect of the MFN clause is likely to be strongest at the time of multilateral negotiations.[27] In light of all this, in our preferred specifications (Tables 5 and 6) we focus on the end of the Uruguay round and estimate the impact of the Herfindahl index in 1993 on the average MFN tariff rates over the following years (1995-1999).

In Table 5, we introduce covariates that capture the effect of domestic political-economy determinants. Such factors have been analyzed both theoretically and

[26] One explanation of this result is that a related free-rider problem arises within the EC, as well. Therefore concentration of export market shares *within* the EC affects the EC's willingness to participate in multilateral negotiations over a product and to pay for a US tariff reduction.

[27] The free-riding effect of the MFN clause is likely to be strongest at the time of multilateral negotiations because, at that time, any shock to the Herfindhal index can affect the contemporaneous MFN tariff rate. If negotiators are forward-looking, after the end of the round, shocks to the Herfindhal index which are anticipated at the time of negotiations can affect the contemporaneous MFN tariff rate. This is not the case for unanticipated shocks (unless renegotiations take place).

empirically in the previous literature (Grossman and Helpman 1994 and 1995, Goldberg and Maggi 1999, and Gawande and Bandyopadhyay 2000) and their importance emerges in our model as well, as pointed out above. Due to lack of data on the degree of political organization (which affects λ_k) and on import-demand elasticities by sector μ_k, we employ industry dummy variables to proxy for them. In particular, we estimate the following specification:

$$\tau_{95-99,k} - 1 = \alpha + \beta \cdot H_{93,k} + \sum_l \eta_l \cdot I_l \frac{X_{93,k}}{M_{93,k}} + \nu \cdot \Theta_{FTA\ 93,k} + \varepsilon_k , \qquad (26)$$

where $\tau_{95-99,k} - 1$ is the average *ad-valorem* U.S. MFN tariff rate over the years 1995-1999, $\frac{X_{93,k}}{M_{93,k}}$ is the inverse import-penetration ratio in 1993 (ratio of domestic total output to imports), $\Theta_{FTA\ 93,k}$ is FTA countries' share of U.S. imports in 1993, k is the 4-digit ISIC code and l is the 3-digit ISIC code. The dummy variables corresponding to the 3-digit ISIC codes (I_l) capture the impact of each industry's political organization and import demand elasticity, which are assumed to be constant over time.[28]

We first account for domestic political-economy determinants. We find that, controlling for the interaction of the inverse import-penetration ratio with industry fixed effects, the correlation between the U.S. MFN tariff rate and the Herfindahl index is still negative and significant (at the 1% level). The impact of MFN-related free riding is even higher than without such controls (regressions (1)-(2)). According to column (2), Table 5, a 10 percentage points increase in the Herfindahl index decreases the MFN tariff rate by

[28] We use industry dummy variables rather than sector ones otherwise there would be no variation left to identify the impact of exporter concentration on MFN tariff rates. Notice, however, that other studies analyzing domestic political-economy determinants of tariffs also run the analysis of such factors at the 3-digit level (Goldberg and Maggi 1999, for example).

0.7 percentage points. We use the estimates from this specification to calculate the average – across sectors and time – percentage difference between the MFN tariff rate corresponding to the actual value of the Herfindahl index in each sector and the tariff rate corresponding to no free riding (Herfindahl index set equal to 1). We find that this average percentage difference equals 96% in 1993, i.e. absent free-riding due to the MFN clause tariff rates would be very close to zero.[29]

Regression (3) confirms our previous result on the *FTA share*, whose coefficient is estimated to be negative and significant (at the 10% level). The remaining specifications further test the robustness of our findings. In particular, our theory assumes that exporting countries reciprocate with transfers, while in practice countries exchange trade barrier concessions of various kinds. In such a world, it could be that the U.S. is more inclined to swap concessions with countries that represent a large market for U.S. exports (e.g., EU). One might be concerned that the goods principally supplied by such countries have high H_k, thus causing a negative correlation between H_k and τ_k unrelated to MFN. To address this, in column (4) we control for the share of U.S. total exports to the top five exporters of each good. This variable represents a measure of U.S. export dependence on the principal suppliers of each good the U.S. imports.[30] It turns out to have no effect on the coefficient of H_k.

Our theory focuses on the participation decisions of GATT/WTO countries. Non-GATT countries receiving MFN (e.g., China) are included in the denominator of $H_{93,k}$,

[29] Strictly speaking, the Herfindahl index doesn't have to be equal to 1 for no free riding at all to take place (it could be smaller than 1). Therefore our calculation might overstate the impact of MFN-related free riding.

[30] Bown (2004) uses essentially the same measure. He finds that the greater a country's export dependence on the principal suppliers of a given product, as measured by the share of its worldwide exports (of all products) sold to those suppliers, the less likely it is to implement protection (safeguards and safeguard-like measures) on that product.

because they enjoy the MFN externality (the terms-of-trade improvement from a reduction in the U.S. tariff) but are excluded from the numerator, because they are not potential participants. To address the possibility that *bilateral* negotiations with these countries might affect the U.S. MFN tariff, we include the non-GATT market share in regression (5). This also serves to check if non-GATT countries drive the results. They turn out to have no effect on the results at all.[31]

Up to now we have addressed the issue of endogeneity of exporter concentration by controlling for domestic political-economy determinants. However, the variation of the Herfindahl index may be endogenous for other reasons. For example, there could be a problem of reverse causality: a higher tariff rate may affect the export market structure in the sector, that is exporting countries' market shares may change as a consequence of the increase in the tariff.[32] To address this problem, we estimate the model using the following two variables as instruments for the Herfindahl index: Canada's Herfindahl index in 1993; and *RankHI*, which is the U.S. Herfindahl index constructed using, as import shares, the predicted values from a gravity model (with, as regressors, per capita GDP, population, distance and the rank of each country in world exports of each product). Regressions (5)-(8) show that our results are robust to instrumental variable regressions.

In Tables 2 to 5, the negative relationship between the MFN tariff rate and the Herfindahl index is estimated exploiting the cross-sectional variation in the two variables. On the other hand, the time variation in the data set is helpful to control for domestic

[31] This is true whether we include their market share separately, include them in the numerator of H_k, or exclude them entirely.
[32] Notice, however, that this is not true in our model, as the export market shares are independent of the world price.

political-economy determinants of MFN tariff rates, which are likely to change substantially year after year. We next estimate the model using a two-stage estimation procedure that allows us to account for both the ongoing effects of political pressure and the once-off effect of the Herfindahl index, between 1995 and 1999 (see footnotes 22 and 27). The regressions in Table 6 represent the second stage of this procedure. In the first stage the US MFN tariff rate is regressed on 4-digit sector-specific fixed effects and the interaction of industry dummy variables with the contemporaneous inverse import-penetration ratio (for the years between 1995 and 1999). In the second stage, the 4-digit sector-specific fixed effects are regressed on the 1993 Herfindhal index and the interaction of industry dummy variables with the average inverse import-penetration ratio in 1995-1999. Thus the dependent variable of the second stage represents time-invariant differences in MFN tariff rates across sectors, in 1995-1999, after netting out the impact of domestic political-economy determinants over time in the same period (see Appendix for details about the two-stage estimation procedure).

Weighted-least-squares (WLS) are employed in regressions (2)-(5), Table 6. Weights are constructed using the variance of the sector fixed effects from the first stage. WLS puts more weight on sectors with smaller variance of the estimated fixed effect.[33] Results from Table 6 are remarkably similar to our previous finding, in particular in terms of the sign and magnitude of the coefficient on sector concentration.

[33] We use the same estimation strategy as in the labor-economics literature on industry wage structure (for example, Pavcnik and Goldberg 2003).

B. Results 1983

We next focus on 1983 for which we have information on a range of additional variables. In particular we can use direct information on sectors' political organization status and import-demand elasticities (which were kindly provided by Gawande). We estimate the following model:

$$\tau_k - 1 = \alpha + \beta \cdot H_k + \gamma \cdot \frac{1}{\mu_k} \cdot \frac{X_k}{M_k} + \delta \cdot PO_k \cdot \frac{1}{\mu_k} \cdot \frac{X_k}{M_k} + \varepsilon_{tk} \tag{27}$$

where ($\tau_k - 1$) is the U.S. post-Tokyo round ad-valorem tariff and PO_k is a political-organization dummy for sector k, classified according to the 4-digit U.S. Standard Industrial Classification (SIC, 1972-based).[34] Notice that, as in the previous literature, we break down the parameter λ_k in formula (24) into two components, according to whether the sector is politically organized or not.[35] Table 7 presents the OLS estimates of this specification. We find that the relationship between the U.S. MFN tariff rate and the Herfindahl index is still negative, once we control directly for domestic political-economy determinants. This result is robust to using different measures of political organization (as in Gawande and Bandyopadhyay 2000 or as in Goldberg and Maggi 1999)[36] and to the inclusion of additional regressors (the direct effect of *Political Organization*; and tariffs and NTB on intermediate goods).[37]

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[34] The remaining variables are defined as above but refer to the year 1983. See Appendix 1 for a list of the variables used in the 1983 analysis, summary statistics and data sources.

[35] In other words, $\lambda_k = \gamma + \delta \cdot PO_k$, with $\gamma = -\alpha_L / (a + \alpha_L) < 0$, $\delta = 1/(a + \alpha_L) > 0$ and $\gamma + \delta > 0$.

[36] We use two different measures of Political organization. *GB Political Organization* is the same variable used in Gawande and Bandyopadhyay (2000), who consider as politically-organized those sectors where import penetration (from major partners) significantly explains the size of political contributions (see p.145 in Gawande and Bandyopadhyay 2000 for details). We construct *GM Political Organization* as in Goldberg and Maggi (1999), using information from their Table B1 (p.1153).

[37] Regressions (2) and (4) in Table 7 provide information on the relative importance of political-economy determinants vs. free-riding. The difference between the two R^2 measures (equal to 0.07) is the variance of

In Table 8, we follow Goldberg and Maggi (1999) in treating the import demand elasticity, the political-organization measure and the inverse import-penetration ratio as econometrically endogenous. We move the import demand elasticity to the left-hand side[38] and we use the same variables as in Goldberg and Maggi (1999) to construct instruments for PO_k and $\frac{X_k}{M_k}$ (using data kindly provided by Trefler). In particular, we model the inverse import-penetration ratio as in cross-commodity regressions[39] of trade flows, i.e. as a function of sector factor shares. As instruments for the political-organization dummy, we use variables employed in the political-economy literature as determinants of endogenous protection (Trefler 1993).[40] Following Goldberg and Maggi 1999), we use both sets of instruments for both variables. The list of instruments used is in Data Appendix 1.

As already pointed out, endogeneity of export concentration is an issue in the estimation of the impact of free-riding. Endogeneity of the Herfindahl index per se is not the only problem. While our estimates may be indicative of a causal negative impact of exporters' concentration on MFN tariff rates, the channel through which the effect is working may not be free riding. For example, a higher concentration of exporters in the

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tariffs, left unexplained by the political-economy determinants, which is explained by free-riding (Greene, 1997).

[38] Notice that, when we move the import demand elasticity to the left-hand side, the coefficient on the export share of free-riders in formula (24) will be a function of both μ_k and ξ_k, i.e. equal to $-\frac{dp^*}{p^*}/\frac{dp}{p}$.

[39] The term "cross-commodity regression" we borrow from Leamer and Levinsohn (1995, p. 1368). In cross-commodity regressions, trade flows by sector are regressed on sector factor intensities. The coefficients on factor intensities are expected to be consistent with the country's relative factor endowments, as predicted in the Heckscher-Ohlin model. This is not inconsistent with our model, which is based on a sector-specific framework, because the Heckscher-Ohlin model can be thought of as a long-run version of the sector-specific model, where in the long-run all factors are perfectly mobile within the economy (Trefler 1993).

[40] Notice that, for the political-organization dummy, in the first stage we specify a linear reduced-form equation. On the other hand, Goldberg and Maggi (1999) use a probit model.

U.S. market of product k may increase the incentive of those few foreign exporters to get organized and lobby directly the U.S. government or their own government (high λ^*) for lower protection. In that case, we would observe a lower tariff rate on that good, but it wouldn't be due to free riding.[41] In order to investigate these issues, we next estimate a model of U.S. nontariff barriers (NTBs). We focus on the same regressors we used to analyze MFN tariff rates.

It is reasonable to assume that tariff rates and NTBs share many common determinants. For example, NTBs are affected by the same domestic political-economy factors as MFN tariff rates (see Goldberg and Maggi 1999, and Gawande and Bandyopadhyay 2000, for analyses of endogenous protection that focus on NTBs). Foreign lobbying is likely to affect tariff and non-tariff import protection in a similar manner. One important difference is that, while in theory NTBs too are subject to the MFN clause - according to Article I of GATT/WTO - in practice NTBs constitute one of the most common departures from nondiscrimination.[42] Thus, loosely speaking, NTBs represent a counterfactual of the level of protection of MFN tariff rates, absent the effect of free riding through the most-favored nation clause. Along the same lines, the coefficient estimates in the NTB equation represent the effect of the various factors on

[41] The Herfindahl index of export shares is likely to be positively correlated with a measure of domestic (firm) concentration in the importing country, which, in turn, positively affects whether the sector is politically organized at home (λ). Since higher domestic firm concentration in the importing country implies a higher level of protection (Bombardini 2005), our coefficient estimate on the Herfindahl index is biased towards zero through this channel, which reinforces our results. In a similar vein, strategic trade policy considerations would suggest tariffs should be higher in sectors where firm concentration is high both at home and abroad. Again this reinforces our results. We thank Ralph Winter and Jim Brander for pointing this out.

[42] NTBs include anti-dumping duties, countervailing duties, country-specific quotas, VERs and a host of other discriminatory policies. Jackson notes that: "Quantitative restrictions often pose an important conceptual challenge to the MFN principle... In a similar context, the explosion of the use of export-restraint arrangements in world trade provided one of the most significant recent challenges to the MFN principle of GATT." (p. 164, 1997)

import barriers, absent MFN-related free riding. According to this argument, we expect exporter concentration to have a different effect on NTBs, relative to what we found for MFN tariff rates. Figures 3 and 4 offer preliminary evidence consistent with this intuition. Using the 1983 data, the correlation between the Herfindahl index and the MFN tariff rate is negative (as it was in 1989-1999), while NTBs appear to be positively related to exporter concentration. Column (4) in Table 8 confirms this result using regression analysis (IV estimation). The impact of exporter concentration on NTBs is positive and insignificant, using the same instruments as in regression (3) for, respectively, the inverse import penetration ratio and the political organization dummy.[43]

To conclude, we believe we found evidence that the negative relationship between sector concentration and MFN tariff rates is indeed related to the effect of free riding due to the most-favored-nation clause.

V. Conclusion

The theory presented in this paper makes basically two assertions. The first is that there should be a negative relationship between the tariff in an industry and the market share of the countries participating in negotiations over that tariff. The intuition is that the larger is this share, the greater is the share of the benefit from tariff reduction that is internalized by the negotiators. This is the most basic aspect of the MFN free-rider problem. The second assertion is that the market share of participants increases with the degree of concentration of the exporters in the industry. This stems from the fact that our optimal mechanism assigns participants according a principal supplier rule. Together

[43] As in the previous literature (Goldberg and Maggi 1999, Gawande and Bandyopadhyay 2000), domestic political-economy determinants affect NTBs as predicted by Grossman and Helpman's (1994) model, though the significance level of the estimates depends on the particular specification used.

these assertions produce a negative relationship between the tariff and the degree of concentration, which we find to be quite robust in the data.

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Appendix

Proof of Proposition 1:

Suppose $\tilde{\tau}$ is feasible under PSR, and let *B* be the PSR set such that $\tilde{\tau} = \tau^e(B)$. For *B* to be an equilibrium set of participants, we need that,

$$\sum_{i \in B} w_i(\tilde{\tau}) - w_i(\tau^e(B \setminus i)) \geq \sum_{i \in \tilde{A}} w_i(\tilde{\tau}) - w_i(\tau^e(\tilde{A} \setminus i))$$

or

$$\sum_{i \in B} \int_{\tilde{\tau}}^{\tau^e(B \setminus i)} \theta_i w'(\tau) d\tau \geq \sum_{i \in \tilde{A}} \int_{\tilde{\tau}}^{\tau^e(\tilde{A} \setminus i)} \theta_i w'(\tau) d\tau$$

The left-hand side of this inequality can be written as,

$$\sum_{i \in B \setminus \hat{i}} \int_{\tau^e(B \setminus \hat{i})}^{\tau^e(B \setminus i)} \theta_i w'(\tau) d\tau + \int_{\tilde{\tau}}^{\tau^e(B \setminus \hat{i})} \Theta_B w'(\tau) d\tau,$$

while the right-hand side is strictly less than,

$$\sum_{i \ni \theta_i > \theta_{\hat{i}}} \int_{\tau^e(B \setminus \hat{i})}^{\tau^e(\tilde{A} \setminus i)} \theta_i w'(\tau) d\tau + \int_{\tilde{\tau}}^{\tau^e(B \setminus \hat{i})} \Theta_{\tilde{A}} w'(\tau) d\tau.$$

This last point follows from fact that $\tilde{A}$ must contain elements with smaller market share than that of the critical exporter in *B*. Now given that $\Theta_B = \Theta_{\tilde{A}}$ by definition, a sufficient condition for *B* to be an equilibrium set is,

$$\sum_{i \in B \setminus \hat{i}} \int_{\tau^e(B \setminus \hat{i})}^{\tau^e(B \setminus i)} \theta_i w'(\tau) d\tau \geq \sum_{i \ni \theta_i > \theta_{\hat{i}}} \int_{\tau^e(B \setminus \hat{i})}^{\tau^e(\tilde{A} \setminus i)} \theta_i w'(\tau) d\tau$$

This must hold, because *B* contains all exporters such that $\theta_i > \theta_{\hat{i}}$, while $\tilde{A}$ does not. Now considering that *B* is a PSR equilibrium set, and $\hat{\tau}$ is the minimum implementable PSR tariff, it must be that $\tilde{\tau} = \tau^e(B) \geq \hat{\tau}$. But if $\tilde{\tau} > \hat{\tau}$, then $\tilde{\tau}$ is not the minimum implementable tariff, which is a contradiction. Hence, $\tilde{\tau} = \hat{\tau}$.

If $\tilde{\tau}$ is not feasible under PSR, then it must lie strictly between two PSR tariffs. Let *C* and *D* denote, respectively, the largest and smallest PSR sets such that $\tau^e(C) > \tilde{\tau} > \tau^e(D)$. Now consider a hypothetical country *k* such that $\theta_k = \Theta_{\tilde{A}} - \Theta_C$. It is straightforward that $\Omega(\tilde{A}) - \Omega(C) < \Omega(C \cup k) - \Omega(C)$. Convexity implies,

$$[\Omega(C \cup k) - \Omega(C)]\theta_{\hat{i}_D} \leq [\Omega(D) - \Omega(C)]\theta_k$$

or

$$\Omega(\tilde{A}) < \Omega(C \cup k) \leq (\theta_k / \theta_{\hat{i}_D})\Omega(D) + (1 - \theta_k / \theta_{\hat{i}_D})\Omega(C)$$

By definition $\Omega(\tilde{A}) \geq 0$, $\Omega(D) < 0$ and $0 < \theta_k / \theta_{\hat{i}_D} < 1$. Thus, $\Omega(C) > 0$. But this means that $C = \hat{A}$ and $D = \hat{A}^+$, so $\hat{\tau} > \tilde{\tau} > \hat{\tau}^+$. Finally, $\tilde{\tau} \to \hat{\tau}$ follows from the fact that $\hat{\tau}^+ \to \hat{\tau}$ as $\theta_{\hat{i}^+} \to 0$. QED

Proof of Proposition 4:

Let $\hat{x}_0$ be optimal value of x under f_0, and suppose there exists x' such that $F_1(x') = F_0(\hat{x}_0)$. If we can show that $\hat{x}_1 < x'$, then we will have proven that the equilibrium market share of participants is higher, and the tariff is lower, under f_0 than under f_1. We show $\hat{x}_1 < x'$ by establishing that at x' the participation constraint (16) is violated. Since the efficient tariff is at x' under f_1 is the same as at $\hat{x}_0$ under f_0 by construction, we need only show that, $h_1(x') < h_0(\hat{x}_0)$. This condition can be written as,

$$h_1(\hat{x}_0) + \sum_{\hat{x}_0}^{x'} f_1(z)^2 < h_0(\hat{x}_0)$$

We can write,

$$\sum_{\hat{x}_0}^{x'} f_1(z)^2 \leq f_1(\hat{x}_0)\sum_{\hat{x}_0}^{x'} f_1(z)$$

which follows from the fact that f_1 is decreasing (as we have ordered the countries in descending order of market share). Similarly, $F_1(x') = F_0(\hat{x}_0)$ can be written as, $F_1(\hat{x}_0) + \sum_{\hat{x}_0}^{x'} f_1(z) = F_0(\hat{x}_0)$. Combining these equations, a sufficient condition for $\hat{x}_1 < x'$ becomes,

$$\sum_{z=1}^{\hat{x}_0}[f_0(z)^2 - f_1(z)^2] - f_1(\hat{x}_0)[F_0(\hat{x}_0) - F_1(\hat{x}_0)] > 0$$

This condition can be re-written as,

$$\sum_{z=1}^{\hat{x}_0}[f_0(z)^2 - f_1(z)^2] - f_1(\hat{x}_0)[F_0(\hat{x}_0) - F_1(\hat{x}_0)]$$

$$= f_0(\hat{x}_0)[F_0(\hat{x}_0) - F_1(\hat{x}_0)] + \sum_{z=1}^{\hat{x}_0 - 1}[f_0(z) + f_1(z) - f_0(z+1) - f_1(z+1)][F_0(z) - F_1(z)] > 0$$

which must hold, because f_1 and f_0 are decreasing in z, and $F_0(z) - F_1(z) > 0$ for all z.

The final part of the Proposition 4 is that $H_0 > H_1$. This follows from the same decomposition we used above, namely,

$$H_0 - H_1 = \left[f_0(N) + f_1(N)\right][F_0(N) - F_1(N)]$$
$$+\sum_{z=1}^{N-1}[f_0(z) + f_1(z) - f_0(z+1) - f_1(z+1)][F_0(z) - F_1(z)] > 0$$

QED

Two-Stage Procedure

In Table 6 we estimate the model using a two-stage estimation procedure which allows us to account for the impact of domestic political-economy determinants *over time* between 1995 and 1999. We are interested in estimating the model:

$$\delta_k = \alpha + \beta \cdot H_{93,k} + \sum_l \gamma_l \cdot I_l \frac{X_{9599,k}}{M_{9599,k}} + \varepsilon_k , \quad \varepsilon_k \sim N(0,\sigma^2)$$

where $X_{9599,k} / M_{9599,k}$ is the average inverse import-penetration ratio in 1995-1999 (recall that k is the 4-digit ISIC code, while l is the 3-digit ISIC code). δ_k is a time-invariant component of the MFN tariff rate for each sector k over the period 1995-1999 after netting out the within variation of domestic political-economy determinants over the same period, as illustrated by the following model:

$$\textit{first stage}: \ \tau_{tk} - 1 = \sum_k \delta_k \cdot I_k + \sum_l \eta_l \cdot I_l \frac{X_{tk}}{M_{tk}} + v_{tk} , \ v_{tk} \sim N(0,1), \ t \geq 1995$$

where X_{tk} / M_{tk} is the inverse import-penetration ratio at year t. Since δ_k is unobserved, we use the estimated coefficients $\hat{\delta}_k = \delta_k + \eta_k$ from the first stage in the following second stage regression:

$$\textit{second stage}: \ \hat{\delta}_k = \alpha + \beta \cdot H_{93,k} + \sum_l \gamma_l \cdot I_l \frac{X_{9599,k}}{M_{9599,k}} + \varepsilon_k + \eta_k , \quad \eta_k \sim N(0,\sigma_k^2)$$

In this regression, σ_k is the standard error of the $\hat{\delta}_k$ from the first stage. We assume that ε and η are uncorrelated.

In the above two-stage model, the dependent variable of the second stage ($\hat{\delta}_k$) is a generated regressand based on the first stage. Generated regressands are analogous to dependent variables characterized by measurement error, as they cannot be directly observed. Assuming that the measurement error in the dependent variable (η) is statistically independent of the explanatory variables ($H_{93,k}$ and $X_{9599,k} / M_{9599,k}$), the OLS estimators of the coefficients ($\hat{\alpha}^{OLS}$, $\hat{\beta}^{OLS}$, $\hat{\gamma}_l^{OLS}$) are consistent. However, the disturbance variance ($\sigma^2 + \sigma_k^2$) is higher than if we could observe the dependent variable without error (σ^2). In our case the disturbance variance is also not constant across observations, since the standard error varies across delta hats: thus the second-stage regression is characterized by heteroskedasticity (Greene, 1997, Ch.12; Wooldridge, 2002, Ch.4). In addition, the specification of the first-stage regression implies that the $\hat{\delta}_k$ are, by construction, correlated within each 3-digit ISIC code. This implies that the second stage is characterized by both heteroskedasticity and correlation in the error term.

One way to deal with this is to account for a general form of heteroskedasticity and correlation in the error term of the second stage by computing robust (Huber-White) standard errors clustered by 3-digit ISIC product code (regression (1), Table 6).

An alternative is to make use of the information available from the first stage, that is the standard errors of the delta hats. In regressions (2)-(5), Table 6, we employ weighted least squares (WLS) using as weights the square root of the inverse of (one plus) the variance of the delta hats from the first stage. (We still cluster standard errors by 3-digit ISIC product code to address correlation in the error term.) WLS puts more weight on sectors with smaller variance of the estimated fixed effect (Goldberg and Pavcnik 2003).[44]

The reason for these weights is as follows. Given the form of heteroskedasticity assumed in our two-stage model, the ideal weight is $\sqrt{\kappa^2/(\sigma^2+\sigma_k^2)}$, where κ is any constant. Given such weights, the variance of the error term in the weighted version of the second-stage regression model is constant across observations and equal to κ^2 (we can therefore use OLS to estimate the weighted regression model):

$$Var\left[(\varepsilon_k+\eta_k)\sqrt{\kappa^2/(\sigma^2+\sigma_k^2)}\right]=(\sigma^2+\sigma_k^2)\left[\kappa^2/(\sigma^2+\sigma_k^2)\right]=\kappa^2$$

Since we lack an estimate of σ, in regressions (2)-(5), Table 6, we set σ=1. We also tested the robustness of our results using as weights $\sqrt{1/(n+\sigma_k^2)}$, for different values of $n\geq 1$.

[44] We also apply Feenstra and Hanson's (1999) procedure but estimate a negative value for σ^2.

Table 1: Summary Statistics of variables from World Bank's Trade and Production Database(1989-1999)

year		N	mean	sd	min	max
1989	US MFN tariff rate	78	5.2345	3.0526	0.0000	14.2400
	Herfindhal index	78	0.2289	0.1537	0.0054	0.8867
	inverse import penetration ratio	75	18.7852	29.7961	0.6439	155.2061
	FTA share	78	0.1714	0.1687	0.0001	0.8220
1990	US MFN tariff rate	78	5.2331	3.0517	0.0000	14.2000
	Herfindhal index	78	0.2311	0.1523	0.0042	0.8733
	inverse import penetration ratio	75	18.1935	27.5926	0.5613	132.3461
	FTA share	78	0.1773	0.1742	0.0021	0.8313
1991	US MFN tariff rate	78	5.2290	3.0449	0.0000	14.2000
	Herfindhal index	78	0.2245	0.1506	0.0060	0.8464
	inverse import penetration ratio	75	17.8491	26.2337	0.5155	123.7547
	FTA share	78	0.1857	0.1756	0.0022	0.8398
1992	US MFN tariff rate	78	5.2279	3.0450	0.0000	14.2000
	Herfindhal index	78	0.2252	0.1551	0.0089	0.8300
	inverse import penetration ratio	75	16.8394	24.2814	0.3310	107.2883
	FTA share	78	0.1895	0.1735	0.0028	0.8263
1993	US MFN tariff rate	78	5.2290	3.0470	0.0000	14.2000
	Herfindhal index	78	0.2191	0.1538	0.0194	0.7911
	inverse import penetration ratio	75	16.2299	23.2409	0.3020	103.9189
	FTA share	78	0.1974	0.1774	0.0054	0.7993
1995	US MFN tariff rate	78	4.7909	2.9900	0.0000	13.8400
	Herfindhal index	78	0.2412	0.1701	0.0157	0.7774
	inverse import penetration ratio	75	13.5984	18.6294	0.2690	78.6234
	FTA share	78	0.2699	0.1807	0.0026	0.8003
1996	US MFN tariff rate	78	4.4891	2.9604	0.0000	13.4500
	Herfindhal index	78	0.2409	0.1693	0.0185	0.7208
	inverse import penetration ratio	75	12.4548	15.5014	0.2700	61.3738
	FTA share	78	0.2884	0.1848	0.0038	0.8250
1997	US MFN tariff rate	80	4.5218	3.6204	0.0100	22.9200
	Herfindhal index	80	0.2525	0.1902	0.0078	0.8303
	inverse import penetration ratio	77	11.9353	14.6745	0.2472	62.9745
	FTA share	80	0.2930	0.1798	0.0041	0.8209
1998	US MFN tariff rate	78	3.8331	2.8837	0.0000	12.7800
	Herfindhal index	78	0.2310	0.1676	0.0072	0.6894
	inverse import penetration ratio	75	11.5272	14.2693	0.2050	60.3533
	FTA share	78	0.2951	0.1789	0.0047	0.8055
1999	US MFN tariff rate	78	3.4862	2.8742	0.0000	12.6700
	Herfindhal index	78	0.2092	0.1540	0.0079	0.6864
	inverse import penetration ratio	0	.	.	.	.
	FTA share	78	0.2956	0.1750	0.0138	0.8007
Total	US MFN tariff rate	782	4.7269	3.1075	0.0000	22.9200
	Herfindhal index	782	0.2304	0.1617	0.0042	0.8867
	inverse import penetration ratio	677	15.2582	22.3108	0.2050	155.2061
	FTA share	782	0.2365	0.1837	0.0001	0.8398

Outliers (US MFN tariff rates higher than 50) are excluded. *US MFN tariff rates* (in percentage points) are simple averages at the 4 digit level ISIC. For each sector, the *Herfindhal index* equals the sum of squared import shares from each exporting country to the US. The *Herfindhal index* is calculated excluding countries which are part of a preferential trade agreement with the US - Israel and Canada since 1989, Mexico since 1994 - and excluding countries without MFN treatment. Countries which do not belong to the WTO but receive MFN treatment by the US (such as Russia (from 1992) and China) are included in the denominator of the *Herfindhal index*, but not in the numerator. The *inverse import penetration ratio* equals the ratio of output value to imports in each sector. The F*TA Share* gives the overall import share (by sector) from countries which are part of a preferential trade agreement with the US (Israel and Canada since 1989, Mexico since 1994).

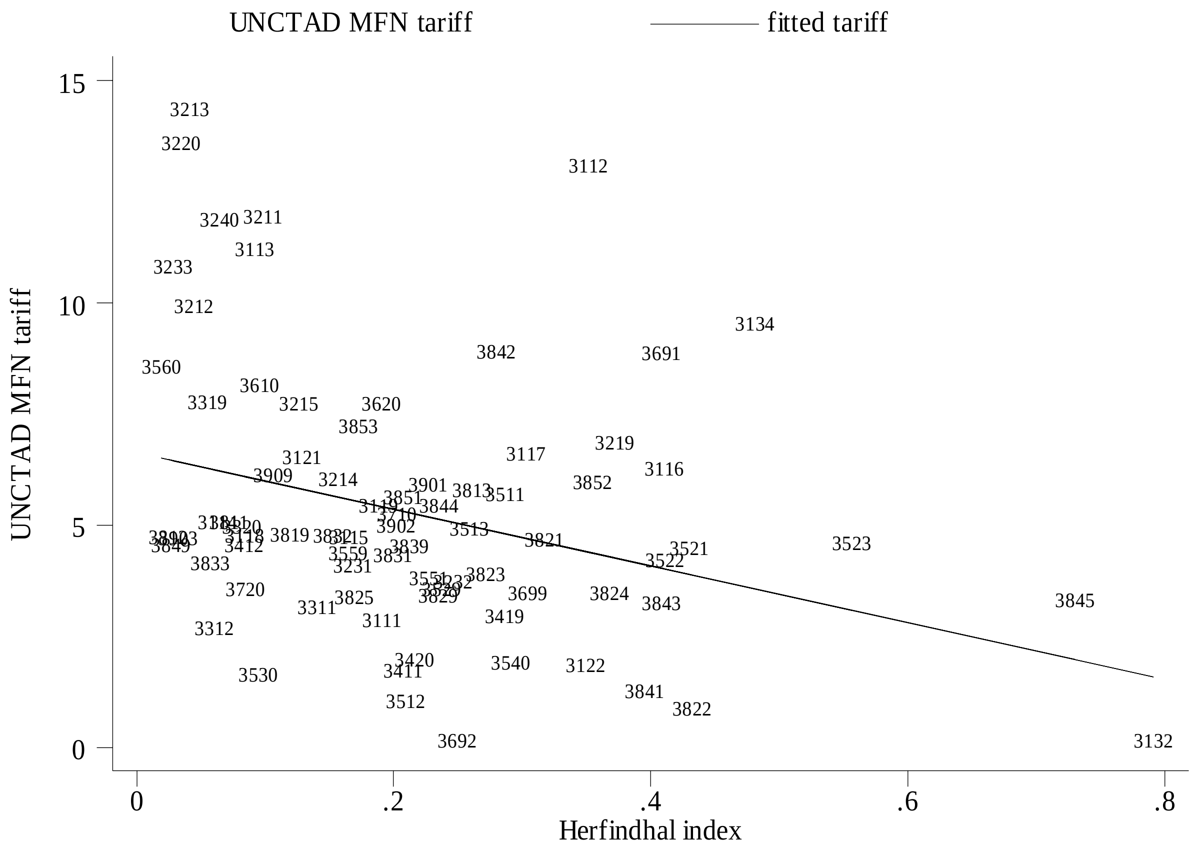

Figure 1. Correlation between MFN tariffs and Herfindhal index, 1993 (see Table 3)
data source: World Bank's Trade and Production Database

Table 2: Free-riding and the US MFN tariff rates (each country in the EC treated as a separate negotiating party)

	1	2	3	4	5	6	7	8	9	10
	1989	**1990**	**1991**	**1992**	**1993**	**1995**	**1996**	**1997**	**1998**	**1999**
					Dependent variable: US MFN tariff rate					
Herfindhal index	-8.44	-8.9	-11.14	-11.94	-11.49	-9.08	-9.55	-9.76	-8.27	-9.53
	4.09*	4.36*	3.94**	3.99**	4.10**	3.91*	4.21*	3.49**	4.31+	4.32*
Constant	6.36	6.4	6.69	6.77	6.7	5.92	5.6	5.69	4.74	4.5
	0.70**	0.71**	0.67**	0.67**	0.68**	0.66**	0.66**	0.69**	0.64**	0.65**
Observations	78	78	78	78	78	78	78	80	78	78
R-squared	0.05	0.05	0.09	0.11	0.11	0.07	0.07	0.05	0.05	0.06

Robust standard errors under each estimated coefficient.

+ significant at 10%; * significant at 5%; ** significant at 1%

Outliers (US MFN tariff rates higher than 50) are excluded. The *US MFN tariff rate* is expressed in percentage points.

See definitions of variables at the end of Table 1.

Table 3: Free-riding and the US MFN tariff rates (EC treated as a negotiating block)

	1	2	3	4	5	6	7	8	9	10
	1989	**1990**	**1991**	**1992**	**1993**	**1995**	**1996**	**1997**	**1998**	**1999**
					Dependent variable: US MFN tariff rate					
Herfindhal index	-5.36	-5.76	-6.28	-6.17	-6.36	-4.72	-4.66	-4.25	-4.64	-4.64
	2.07*	2.12**	2.09**	2.15**	2.18**	2.12*	2.11*	1.84*	1.99*	2.15*
Constant	6.46	6.56	6.64	6.62	6.62	5.93	5.61	5.6	4.9	4.46
	0.64**	0.64**	0.63**	0.62**	0.62**	0.64**	0.64**	0.61**	0.61**	0.60**
Observations	78	78	78	78	78	78	78	80	78	78
R-squared	0.07	0.08	0.1	0.1	0.1	0.07	0.07	0.05	0.07	0.06

Robust standard errors under each estimated coefficient.

+ significant at 10%; * significant at 5%; ** significant at 1%

Outliers (US MFN tariff rates higher than 50) are excluded. The *US MFN tariff rate* is expressed in percentage points.

See definitions of variables at the end of Table 1.

EC countries are considered as one block (taking into account when each country joined the EC – date in parentheses): Belgium (1958), Luxembourg (1958), Netherlands (1958), Germany (1958), France (1958), Italy (1958), Denmark (1973), Ireland (1973), United Kingdom (1973), Cyprus (1973), Greece (1981), Portugal (1986), Spain (1986) were part of the EC in 1989; (Andorra joined it in 1991;) Austria, Finland, and Sweden joined it in 1995; Turkey joined it in 1996.

Table 4: Free-riding and the US MFN tariff rates, given US participation in FTAs (EU treated as a negotiating block)

	1	2	3	4	5	6	7	8	9	10
	1989	**1990**	**1991**	**1992**	**1993**	**1995**	**1996**	**1997**	**1998**	**1999**
	Dependent variable: US MFN tariff rate									
Herfindhal index	-4.94	-5.06	-5.34	-5.08	-5.36	-3.89	-3.83	-3.37	-4.3	-4.43
	2.13*	2.19*	2.16*	2.21*	2.22*	2.27+	2.23+	1.95+	2.03*	2.19*
FTA share	-5.86	-5.58	-4.96	-5.42	-5.34	-3.62	-3.43	-4.22	-2.01	-1.83
	2.41*	2.18*	2.05*	1.80**	1.94**	1.97+	1.87+	2.33+	1.78	1.78
Constant	7.37	7.39	7.35	7.4	7.46	6.71	6.4	6.61	5.42	4.95
	0.79**	0.75**	0.74**	0.73**	0.73**	0.78**	0.80**	0.92**	0.82**	0.85**
Observations	78	78	78	78	78	78	78	80	78	78
R-squared	0.18	0.18	0.18	0.19	0.2	0.12	0.11	0.09	0.09	0.07

Robust standard errors under each estimated coefficient.
+ significant at 10%; * significant at 5%; ** significant at 1%
Outliers (US MFN tariff rates higher than 50) are excluded. The *US MFN tariff rate* is expressed in percentage points.
See definitions of variables at the end of Table 1.

EC countries are considered as one block (taking into account when each country joined the EC – date in parentheses): Belgium (1958), Luxembourg (1958), Netherlands (1958), Germany (1958), France (1958), Italy (1958), Denmark (1973), Ireland (1973), United Kingdom (1973), Cyprus (1973), Greece (1981), Portugal (1986), Spain (1986) were part of the EC in 1989; (Andorra joined it in 1991;) Austria, Finland, and Sweden joined it in 1995; Turkey joined it in 1996.

Table 5: The impact of free-riding on US MFN tariff rates, *cross-sectional regressions* (1995-1999)

	1	2	3	4	5	6	7	8	9
	Dependent variable: average US MFN tariff rate (1995-1999)								
Method	**OLS**	**OLS**	**OLS**	**OLS**	**OLS**	**IV**	**IV**	**IV**	**IV**
Herfindhal index (1993)	**-5.92**	**-7.45**	**-7.78**	**-7.47**	**-8.25**	**-7.4**	**-6.77**	**-7.59**	**-7.24**
	1.99**	**2.71****	**2.73****	**2.70****	**3.08***	**3.51***	**3.66+**	**3.89+**	**3.87+**
FTA share (1993)			-4.5				-4.46		-4.48
			2.62+				2.62+		2.62+
Share of US exports to top 5 exporters (1993)				0.21					
				4.74					
non-GATT market share (1993)					-1.5				
					3.37				
Constant	5.53	5.94	6.62	5.86	6.36	5.92	6.41	5.96	6.51
	0.59**	1.08**	1.15**	2.18*	1.46**	1.18**	1.26**	1.26**	1.31**
inverse import penetration ratio (1993)*ISIC3 DV	no	yes	yes	yes	yes	yes	yes	yes	yes
Observations	78	75	75	75	75	75	75	75	75
R-squared	0.09	0.55	0.59	0.55	0.55	0.55	0.59	0.55	0.59

Robust standard errors under each estimated coefficient. + significant at 10%; * significant at 5%; ** significant at 1%
Outliers, that is US MFN tariff rates higher than 50, are dropped. The *US MFN tariff rate* is expressed in percentage points.
The *Share of US exports to top 5 exporters* is equal to the fraction of total US exports going to the principal suppliers of each product.
The *non-GATT market share* is the export share of countries which receive MFN treatment but are not GATT/WTO members, as a fraction of total imports of countries which receive MFN treatment. See definitions of remaining variables at the end of Table 1.
EC countries are considered as one block (taking into account when each country joined the EC – date in parentheses): Belgium (1958), Luxembourg (1958), Netherlands (1958), Germany (1958), France (1958), Italy (1958), Denmark (1973), Ireland (1973), United Kingdom (1973), Cyprus (1973), Greece (1981), Portugal (1986), Spain (1986) were part of the EC in 1989; (Andorra joined it in 1991;) Austria, Finland, and Sweden joined it in 1995; Turkey joined it in 1996.
The instrument in regressions (6)-(7) is Canada's Herfindhal index (1993). The instruments in regressions (8)-(9) are Canada's Herfindhal index (1993) and RankHI (1993), which is the U.S. Herfindahl index in 1993 constructed using, as import shares, the predicted values from a gravity model (with, as regressors, per capita GDP, population, distance and the rank of each country in world exports of each product).

Table 6: The impact of free-riding on US MFN tariff rates, *two-stage procedure* (1995-1999)

	1	2	3	4	5	6
	Dependent variable: US MFN tariff rate (1995-1999)					
Method	**OLS**	**WLS**	**WLS**	**WLS**	**WLS**	**WLS**
Herfindhal index (1993)	**-7.01**	**-7.39**	**-7.96**	**-7.6**	**-7.41**	**-7.99**
	2.92*	**3.54***	**3.59***	**3.37***	**3.62+**	**3.60***
FTA share (1993)				-3.3		
				4.12		
Share of US exports to Top 5 Exporters (1993)					1.54	
					7	
non-GATT market share (1993)						-1.04
						3.31
Constant	6.05	5.94	5.93	6.49	5.38	6.25
	1.22**	1.52**	1.53**	1.74**	3.59	1.73**
inverse import-penetration ratio (1995-1999)*ISIC3	yes	yes	no	yes	yes	yes
inverse import-penetration ratio (1993)*ISIC3	no	no	yes	no	no	no
Observations	75	75	75	75	75	75
R-squared	0.94	0.63	0.62	0.65	0.63	0.63

Standard errors, clustered by 3 digit ISIC code, are presented under each estimated coefficient. + significant at 10%; * significant at 5%; ** significant at 1%
Outliers, that is US MFN tariff rates higher than 50, are dropped. The *US MFN tariff rate* is expressed in percentage points.
The *Share of US exports to top 5 exporters* is equal to the fraction of total US exports going to the principal suppliers of each product. The *non-GATT market share* is export share of countries which receive MFN treatment but are not GATT/WTO members, as a fraction of total imports of countries which receive MFN
See definitions of remaining variables at the end of Table 1.
EC countries are considered as one block (taking into account when each country joined the EC – date in parentheses): Belgium (1958), Luxembourg (1958), Netherlands (1958), Germany (1958), France (1958), Italy (1958), Denmark (1973), Ireland (1973), United Kingdom (1973), Cyprus (1973), Greece (1981), Portugal (1986), Spain (1986) were part of the EC in 1989; (Andorra joined it in 1991); Austria, Finland, and Sweden joined it in 1995; Turkey joined it in 1996.
Regressions (1)-(6) represent the second stage of a two-stage estimation procedure. In the first stage the US MFN tariff rate is regresssed on 4-digit sector-specific fixed effects and the interaction of 3-digit sector dummy variables with the contemporaneous inverse import-penetration ratio (for the years between 1995 and 1999). In the second stage (regressions in this Table) the 4-digit sector-specific fixed effects are regressed on the 1993 Herfindhal index (plus other controls) and the interaction of 3-digit sector dummy variables with the inverse import-penetration ratio. Weighted-least-squares (WLS) are employed in regressions (2)-(5), using as weights the square root of the inverse of (one plus) the variance of the sector fixed effects from the first stage. WLS puts more weight on sectors with smaller variance of the estimated fixed effect.

Table 7: Free-riding and the US MFN tariff rates, controlling for domestic political-economy determinants (1983)

	1	2	3	4	5	6	7	8
OLS	**Dependent variable: US post-Tokyo round ad valorem tariff**							
Herfindhal index	**-8.95**			**-8.46**	**-4.06**	**-8.68**	**-8.83**	**-7.52**
	1.59**			**1.59****	**1.14****	**1.61****	**1.59****	**1.47****
(inverse import penetration ratio)/elasticity		-97.6	-65.75	-70.72	-53.66	-42.04	-125.23	-85.48
		28.78**	14.86**	28.30*	14.98**	19.46*	62.49*	21.38**
(inverse import penetration ratio)/elasticity* GB Political Organization		86.74	53.3	62.31	42.4	32.13		76.69
		28.50**	14.85**	28.18*	14.86**	19.65		21.26**
(inverse import penetration ratio)/elasticity* GM Political Organization							115.89	
							62.29+	
GB Political Organization						1.57		
						0.69*		
intermediate goods' tariffs			1.06		1.02			
			0.11**		0.11**			
intermediate goods' NTB			-0.01		-0.02			
			0.02		0.02			
Share of US exports to Top 5 Exporters (1993)								-13.48
								4.16**
Constant	8.83	6.67	0.44	8.86	1.82	7.81	8.95	14.91
	0.64**	0.39**	0.63	0.65**	0.80*	0.63**	0.65**	2.16**
Observations	242	242	242	242	242	242	242	242
R-squared	0.08	0.02	0.42	0.09	0.44	0.11	0.09	0.15

Robust standard errors under each estimated coefficient
+ significant at 10%; * significant at 5%; ** significant at 1%
EC countries are considered as one block (taking into account when each joined the EC – date in parentheses): Belgium (1958), Netherlands (1958), Germany (1958), France (1958), Italy (1958), Luxembourg (1958), Denmark (1973), Ireland (1973), United Kingdom (1973), Cyprus (1973), Greece (1981), were part of the EC in 1983.
The US post-Tokyo round ad valorem tariff is expressed in percentage points.
The *inverse import penetration ratio* equals the gross output to import ratio. The *elasticity* equals the absolute value of the import demand elasticity (after correcting for measurement errors). The *Political Organization* variable is a dummy variable equal to 1 if the industry is politically organized, 0 otherwise (GB stands for Gawande and Bandyopadhyay; GM stands for Goldberg and Maggi).
The *Share of US exports to top 5 exporters* is equal to the fraction of total US exports going to the principal suppliers of each product.

Table 8: Free-riding and the US MFN tariff rates, controlling for domestic political-economy determinants (1983)

	1	2	3	4	5
Method	**OLS**	**OLS**	**IV**	**Tobit IV**	**IV**
Dependent variable:	**(US ad valorem tariff)*elasticity**				**(US NTB)*elasticity**
Herfindhal index		**-15.12**	**-9.04**	**-9.02**	**19.44**
		2.82**	**2.05****	**2.38****	**19.16**
inverse import penetration ratio	-105.17	-73.14	-142.99	-317.75	-154.6
	35.50**	34.10*	117.8	120.61**	373.52
inverse import penetration ratio*GB Political Organization	91.85	63.25	126.35	296.38	63.36
	35.13**	34.01+	124.65	125.25*	418.54
Constant	10.28	14.2	11.45	11.65	10.89
	0.67**	1.17**	0.96**	0.80**	5.38*
Observations	242	242	194	194	194
R-squared	0.02	0.1	0.06		

Robust standard errors under each estimated coefficient

+ significant at 10%; * significant at 5%; ** significant at 1%

EC countries are considered as one block (taking into account when each joined the EC – date in parentheses): Belgium (1958), Netherlands (1958), Germany (1958), France (1958), Italy (1958), Luxembourg (1958), Denmark (1973), Ireland (1973), United Kingdom (1973), Cyprus (1973), Greece (1981), were part of the EC in 1983.

The US post-Tokyo round ad valorem tariff is expressed in percentage points.

The *inverse import penetration ratio* equals the gross output to import ratio. The *elasticity* equals the absolute value of the import demand elasticity (after correcting for measurement errors). The *Political Organization* variable is a dummy variable equal to 1 if the industry is politically organized, 0 otherwise (GB stands for Gawande and Bandyopadhyay).

Instruments used in IV regressions (columns (3) and (4)): Seller concentration, Buyer concentration, Seller number of firms, Buyer number of firms, Scale, Capital Stock, Unionization, Geographic concentration, Tenure; Physical capital, Inventories, Engineers&scientists, White-collar, Skilled, Semi-skilled, Unskilled, Cropland, Pasture, Forest, Coal, Petroleum, Minerals.

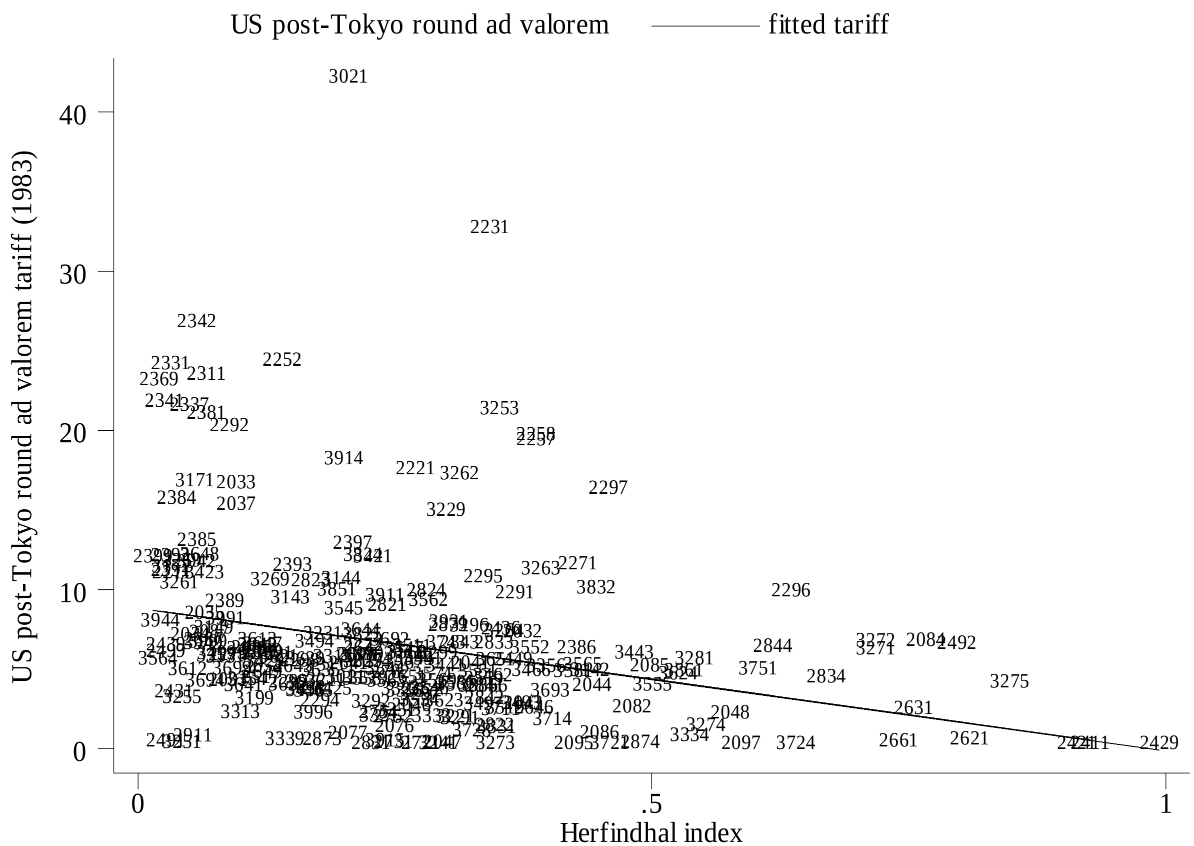

Figure 2. Correlation between US tariffs and Herfindhal index, 1983 (see Table 7)

data source: data from Gawande and Banyopadhyay, Feenstra, and Trefler

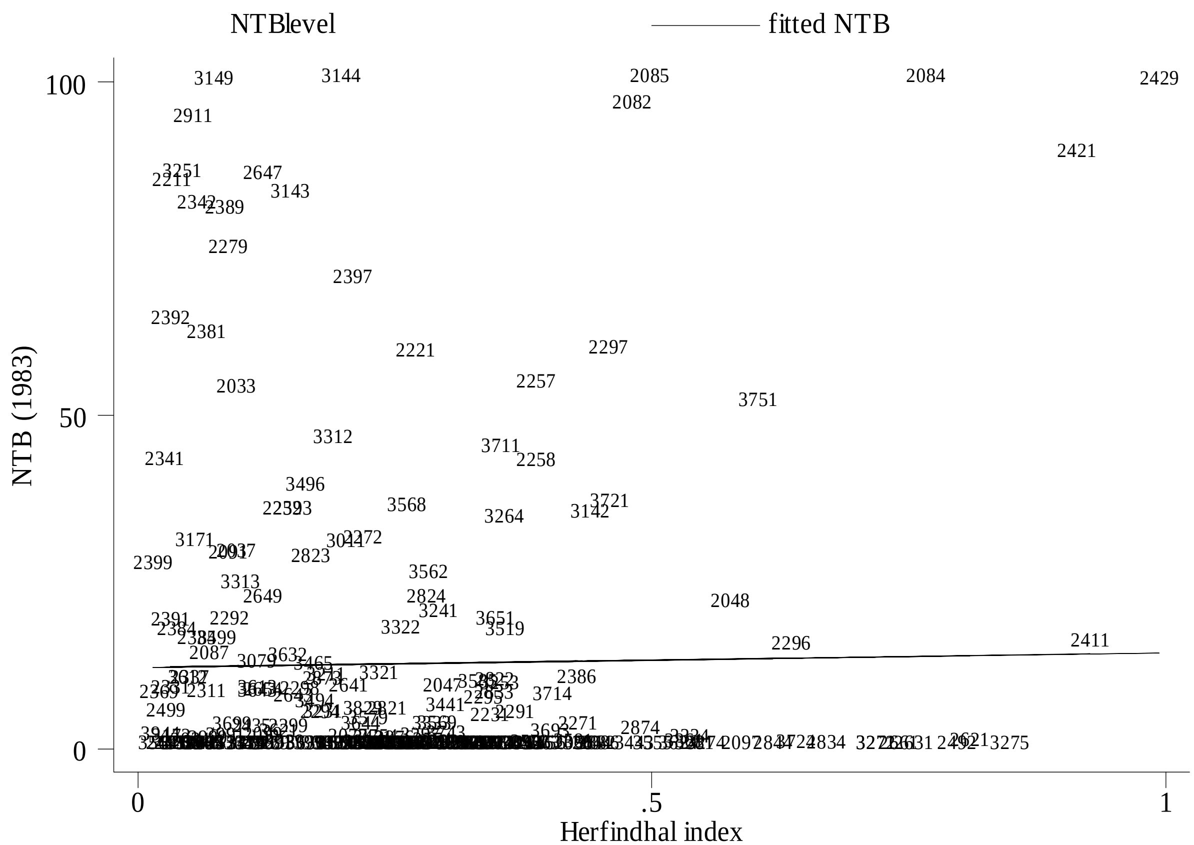

Figure 3. Correlation between US NTB and Herfindhal index, 1983 (see Table 8)

data source: data from Gawande and Banyopadhyay, Feenstra, and Trefler

Data Appendix 1 - Summary Statistics of variables used in 1983 analysis

Variable	N	mean	sd	min	max
US post-Tokyo round ad valorem tariff (in %)	242	6.4535	5.8833	0.0000	41.8770
Herfindhal index	242	0.2655	0.1883	0.0149	0.9936
Inverse import penetration ratio	242	0.0094	0.0482	0.0000	0.7042
Elasticity (import demand)	242	1.5027	0.3705	0.5491	2.1647
GB Political Organization	242	0.6818	0.4667	0.0000	1.0000
GM Political Organization	256	0.7539	0.4316	0.0000	1.0000
Intermediate goods' tariffs (in %)	242	6.1200	3.5848	1.1586	17.2340
Intermediate goods' NTB (in %)	242	22.9144	14.1702	2.2551	67.8470
NTBs (in %)	242	12.7523	24.3472	0.0000	100.0000

Data sources: Gawande and Bandyopadhyay (2000), Goldberg and Maggi (2000) (*GM Political Organization*), Feenstra (1998) (bilateral trade data to construct *Herfindhal index*)

Data Appendix 1 (cont.) - Instrumental variables for *Political Organization*

Variable	N	mean	sd	min	max
Seller concentration	194	0.3934	0.1924	0.0600	0.9400
Buyer concentration	194	0.3723	0.0719	0.1475	0.5806
Seller number of firms	194	0.2710	0.3834	0.0015	2.3826
Buyer number of firms	194	0.7341	1.4279	0.0027	14.3340
Scale	194	0.0344	0.0701	0.0003	0.6978
Capital Stock	194	0.3800	0.2373	0.0698	1.5076
Unionization	194	0.3496	0.1346	0.0660	0.7540
Geographic concentration	194	0.6948	0.1440	0.3330	1.0184
Tenure	194	5.3624	1.4595	2.3000	12.7000

Data sources: Trefler (1993). *Seller concentration* is the four-firm concentration ratio; *Buyer concentration* is the weighted average of the four-firm concentration ratios among buyers of an industry's output (consumers and downstream industries); *Seller number of firms* is the number of companies scaled by industry sales; *Buyer number of firms* is the weighted average of the number of firms among buyers of an industry's output, scaled by industry sales; *Scale* is Caves's (1976) minimum efficient plant size, defined as the percentage of industry sales supplied by the median plant; *Capital Stock* is the value of depreciable assets such as physical plant and machinery; *Unionization* is the percentage of workers unionized; *Geographic concentration* is the measure of the difference between population and industry production patterns across the 50 states; *Tenure* is the number of years the average worker in the industry has been with his or her current employer.

Data Appendix 1 (cont.) - Instrumental variables for *Inverse Import Penetration Ratio*

Variable	N	mean	sd	min	max
Physical capital	194	0.1092	0.0344	0.0162	0.2849
Inventories	194	0.0316	0.0135	0.0077	0.1045
Engineers, scientists	194	0.0294	0.0208	0.0023	0.1397
White-collar	194	0.1509	0.0401	0.0257	0.2950
Skilled	194	0.0962	0.0390	0.0133	0.2085
Semi-skilled	194	0.1161	0.0397	0.0193	0.2525
Unskilled	194	0.0370	0.0269	0.0035	0.2190
Cropland	194	0.0194	0.0548	0.0002	0.4798
Pasture	194	0.0047	0.0135	0.0001	0.1335
Forest	194	0.0004	0.0017	0.0000	0.0204
Coal	194	0.0021	0.0025	0.0003	0.0234
Petroleum	194	0.0297	0.0359	0.0027	0.4586
Minerals	194	0.0009	0.0021	0.0001	0.0274

Data sources: Trefler (1993)