Do terms-of-trade effects matter for trade agreements? Theory and evidence from WTO countries*

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November 2011

Abstract

In the literature on the economics of international trade institutions, a key question is whether or not terms-of-trade effects drive international trade agreements. Recent empirical work addressing terms-of-trade effects has been restricted to non-WTO countries or accession countries, which differ markedly from existing WTO members and account for only a tiny fraction of world trade. This paper investigates whether MFN tariffs set by existing WTO members in the Uruguay round are consistent with the terms-of-trade hypothesis. We present a model of multilateral trade negotiations featuring endogenous participation that leads the resulting tariff schedule to display terms-of-trade effects. Specifically, the model predicts that the level of the importer's tariff resulting from negotiations should be negatively related to the product of exporter concentration, as measured by the Herfindahl-Hirschman index (sum of squared export shares), and the importer's market power, as measured by the inverse elasticity of export supply, on a product-by-product basis. We test this hypothesis using data on tariffs, trade and production across more than 30 WTO countries and find strong support. We estimate that the internalization of terms of trade effects through WTO negotiations has lowered the average tariff of these countries by about 20% compared to its non-cooperative level.

JEL Codes: F1, F5

Key Words: Trade agreements, Terms of trade, Negotiations.

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*We thank seminar participants at Stanford, Ente Einaudi, Munich, Geneva, and Michigan and conference participants at the NBER summer institute, EITI Tokyo, ETSG Rome and the Political Economy of the WTO conference in Seoul. Finally, we thank Justin Pierce and Anastasiya Denisova for excellent research assistance and the NSF (#SES-0649468, Project title: "Free Riding and the Most-Favored Nation Clause") for financial support.

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1 Introduction

International agreements are often established for the purpose of discouraging countries from pursuing beggar-thy-neighbor policies. A growing body of literature, led by Bagwell and Staiger (2002), argues that international trade agreements, like the World Trade Organization (WTO), can be understood in these terms. Specifically, the theory makes two claims, which together we refer to as the *terms-of-trade hypothesis.* First, governments acting unilaterally will tend to overuse tariffs and other trade restrictions, to the extent that they are able to shift the cost of protecting a domestic industry onto foreign producers by altering the terms of trade. Second, and conversely, the WTO causes countries to internalize the terms-of-trade effects of their policies and thus leads to efficient policy choices. As compelling as this theory is, its empirical verification is hampered by its own logic, for if terms-of-trade effects are fully internalized under the WTO, then *ex post* we should observe no relationship between a WTO member's tariff schedule and its ability to affect the terms of trade (i.e., its market power); however, this would also be true of any alternative theory in which the terms of trade plays no role. Recent papers have sought to surmount this problem by focusing on special cases: Broda, Limão and Weinstein (2008) examine the tariff schedules of non-WTO countries;[1] Bagwell and Staiger (2011) consider changes in the tariff schedules of recent accession countries; and Bown (2004) studies WTO disputes. All produce findings consistent with the terms-of-trade hypothesis. As yet, however, the hypothesis is untested on the most-favored-nation (MFN) tariff schedules of the vast majority of WTO members, which cover the bulk of world trade.

This paper investigates whether MFN tariffs set by existing WTO members after the Uruguay round are consistent with the terms-of-trade hypothesis. To do this, we take a new approach to the problem of linking tariffs to market power in the context of trade agreements. It is based on the idea that if not all countries participate in negotiations over a given MFN tariff, then the negotiators may not fully internalize the terms-of-trade effects of reducing that tariff, and thus the negotiated tariff level may continue to bear the imprint of market power. In a standard competitive model, when an importer cuts an MFN tariff, all exporters subject to that tariff experience the same terms-of-trade improvement, which is proportional to the importer's market power. Yet the welfare gain

[1] In focusing on nonWTO countries, Broda, Limão and Weinstein (2008) address only the first part of the hypothesis. As for the second part, they find evidence for the U.S. by comparing the tariffs it applies to certain non-WTO countries with its MFN tariffs.

each exporter derives from this improvement depends on its share of total exports to the importer's market. Thus, if only a fraction of the exporters participate in negotiations over the tariff (and, importantly, if there is no way to extract reciprocal concessions from non-participants), then only a fraction of the potential gains from liberalization, corresponding to the aggregate export share of the participants, is internalized. In practice, it is typically only the exporters with the largest export shares, known as "principal suppliers," that actively engage in negotiations over a given tariff, suggesting that internalization can be captured by a measure of exporter concentration for each importer-product pair.[2] Hence, if the terms-of-trade hypothesis is correct, the tariff schedules of WTO members should be such that for products with high exporter concentration, corresponding to full or nearly full internalization, the negotiated tariffs bear little if any relation to the importer's market power. For products with low exporter concentration, however, greater importer market power should be associated with higher tariffs, as in standard optimal tariff theory.

Testing this hypothesis requires measures of both exporter concentration and importer market power. The difficulty in measuring the former is that we do not observe the exporters participating in negotiations over each tariff, and WTO rules offer no precise formula for deducing them. The principal supplier rule states that "countries may request concessions on products of which they individually, or collectively, are the principal suppliers to the countries from which the concessions are asked," but it does not specify exactly how large a supplier must be to qualify (WTO, 1995, p. 992). Thus, we model the participation decision as an endogenous choice within a many-country, many-good game of multilateral trade negotiations. The measure of exporter concentration derived from this model is the Herfindahl-Hirschman index (sum of squared export shares). This index measures the maximum total concession the importer can extract in any agreement involving the voluntary participation of *all* exporters. If this is too small, full participation cannot be sustained, and the smaller exporters drop out.

Measuring importer market power is conceptually straightforward – it is equal to the inverse elasticity of export supply – though available estimates tend to be very imprecise. We thus take an eclectic approach. Our main specification uses estimates from Broda, Greenfield and Weinstein

[2] Horn and Mavroidis (2001) 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, 2001, p. 34).

(2006), which have the advantage of being the most comprehensive available in terms of country and product coverage. Other specifications use proxy measures that are both theoretically plausible determinants of market power and are also correlated with the inverse elasticity estimates. The proxies we consider are the log of GDP, which varies by country, and the Rauch index of product differentiation (Rauch, 1999), which varies by product.[3]

To conduct the empirical analysis, we gather data on tariffs, trade and production for more than 30 WTO countries between 1993 and 2000. We estimate the determinants of MFN tariff schedules covering the period 1995-2000, using covariates from 1993, the final year of the Uruguay Round negotiations (signed in April 1994 and implemented gradually thereafter).[4] Our main dataset contains bound and applied tariffs and trade flows drawn from COMTRADE and UNCTAD's TRAINS. These are disaggregated to the 6-digit HS level, which corresponds to the tariff-line level for most WTO countries. The one drawback of this dataset is the lack of production data, which allows us to only indirectly control for domestic political economy determinants of tariffs. Thus, we construct a second dataset, which includes production levels by sector but follows the more aggregated 4-digit ISIC classification. It is based on the World Bank Trade and Production database (WBTPD) (Nicita and Olarreaga 2001), which contains the necessary data for a small sample of mostly low and middle-income countries. We expand and update the WBTPD adding data for several high and middle-income countries.

The empirical results strongly support the terms-of-trade hypothesis. Using the log GDP measure, we find that the tariff schedules of larger countries are more sensitive to cross-product variation in exporter concentration than those of smaller countries, which is consistent with the theory. Using the other two market power measures (and thus exploiting within-country variation in market power), we find a positive and significant effect of market power on MFN tariff levels, which diminishes significantly with exporter concentration. These results are consistent across datasets, are robust to controlling for domestic political economy factors, preferential trade agreements, industry and country fixed effects and a host of other factors, and hold for both bound and applied tariffs.

[3]Broda, Limão and Weinstein (2008) find these measures to be significant determinants of the inverse export supply elasticity for non-WTO countries.

[4]Our goal is to explain the variation in tariff levels across countries and products rather than intertemporal tariff changes resulting from the Uruguay Round per se. While MFN tariff levels may have undergone numerous changes before and after 1993, the Uruguay Round is the last time they were adjusted through negotiations. For many of the developing countries in our sample, this was also the first time.

They are further reinforced by instrumental variables estimation. In our view, this is the clearest evidence to date that the terms-of-trade motive drives trade policy and that trade agreements are intended to neutralize this motive.

Finally, our estimates allow us to quantify the effects of the WTO negotiations. We find that the internalization of terms-of-trade effects through WTO negotiations makes the average applied MFN tariff of our sample countries about 20% lower than its non-cooperative level (i.e., that which our model predicts, based on the same data, absent any internalization), and this figure is larger for developed economies. This accounts for about two thirds of the total post-war liberalization that has occured since 1945, with the remainder attributable to diminished unilateral motives for protection. However, this accounts for only 63 to 80 percent of all tariff liberalization that is possible through internalization, since free riding has prevented some terms-of-trade effects from being internalized. Machines, transport equipment and instruments have experienced the greatest terms-of-trade driven tariff reductions, while agriculture, prepared food, textiles and footwear have experienced the smallest. This suggests that the explanation for the high tariffs in the latter sectors goes beyond the domestic political-economy factors emphasized in the literature (see, Rodrik, 1995, for a survey). In particular, low levels of exporter concentration in these sectors inhibit trade negotiations from neutralizing the terms-of-trade motive.

Section 2 presents the model of trade negotiations from which we derive our main predictions and our measure of exporter concentration. Section 3 describes the cross-country data sets used. Section 4 discusses the empirical strategy and main results of the analysis. Section 5 concludes.

2 Theory

In this section, we present a model of trade negotiations under MFN to motivate our empirical analysis. We generalize Ludema and Mayda (2009) to the case of many countries and many goods and posit an extensive-form negotiation game, instead of the mechanism design approach of the earlier paper. While the two approaches are complementary, the advantage of the game is that it is based on actual WTO procedures, provides a full account of government behavior and allows us to relax several assumptions (such as the presence of a mechanism designer and the independence of negotiations across goods). The underlying trade model is the "competing exporters" framework, originally developed by Bagwell and Staiger (1998) and used extensively in the literature on MFN (e.g., Saggi, 2009). In this model, there is a set of countries C, a single numeraire good, and a set of non-numeraire goods Γ, where $|\Gamma| > |C| > 2$. Each non-numeraire good is imported by a single country and exported by all the others. We assume that these goods are produced with sector-specific capital and a common factor, labor, under conditions of perfect competition and constant returns to scale, while the numeraire is produced with labor alone, and each country has a representative consumer with a quasi-linear utility function.

2.1 Policies and Payoffs

All countries are assumed to be members of the WTO and therefore entitled to either MFN or FTA treatment.[5] For any country $i \in C$, let $\Gamma_i \subset \Gamma$ denote the set of all goods that i imports, and let MFN_i and FTA_i partition the set of exporters of any good $g \in \Gamma_i$ into those subject to i's MFN tariff $\tau_g \geqq 1$ (measured as one plus the ad valorem tariff rate) and those facing no tariff, respectively.[6] Let X_g, M_g, p_g and p_g^* denote, respectively, domestic production, total imports, the domestic price and the world price of good g, where $p_g = p_g^* \tau_g$. Let Φ_g denote the share of M_g imported from FTA partners, and let θ_{jg} denote the exports of country $j \in MFN_i$, as a share of total MFN exports, $M_g(1-\Phi_g)$. Finally, let, $\tilde{\mu}_g$ and ξ_g denote the elasticities of demand and supply for MFN exports, respectively.[7] For simplicity, we assume a common export supply elasticity for all MFN exporters, and thus θ_{jg} is independent of τ_g.

The welfare country i derives from good $g \in \Gamma_i$ is the sum of consumer surplus, producer surplus and tariff revenue: $w_{ig} = s_{ig}(p_g) + \pi_{ig}(p_g) + (p_g - p_g^*) M_g(p_g)(1-\Phi_g)$. On the export side, the welfare country i derives from an exported good $g \in \Gamma_j$ (for $j \neq i$) is given by $w_{ig} = s_{ig}(p_g^*) + \pi_{ig}(p_g^*)$ if $i \in MFN_j$ and by $w_{ig} = s_{ig}(p_g) + \pi_{ig}(p_g)$ if $i \in FTA_j$. We assume the government of country i

[5]By "country", we actually mean customs territory. Thus, if two or more WTO members are part of a customs union, we treat the group as a single country.

[6]In terms of notation, except where it would lead to confusion, we generally supress the country i subscript, because each good g is associated with a unique importing country

[7]The elasticity of demand for non-FTA exports is defined as $\tilde{\mu} \equiv \mu + \xi_F \Phi$, where μ is the importing country's elasticity of total import demand, and ξ_F is the elasticity of export supply from FTA members.

wishes to maximize $\sum_{g \in \Gamma} v_{ig}$, where

$$v_{ig} = \begin{cases} w_{ig} + \lambda_{ig}\pi_{ig} + \phi_{ig} \sum_{j \in FTA_i} w_{jg} & g \in \Gamma_i \\ w_{ig} & g \notin \Gamma_i \end{cases} \tag{1}$$

That is, for each good it imports, the government's payoff is a weighted sum of welfare, producer surplus, and the welfare of its FTA partners. The weight λ_{ig} represents the political clout of import-competing sector g in country i. We do not model the exact political mechanism behind this weight, though it is consistent with a variety of political economy models (Baldwin, 1987; Helpman, 1997). The weight ϕ_{ig} represents country i's concern about the interests of its FTA partners on goods it imports. We have in mind that FTA partners may apply diplomatic pressure on the importing country to preserve their preferential market access. While we prefer not to digress into a complete model of this intra-FTA interaction, we believe it is potentially important enough (see, for example, Limão, 2007) to warrant the inclusion of an exogenous parameter to capture this effect. Finally, on goods it exports, the government's payoff coincides with welfare.[8]

A critical element of any model of trade negotiations is how, and in what form, countries exchange concessions. If the exporters of a good are to convince an importer to cut its tariff, they must promise to reciprocate that tariff cut in some fashion. We assume that the exporters can fulfill this obligation by making tariff cuts of their own or by making side payments in the form of transfers of the numeraire good. We allow side payments for both theoretical and factual reasons. The theoretical motivation is that it expands the efficiency frontier. Tariffs can be chosen to maximize the surplus of the negotiators, while side payments can be used to achieve the desired division of surplus. It also simplifies the analysis substantially, because it, coupled with the quasi-linearity assumption, implies that the surplus maximization problem is separable across tariffs. As a factual matter, while cash transfers are rarely observed in the WTO context, it would also be a drastic oversimplification to assume that MFN tariffs alone are used. Finger, Reincke, and Castro (2002) provide evidence of large and pervasive deviations from balance in MFN tariff concessions in the Uruguay Round. Part of the explanation is that the scope of negotiations was far wider than tariffs,

[8]That trade regimes are biased toward import-competing sectors is well known (Rodrik, 1995). We should point out, however, that our theoretical model could easily accommodate politically influential exporters. The main reason we leave this aspect aside is practical: no data is available to measure exporter political influence. Thus, we focus only on the components for which we have data.

including a host of non-tariff issues, such as services, technical barriers to trade, intellectual property protection, investment measures and government procurement. In addition, there are numerous bilateral interactions between countries both within the WTO (e.g., disputes) and without (e.g., bilateral investment treaties). In our view, transfers are a reasonable way to capture the flexibility in concessions that these "issue linkages" afford

A related issue is whether countries are obligated to reciprocate tariff cuts that they did not request. While the WTO principle of reciprocity ostensibly applies to all tariff reductions, in practice there are a number of exceptions. Developing countries are explicitly exempted from reciprocity in GATT Part IV. It is also well documented that countries making unilateral tariff reductions have had very little success in getting "credit" for those reductions in GATT rounds. Finally, there is a sizable literature on the MFN free rider problem (e.g., Viner, 1924; Caplin and Krishna, 1988; Ludema and Mayda, 2009), which occurs when participants in trade negotiations are at once constrained by MFN to provide negotiated market access to all countries yet unable to force non-participants to reciprocate. Finger (1979), Lavergne (1983) and Ludema and Mayda (2009) supply evidence of this problem in GATT tariff negotiations. Here we shall follow this literature in assuming that non-participants completely discount the obligation to reciprocate; however, we show in the Appendix that our model can accommodate any degree of reciprocity from non-participants less than 100% with no effect on the results.

2.2 The Negotiation Game

Our model of negotiations is based on the item-by-item request and offer method of tariff negotiations, which is GATT's most common procedure historically and which characterized the Uruguay Round.[9] It consists of four stages. First, each country i submits a "request" list $R_i \subseteq \bigcup_{j \in MFN_i} \Gamma_j$, indicating the foreign tariffs it would like to negotiate over. Second, each country submits an "offer" list $O_i \subseteq \Gamma_i$, indicating which of its own tariffs are negotiable. Third, countries meet in pairs $(i,\, j)$, each one engaging in simultaneous bilateral bargaining over the items mutually designated,

[9]The first five GATT rounds used this method exclusively, whereas 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."

$g \in (R_i \cap O_j) \cup (R_j \cap O_i)$. The negotiation between each pair of countries seeks to determine a set of bilateral compensation functions: $c_{ig}(\tau_g)$ for $g \in R_i \cap O_j$ and $c_{jg}(\tau_g)$ for $g \in R_j \cap O_i$, where $c_{ig}(\tau_g)$ is the compensation that country i (the exporter) pays to country j (the importer) as a function of τ_g. These functions are equivalent to the contribution schedules found in common agency games (Bernheim and Whinston, 1986). In keeping with that literature, we focus on truthful compensation functions of the form, $c_{ig}(\tau_g) = min[0, v_{ig}(\tau_g) - u_{ig}]$, where u_{ig} is a constant and is interpreted as the level of welfare that importer j guarantees to exporter i from good g if their bilateral negotiation is successful. The negotiation between each pair of countries is resolved according to the Nash bargaining solution, taking the outcome of all other negotiations as given and setting the bilateral compensation functions of the pair to zero in case of disagreement. In the fourth and final stage, each importer chooses its tariff schedule so as to maximize its payoff net of compensation.[10]

To solve the final stage, let A_g denote the set of exporters participating in negotiations over good g. Note that this set is empty for any good not included on an importer's offer list; otherwise, it is the set of countries requesting negotiations over g. For every $g \in \Gamma_i$, the tariff chosen by country i in the final stage is $\tau_g^n(A_g) = \arg\max v_{ig}(\tau_g) + \sum_{j \in A_g} c_{jg}(\tau_g)$. Denoting the joint payoff of the participants by $W_{A_g}(\tau_g) \equiv v_{ig}(\tau_g) + \sum_{j \in A_g} v_{jg}(\tau_g)$, we see that $\tau_g^n(A_g) = \arg\max W_{A_g}(\tau_g) - \sum_{j \in A_g} u_{jg}$. Thus, for each good, the tariff emerging from negotiations is Pareto efficient for the participants in that good. Setting $W'_{A_g}(\tau_g) = 0$ yields,

$$\tau_g^n(A_g) = \frac{1 + \frac{1}{\xi_g}(1 - \Theta_{A_g})}{1 - \frac{\lambda_{ig}}{\tilde{\mu}_g}\frac{X_g}{M_g} + \frac{1-\phi_{ig}}{\tilde{\mu}_g}\Phi_g} \tag{2}$$

where $\Theta_{A_g} \equiv \sum_{j \in A_g} \theta_{jg}$ is the aggregate export share of participants. The numerator of (2) is key to our paper. Evaluated at $\Theta_{A_g} = 0$, it equals the standard optimal tariff, which depends on importer market power, as measured by the inverse elasticity of export supply. Evaluated at $\Theta_{A_g} = 1$, it equals the worldwide efficient tariff, which would correspond to free trade but for the political power of domestic producers and FTA partners captured in the denominator. Importer

[10] Here we are assuming that if a good is not included in a country's offer list, the country chooses its noncooperative optimal tariff. Alternatively, we could assume that such tariffs revert to a pre-existing tariff held over from some previous negotiating round. This would effectively add an exogenous upper bound on the negotiated tariff found below in equation (2). However, in our view it would be counterproductive to treat pre-existing tariffs as exogenous, when the purpose is to explain current tariff levels (which is the focus of our empirical work). To endogenize the pre-existing tariff would require a dynamic model that accounts for gradualism. Our static model effectively collapses all GATT rounds into a single round, and thus the optimal tariff is an appropriate baseline. Ludema and Mayda (2009) provide a dynamic adaptation of the model suitable for examining changes in tariffs across rounds.

market power is irrelevant in this case. In between these two extremes, the negotiated tariff depends on both importer market power and exporter participation.

Given (2) we can find the Nash bargaining solution for countries i and j. This involves choosing u_{ig} and u_{jg} to maximize the Nash product,

$$\begin{aligned}&\left(\sum_{g\in R_j\cap O_i} W_{A_g}(\tau_g^n(A_g)) - u_{jg} - W_{A_g/j}(\tau_g^n(A_g/j)) + \sum_{g\in R_i\cap O_j} u_{ig} - v_{ig}(\tau_g^n(A_g/i))\right)\\ \times&\left(\sum_{g\in R_i\cap O_j} W_{A_g}(\tau_g^n(A_g)) - u_{ig} - W_{A_g/i}(\tau_g^n(A_g/i)) + \sum_{g\in R_j\cap O_i} u_{jg} - v_{jg}(\tau_g^n(A_g/j))\right)\end{aligned} \tag{3}$$

Maximization of (3) yields an expression for the net compensation country i must pay to j:

$$\begin{aligned}\sum_{g\in R_i\cap O_j} c_{ig} - \sum_{g\in R_j\cap O_i} c_{jg} = \sum_{g\in R_i\cap O_j} & v_{ig}(\tau_g^n(A_g)) - v_{ig}(\tau_g^n(A_g/i)) - \frac{1}{2}\left[W_{A_g}(\tau_g^n(A_g)) - W_{A_g}(\tau_g^n(A_g/i))\right]\\ - \sum_{g\in R_j\cap O_i} & \left\{v_{jg}(\tau_g^n(A_g)) - v_{jg}(\tau_g^n(A_g/j)) - \frac{1}{2}\left[W_{A_g}(\tau_g^n(A_g)) - W_{A_g}(\tau_g^n(A_g/j))\right]\right\}\end{aligned} \tag{4}$$

The right-hand side of the top line of (4) is the gross compensation i pays for the negotiated tariffs on goods it exports to j. It depends on two components. The first component is the increase in country i's export surplus from succeeding in negotiations, and thus inducing the tariff $\tau_g^n(A_g)$, rather than failing and inducing the higher tariff $\tau_g^n(A_g/i)$. This can be thought of as country i's stake in the outcome, and it represents the maximum country i would be willing to pay for a successful settlement. The second component (in brackets) is country i's contribution to the total surplus of all participants, which is split evenly between the importer and the exporter by Nash bargaining. The second line of (4) is the gross compensation i receives from j for its negotiated tariffs. Note that if i and j are symmetric, then the net compensation is zero, and a bilateral balance is achieved through tariff committments alone without resort to transfers; otherwise, it could be positive or negative. However, the size of country's total transfer depends on the multilateral balance of net compensation across all pairs.

Given (4), country i would choose to include good g on its offer list if and only if,

$$\sum_{j\in A_g} v_{jg}(\tau_g^n(A_g)) - v_{jg}(\tau_g^n(A_g/j)) - \frac{1}{2}\left[W_{A_g}(\tau_g^n(A_g)) - W_{A_g}(\tau_g^n(A_g/j))\right] \geq \bar{v}_{ig} - v_{ig}(\tau_g^n(A_g)) \tag{5}$$

where $\bar{v}_{ig}$ denotes the payoff to country i when g is subject to its noncooperative optimal tariff. The left-hand side of (5) is the gross compensation the importer receives from all participating exporters if the good is negotiated, while the right-hand side measures the cost to the importing country of giving up its optimal tariff for the negotiated tariff. For an arbitrary set of participants, it is entirely possible for the compensation to fall short of the cost, in which case the importer would not include the good on its offer list. This might seem odd: why would the importer refuse to negotiate? The reason is that the importer can never extract more than an exporter's stake, which is limited by the fact that the exporter gets a free ride on the negotiations of the other exporters in case of bilateral disagreement. That is, by refusing to conclude its bilateral negotiation with the importer, an exporter can benefit from the bilateral negotiations of the other exporters while not paying compensation, whereas the importer cannot credibly commit to refusing to conclude all of its bilateral negotiations as a way of extracting more compensation from any one exporter. This asymmetry of bargaining power creates a hold up problem. It may be better for the importer to not open negotiations on a product than to negotiate an efficient tariff from such weak bargaining position.

Finally, consider the first stage. Suppose country j includes a good $g \in \Gamma_i$ in R_j anticipating that $g \in O_i$. The payoff from this decision is $u_{jg} = v_{jg}(\tau_g^n(A_g/j)) + (1/2)[W_{A_g}(\tau_g^n(A_g)) - W_{A_g}(\tau_g^n(A_g/j))]$. On the other hand, if j does not include g in R_j, its payoff is $v_{jg}(\tau_g^n(A_g/j))$. Clearly, it is always better to include g than to leave it out, so long as including g does not cause (5) to be violated. However, if including g does cause (5) to be violated, then j would receive $\bar{v}_{jg}$ (i.e., it would face i's optimal tariff) and would be strictly better off not including g. With this decision rule in hand, it is easy to see that there are multiple equilibria: any set A_g that cannot be increased without violating (5) would be an equilibrium. To resolve this multiplicity, we invoke the principal supplier rule. Suppose that an exporter j may request a good if and only if all exporters with market share greater than θ_{jg} also request it. Under this rule, the unique equilibrium is the largest set of consecutive exporters (in descending order of export share) that satisfies (5). Notice that because (5) is satisfied in equilibrium, importers always include all requested goods on their offer lists. If inefficiency occurs in equilibrium, therefore, it is manifest in a fraction of the exporters (those below a certain export-share threshold) excluding goods from their request lists.

Before moving on to comparative statics, it is worth discussing the generality of the findings so far. We have found that an inefficiency in negotiations may occur because not all exporters participate in negotiations over all goods. Ludema and Mayda (2009) show that any mechanism that satisfies the constraints of MFN, voluntary participation and Pareto efficiency for participants has this feature. Thus, this is *not* an artifact of the timing of the model or the bilateral nature of Nash bargaining. They also show that an optimal mechanism – one that maximizes total world payoffs subject to these constraints – will typically induce the participation of the largest set of consecutive exporters subject to a participation constraint slightly weaker than (5).[11] Thus, the principal supplier rule can be rationalized as a means of selecting the most desirable equilibrium (for the world as a whole) from among the equilibria in our model.[12]

2.3 The Herfindahl-Hirschman Index

Henceforth, we drop the subscript g and consider requests for a generic good. Since all exporters above a certain export-share threshold participate, there is a one to one relationship between the set of participating exporters and the cumulative export share of participants Θ. Thus, we can write τ^n as a function of Θ, instead of A, and find the equilibrium by maximizing Θ subject to (5). Our focus will be on how the equilibrium is affected by the concentration of exporters.

Let $H = \sum_{j \in MFN} \theta_j^2$ denote the Herfindahl-Hirschman index (HHI) of exporters. The HHI ranges from one (the case of a single exporter) to zero (infinitely many exporters with equal market shares). If $H = 1$, it is easy to show that (5) must hold at $\Theta = 1$, in which case the exporter requests negotiations and the negotiated tariff equals the worldwide efficient tariff. Suppose instead that there are many exporters, each with a relatively small share of the market. In this case, we

[11] In an optimal mechanism, each participating exporter pays exactly its stake in each good. Thus, the second term on the lefthand side of (5) vanishes. The reason this term is present in our model is due to the symmetry of the Nash bargaining solution. An optimal mechanism would require an asymmetric bargaining solution in which each country extracts the entire surplus for the goods it imports. That said, in the case of many countries with small export shares, this term vanishes anyways because of the envelope theorem, and thus our model converges to the optimal mechanism.

[12] Another possible explanation for why principal suppliers engage in negotiations might be that there are negotiation costs that increase with the number of items negotiated. This might deter countries from adding to their request lists those goods for which they have small export shares. If such costs were so large as to deter requests from all but the top one or two exporters, then the principal supplier rule would be unnecessary. However, if negotiation costs are small, there would continue to be multiple equilibria, albeit a smaller set of equilibria, and the principal supplier rule would continue to serve as a valuable selection device.

can replace the lefthand side (5) by its first-order approximation,

$$\omega(\Theta)h(\Theta) \geq \bar{v}_i - v_i(\tau^n(\Theta)) \tag{6}$$

where $\omega(\Theta) = \sum_{j \in MFN_i} v'_j(\Theta)$ and $h(\Theta) = \sum_{j \in A(\Theta)} \theta_j^2$. The function $\omega(\Theta)$ measures the marginal benefit to all exporters from a small increase in Θ, while $h(\Theta)$ is the HHI of *participating* exporters. The intuition behind this expression is as follows. Each participating exporter pays compensation approximately equal to its stake (its effect on the total surplus is second-order). This depends on how much its export surplus is affected by the tariff and on how much its participation decision influences the tariff. The increase in j's export surplus due to a small increase in Θ is $\theta_j \omega(\Theta)$, which is just j's share of the marginal benefit to all exporters. The increase in Θ caused by j's decision to participate is θ_j. This gives $\theta_j^2 \omega(\Theta)$, which is summed over all participating exporters to obtain (6). If H is sufficiently small, then (6) cannot hold at $\Theta = 1$. Thus, full participation is not an equilibrium and the negotiated tariff must exceed the worldwide efficient tariff.

This point is illustrated in Figure 1, which considers compensation $\omega(\Theta)h(\Theta)$ versus cost $\bar{v}_i - v_i(\tau^n(\Theta))$ for two different distributions of export shares, a and b, such that $H_a > H_b$. Under mild regularity conditions, these curves intersect at most once (besides the origin).[13] Under distribution a, compensation exceeds cost for all Θ, and thus all exporters request negotiations and the negotiated tariff is fully efficient. For distribution b, on the other hand, exporters request negotiations only up to $\Theta_b^* < 1$, and thus the negotiated tariff is higher than under a. It can further be shown that if the two export share distributions can be ranked according to first-order stochastic dominance, then $h_a(\Theta) > h_b(\Theta)$ for all Θ, as drawn in the figure (see, Ludema and Mayda, 2009, proposition 3). This implies that Θ^* is monotonically increasing in H. This is a useful result because, while the actual market share of participants is not observable without the request lists of the countries, H is readily computed from available trade data.

[13] Sufficient conditions are $d^2\tau/d\Theta^2 \leq 0$ and $\omega'' \leq 0$, which hold if third and fourth order derivatives of the welfare functions are sufficiently small.

3 Cross-country Data

To carry out the cross-country empirical analysis, we need information for a multitude of importing countries on MFN tariffs, trade and production levels, and import and export elasticities. Obtaining internationally comparable data for all these variables according to a common classification and level of aggregation is almost impossible. Thus, we have chosen to construct two complementary datasets, which differ in the number of variables available, level of aggregation and country coverage. The results turn out to be the same using both datasets.

The first dataset contains bound and applied MFN tariff rates along with multilateral and bilateral trade flows for 36 countries[14], comprising a wide range of income levels, according to the 6-digit Harmonized System (HS) classification. The data set covers the period from 1993 to 2000. This period of time includes the final years of the Uruguay round, which took place in 1986-1994, and its implementation period. We constructed the data set by combining information collected from COMTRADE and UNCTAD's TRAINS. Data on the individual members of the European Union were combined, so as to create, in effect, a single country called the EU. This is because the EU maintains a common external tariff and negotiates as a bloc.[15]

The main advantage of the 6-digit HS dataset is its very fine level of disaggregation (more than one thousand sectors per country with upwards of four thousand sectors for several of them) and the extensive country coverage. The main disadvantage is that this dataset lacks production data, which prevents the construction of import penetration, an important factor in controlling for domestic political economy determinants of protection. To address this problem we construct a second dataset, which includes 31 countries. Twenty countries overlap with the 6-digit HS dataset, including nearly all of the developed countries. This second dataset contains information on MFN

[14]The countries are (the date of entry into GATT/WTO is in parentheses): Argentina (1967), Australia (1948), Belize (1983), Bolivia (1990), Brazil (1948), Canada (1948), Chile (1949), Colombia (1981), Dominica (1993), Ecuador (1996), European Union (varies by country), Gabon (1963), Grenada (1994), Guatemala (1991), Hungary (1973), Iceland (1968), India (1948), Indonesia (1950), Japan (1955), Korea (1967), Madagascar (1963), Malaysia (1957), Mauritius (1970), Mexico (1986), Morocco (1987), New Zealand (1948), Nicaragua (1950), Norway (1948), Peru (1951), Romania (1971), Saint Kitts & Nevis (1994), Saint Vincent & the Grenadines (1993), Sri Lanka (1948), Thailand (1982), Tunisia (1990), United States (1948).

[15]The European-Union (EU) includes the following countries (date of entry into the EU 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), Austria (1995), Finland (1995), and Sweden (1995). To construct the EU data, we averaged the tariffs reported by TRAINS and summed together the production and trade data across members (netting out intra-EU trade flows). To obtain representative EU-wide elasticity estimates, we used the average of Germany, France, Italy and the UK.

tariff rates (applied only), multilateral and bilateral trade flows, and production for 81 (or fewer) manufacturing industries at the 4-digit level of the International Standard Industrial Classification (ISIC Rev. 2). The data set covers the period from 1993 to 1999. All bilateral and multilateral import and export data are from the World Bank's Trade and Production Database (WBTPD) (Nicita and Olarreaga 2001).[16] The WBTPD is also the source of data on domestic production and MFN tariff rates (applied only) for 18 countries in the sample, mostly middle and low-income countries.[17] We have augmented this initial dataset with data for 13 additional countries by collecting production and tariff data from the UNIDO INDSTAT4 (2006) Industrial Statistics Database and UNCTAD's TRAINS, respectively.[18] Drawing data from these additional sources is particularly important because it allowed us to expand the analysis to include a greater number of high-income, high-trade countries, including the EU.

To construct MFN tariff rates at the 4-digit ISIC level, the WBTPD uses the simple average of the tariff lines within each product category. The benefit of simple averages, instead of trade-weighted averages (revenue divided by dutiable imports), is that they are invariant to changes in trade flows. The drawback is that a few highly protected tariff lines within a sector can seriously affect the average. To mitigate the effect of outliers, we restrict our ISIC sample to tariff averages less than 50% ad valorem.[19]

The 6-digit HS and 4-digit ISIC datasets are augmented with information from secondary sources. Information on GATT/WTO membership is drawn from Rose (2004). Estimates of export supply and import demand elasticities are derived from Broda, Greenfield and Weinstein (2006) and kindly provided by David Weinstein. These vary by country and product (but not time) at the 3-digit HS level. Information about the degree of product differentiation is from Rauch (1999) and varies by product, according to the 4-digit SITC classification. The Rauch product classification

[16]The WBTPD derives from several sources: UNCTAD Trains, UN Comtrade, and UNIDO Industrial Statistics are the sources of MFN tariffs, trade flows and production data, respectively.

[17]The 18 countries covered by the World Bank data set are (date of entry into GATT/WTO is in parenthesis): Bolivia (1990), Canada (1948), Chile (1949), Colombia (1981), Costa Rica (1990), Ecuador (1996), Egypt (1970), Guatemala (1991), Honduras (1994), Indonesia (1950), India (1948), Korea (1967), Mexico (1986), Malaysia (1957), Philippines (1979), Turkey (1951), United States (1948), and Venezuela (1990).

[18]Production and tariff data from these sources is used for the following 13 countries (date of entry into GATT/WTO is in parenthesis): Australia (1948), Bangladesh (1972), European Union (varies by country), Japan (1955), Morocco (1987), New Zealand (1948), Norway (1948), Pakistan (1948), Panama (1997), Peru (1951), Romania (1971), South Africa (1948) and Thailand (1982).

[19]This restriction amounts to less than 5% of our observations. Our main results are not sensitive to this threshold, though overall fit diminishes if outliers are not excluded. Note that, as the 6-digit HS level is the tariff-line level for almost all WTO countries, we do not censor tariffs in the 6-digit HS dataset.

divides goods into those that are sold on organized exchanges, those for which reference prices can be found in trade journals, and others. Products in the third category are interpreted as differentiated products. We use concordances to map the elasticity estimates and the Rauch classification to the 6-digit HS and 4-digit ISIC classifications.[20]

Our datasets have three dimensions: importing country, product and time. The period of time they cover allows us to pay attention to the timing of the negotiation and implementation of tariff agreements. This is important in the empirical analysis given that one might expect tariffs observed during the implementation period to be affected more by conditions prevailing during the negotiation period than by contemporaneous conditions. Thus, our main dependent variable will be the MFN tariff rate averaged over 1995-2000 (or 1995-1999), while the independent variables are drawn from 1993, which was the final and most critical year of the Uruguay Round negotiations. With the time dimension collapsed in this way, our estimation exploits cross-commodity and cross-country variation.

In most of our specifications, the MFN tariff rates used are applied rates, averaged over several years, instead of bound rates.[21] In practice, the difference between the two tariff rates in many countries like the US is quite small, though the gaps can be large for developing countries. Our choice to use applied is based on two sets of considerations. First, an important institutional feature is that applied tariffs are not immediately subject to the bound rates negotiated in a Round but are phased-in in stages, with more politically sensitive products phased-in as late as possible. This feature would be lost if we used only final bound rates. Second, while our theoretical model makes no distinction between bound and applied rates, Bagwell and Staiger (2005) provide a theory that accounts for the difference, based on private information about political pressure.[22] In their model, the bound rate is chosen to ensure the incentive compatibility of applied rates, whereas applied rates fluctuate but on average maximize the expected welfare of the negotiating parties. Accordingly, the average applied rate is the more appropriate measure of our negotiated tariff. Empirically,

[20] Since 4-digit ISIC is more aggregated than 3-digit HS and 4-digit SITC, concording the data to ISIC required some care. To concord the elasticities, we took the median of the 3-digit HS values within each 4-digit ISIC. We used the median, rather than the mean, to diminish the effect of outliers, as the elasticity estimates had large standard errors. For the Rauch classification, we created a continuous measure (*Diffshare*) equal to the share of the 4-digit SITC codes within each 4-digit ISIC category that were classified as differentiated according to Rauch's liberal definition.

[21] In GATT/WTO negotiations, countries negotiate tariff bindings, i.e. they do not explicitly agree to tariff levels but instead to tariff ceilings (bound rates) that tariff levels must not exceed.

[22] Horn, Maggi and Staiger (2010) offer an alternative theory based on contracting costs rather than private information but obtain similar results.

Bacchetta and Piermartini (2011) show that tariff bindings moderate applied rates even when gaps exist, indicating that negotiations over bound tariffs are instrumental in determining applied rates. In any case, the use of final bound rates as our dependent variable has no effect on the results, as we show below. Summary statistics of applied and bound tariff rates, as well as additional variables used in the empirical analysis, are presented in Tables 7 and 8.

4 Empirical Analysis

4.1 Empirical strategy

In the empirical analysis, we use a specification that is closely related to the theoretical model. To make the link from our model, which assumes importer-specific goods, to the data, which are organized by product categories common to all countries, we partition the set of goods Γ into K "products", where each product k groups goods with similar characteristics each imported by a different country. Thus, g can be represented by a combination ck, where c is the country importing good g and k is the product to which g belongs.[23] The tariff τ_{ck} is country c's tariff on the good it imports from product k, and we assume it is the outcome of negotiations as previously modeled. Note that the negotiated tariff in equation (2) is equal to 1 (free trade) if there is full participation, no domestic political pressure and negligible FTA share. Taking a first-order Taylor approximation of (2) around this point, and adding an error term, we obtain the following estimating equation for sector k and importing country c:[24]

$$\tau_{ck} - 1 = \frac{1}{\xi_{ck}} (1 - \Theta_{A_{ck}}) + \frac{\lambda_{ck}}{\mu_{ck}} \frac{X_{ck}}{M_{ck}} - \frac{1 - \phi}{\mu_{ck}} \Phi_{ck} \tag{7}$$

The first challenge is to measure $1/\xi_{ck}$, the inverse elasticity of foreign export supply of product k to country c, which captures country c's market power. Finding an accurate measure has long been a problem in the international trade literature. Although the elasticity estimates of Broda,

[23]Product categories are either 6-digit HS codes or 4-digit ISIC codes, depending on the dataset. We shall use the terms products and sectors interchangeably to refer to these product categories. We use the term "industry" to refer to a higher level of aggregation than products. In the HS dataset, industries refer to HS sections. In the ISIC dataset, industries are defined as 3-digit ISIC codes.

[24]Note that the import demand elasticity appears in equation (7) instead of the FTA-augmented elasticity found in (2). This is because our approximation occurs around the point of zero FTA share, where the two elasticities are the same.

Greenfield and Weinstein (2006) are the most comprehensive available in terms of country and product coverage, they are very imprecise. We deal with this issue in two different ways. One is to follow Broda, Limão and Weinstein (2008) and create a categorical variable, "High inverse export elasticity" (HIEE), which is equal to 1 if the inverse export elasticity estimate is in the top two thirds of all products' estimates within the same country and zero otherwise. The second approach is to use proxy measures that are both theoretically plausible determinants of market power and are also correlated with the inverse elasticity estimates. The proxies we consider are the log of GDP, which varies by country, and the Rauch classification, which varies by product. To justify using log of GDP, we note that textbook treatments of optimal tariffs attribute market power to large countries and indeed, in the data (see footnote 25 below), countries with larger GDP face lower export elasticities on average. As for the Rauch classification, product differentiation is normally associated with a low elasticity of substitution in consumption between varieties. When a country imposes a tariff, it decreases its demand for imported varieties and thereby drives down their world prices; however, with a low substitution elasticity, there is less of a tendency for consumers in other countries to substitute towards those varieties and thereby mitigate the price decline. Thus we expect that products classified as differentiated by the Rauch classification should have lower export elasticities (i.e., higher importer market power) than homogenous products. This is too borne out in the data, as the export supply elasticity estimates are much lower for products classified as differentiated.[25]

The second challenge is to measure $\Theta_{A_{ck}}$, which captures how much of the terms-of-trade effect of the tariff is internalized by the participants in negotiations over each product. In particular, $\Theta_{A_{ck}}$ measures country c's imports from participants in GATT/WTO negotiations over product k as a fraction of its imports from all countries that are entitled to MFN treatment and are not its FTA partners. While we cannot measure the market share of participants directly, our theory tells us that it should be positively related to the HHI. In our calculation of the HHI, we must account for the presence of non-GATT countries that receive MFN treatment and exclude each importing

[25]Broda, Limão and Weinstein (2008) investigate the correlation between inverse export elasticity and several market power variables, including log GDP, the Rauch index and the importing country's share of world imports by product, for a group of non-WTO countries. They find the same results for log GDP and the Rauch index as we do for WTO countries. We find a positive correlation between HIEE and the indicator of product differentiation. We also estimate a positive correlation between the inverse export elasticity and log GDP, controlling for product fixed effects, although this correlation is less robust. Broda, Limão and Weinstein (2008) also find that an importing country's share of world imports is correlated with the inverse export elasticity by product (although this result does not survive controlling for log GDP). We find no such correlation among WTO countries, thus we do not use the importing country's share of world imports as a proxy of market power.

country's FTA partners and other countries that do not receive MFN treatment. Thus, we measure the HHI as:

$$H_{ck} = \frac{\sum_{i \in GATT_c} M_{ick}^2}{\left(\sum_{i \in MFN_c} M_{ick}\right)^2} \tag{8}$$

Here MFN_c is the set of all countries that are granted MFN treatment by importing country c, excluding c's FTA partners, while $GATT_c$ is the subset of MFN_c consisting of members of the WTO (these countries are therefore potential participants in the multilateral negotiations). We have data on MFN treatment only for the United States, which grants MFN treatment to all but a few, small, isolated countries.[26] We therefore exclude these same countries from MFN_c for all countries in our sample. M_{ick} is the value of importing country c's imports of product k from country i. Thus the HHI so defined equals the sum of squared shares of exports to importing country c by all potential (non-FTA) participants in multilateral negotiations.

The third challenge is to measure λ_{ck}, which captures the degree of domestic political pressure in sector k of country c. Lacking internationally comparable data on political variables, we take an indirect approach, as explained in detail in the following two sections. Finally, we also control for the FTA market share[27] – which captures the third term in (7) – and add country fixed effects.

4.2 Estimation based on the 6-digit HS data set

We begin our analysis by investigating the role of country size. Ludema and Mayda (2009) estimate the average effect (across products) of MFN free riding on U.S. tariffs, ignoring cross-sector variation in market power. In this section, we conduct a similar exercise for each importing country in our sample to see if this effect depends on market size. If larger countries have greater market power on average, we should expect their tariff schedules to be more sensitive to variation in the market share of participants and thus to the HHI. To test this, we estimate country-specific regressions of the average MFN tariff rate (over the years 1995-2000) on the 1993 HHI.[28] For each of these

[26] From 1996 onwards, the only countries that were not granted MFN treatment by the United States were Afghanistan, Cuba, Laos, North Korea, Iran, Vietnam, Serbia and Montenegro. Before then, the US granted unconditional MFN to all other countries, except Communist countries.

[27] We use the 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 non-FTA countries. We take this approach mainly because of the inconsistent coverage and conditional nature of these preferences.

[28] We also control for the 1993 FTA market share and HS section dummy variables, both divided by the import demand elasticity. The rationale for these controls is explained below.

regressions, we consider the estimated coefficient on the HHI – which is indeed negative for most countries in the sample – and plot it against the country's log GDP (Figure 2). We estimate the fitted regression line with weighted least squares (WLS) using as weights the inverse of the variance of the HHI coefficients. The slope of the regression line is negative (-0.18) and significant at the 10% level (the robust standard error is 0.1036), which is consistent with the proposition that the MFN free-rider problem (as evidenced by a negative average effect of the HHI on the tariff) is more severe for larger countries.

The coefficients on the HHI for many developing countries in the sample are not statistically significant, whereas most of the OECD countries have significant coefficients of the correct sign. Since the country-specific regressions implicitly assume that each country's market power for a product equals its average market power, the result for developing countries is consistent with the supposition that these countries have little market power on average. However, it could also be that the theory does not apply to developing countries. To find out, we must exploit the cross-product heterogeneity in market power that is present in our data. While a developing country may have little market power on average, the tariffs it imposes on products where it does have market power should be negatively related to the HHI if our theory is correct.

We next estimate regressions with data pooled across countries. Incorporating the considerations of Section 4.1, we derive the following specification:

$$\tau_{ck} - 1 = \alpha + \beta_1 MP_{ck} + \beta_2 H_{ck} \cdot MP_{ck} + \beta_3 H_{ck} + \sum_l \eta_l \frac{I_l}{\mu_{ck}} + \nu \frac{\Phi_{ck}}{\mu_{ck}} + \sum_c \gamma_c I_c + \varepsilon_{ck} \tag{9}$$

where $\tau_{ck} - 1$ is the ad-valorem MFN tariff rate on product k of importing country c averaged over the years 1995-2000, H_{ck} is the HHI of country c's imports of product k in 1993, MP_{ck} is one of our two proxies for product-specific market power (*Diff* or HIEE), μ_{ck} is country c's import demand elasticity for product k, Φ_{ck} is country c's imports from FTA partners as a share of total imports of product k also in 1993.

As mentioned before, our 6-digit HS data set lacks information on production and therefore on the inverse import-penetration ratio. Thus, in the HS regressions, we let the industry (HS section) dummies (I_l) absorb the effect of both political power and inverse import-penetration ratio at the industry level (see second term in equation 7). On the other hand, we can control for the product and country-specific import demand elasticities. Thus, we interact industry dummies and FTA shares with the inverse import demand elasticities (see third term in equation 7).

Given that MP_{ck} and H_{ck} serve as *proxies* for the true inverse export supply elasticity and the market share of participants, respectively, we should not expect the estimated coefficients of MP_{ck} and $H_{ck} \cdot MP_{ck}$ to be 1 and -1, respectively, as in equation (7). Nevertheless, the theoretical model pins down expected signs. First, we expect $\beta_1 > 0$, as this captures the effect of the importing country's market power when $H_{ck} = 0$, which is when free riding is complete and the negotiated tariff is equal to the non-cooperative optimal tariff. As in the optimum tariff theory, the higher country c's market power in sector k, the higher the tariff it sets. Second, we expect the effect of the HHI on tariffs to be negative in sectors where the importing country has high market power, i.e., $\beta_2 < 0$, as the HHI interacted with market power is intended to capture the internalization of terms of trade effects through negotiations. We expect β_3 to be zero or slightly negative, since it captures the effect of the HHI when $MP_{ck} = 0$, i.e. zero or low market power. The coefficient on the FTA share is theoretically ambiguous. A negative coefficient would indicate that the importing country does not fully internalize the effect of its tariff on its FTA partners (i.e., $\phi < 1$), while the opposite interpretation is true for a positive coefficient.

Table 1 shows the results of estimating equation (9) on MFN applied tariffs. The standard errors reported in these and all the following regressions in the paper are robust – to address heteroskedasticity – and clustered by country – to account for correlation of observations within a country. The first four columns contain estimates using the Rauch proxy for market power. Specifically, the categorical variable *Diff* is equal to 1 if the product is differentiated and zero otherwise. Columns (5)-(8) use *HIEE* as the measure of market power. Overall the results are strongly in line with the theory: a country's MFN tariff is increasing in its market power in the absence of internalization, as indicated by the positive and significant coefficient β_1. This market power effect is diminishing in the HHI, as indicated by the negative and significant β_2. The direct effect of the HHI, β_3, is insignificant, except in column (8) where β_3 is negative and significant at the 10% level. The FTA share variable is consistently positive but significant only in regressions (2) and (6).

Columns (1) and (5) contain the OLS results for the baseline specification, which includes industry (HS section) dummy variables interacted with the inverse import demand elasticities. Columns

(3) and (7) add industry fixed effects as well. In our model, industry effects enter only through the domestic political economy term, which is why we have only considered industry dummies interacted with the inverse import demand elasticities in the baseline specification. More generally, however, there may be industry-level effects that lie outside of our model, such as alternative domestic political determinants or possibly foreign political pressure. As shown in the table, adding industry fixed effects has no appreciable effect on the results.

Even with country and industry fixed effects and our political-economy controls, we cannot rule out the possibility of endogeneity affecting our estimates of the impact of the HHI. The most obvious sources of endogeneity, however, would tend to imply a positive correlation between the tariff and the HHI. Thus they would bias toward zero our estimates of a negative effect of the HHI for instances of high market power and could possibly explain the insignificant or positive effects of the HHI for instances of zero/low market power. For example, it is likely that a market with few foreign suppliers (and thus high HHI) is also less competitive domestically. In this case, the government might use the tariff as a second-best instrument for correcting the domestic distortion of monopolistic pricing. It is also likely that concentrated domestic producers wield disproportionate political influence and therefore high tariffs. These effects would imply a positive correlation between the HHI and the tariff. Another possibility is reverse causality. A higher tariff rate in country c may affect the exporting countries' market shares in c and thereby influence c's HHI. This cannot occur in our theoretical model, which assumed the shares to be independent of prices, but it might be true in the data if the export supply elasticities differ across countries. Even then, for the tariff to influence the HHI substantially in one direction or the other, the export supply elasticities would have to be systematically related to export shares. The most likely scenario along these lines is that a high tariff weeds out the smaller foreign suppliers (i.e., adjustment occurs at the extensive margin), in which case there would be a positive effect of the tariff on the HHI.

Columns (2), (4), (6) and (8) address the issue of potential endogeneity of the HHI using an IV approach. We construct an instrument for the HHI of each country c by finding the three countries in our sample with HHI most highly correlated with that of c and using their average HHI as an instrument for c's HHI. The reason for averaging is to avoid data loss resulting from cross-country variation in the number of observations. This instrument is particularly appropriate where domestic distortions or political economy determinants of a country's MFN tariff rates, not captured in our theoretical model, are correlated with the HHI.[29] We do not instrument for the market power variables, as we regard the elasticity estimates and product classification to be exogenous. The results in columns (2), (4), (6) and (8) are qualitatively the same as in the OLS regressions, although the effect of market power and the interaction between market power and the HHI are larger in absolute value in the IV estimates.

4.3 Quantification

A useful way to gauge the magnitude of our results is to consider some counterfactual comparisons. The first counterfactual is to set the HHI equal to zero. This produces an estimate of what the tariff would be in the absence of negotiations (the noncooperative tariff), because an HHI of zero corresponds to such extreme free riding that none of the terms-of-trade effects of a country's tariff reduction would be internalized among the participants. The second counterfactual is to set the HHI equal to $-\beta_1/\beta_2$, which is the HHI at which the positive effect of high market power β_1 is exactly offset by the negative negotiation effect β_2. This produces an estimate of what the tariff would be if internalization were complete.[30] We call this the "potential" tariff. In between these two extremes is the actual HHI, which corresponds to partial internalization of terms-of-trade effects and results in the negotiated tariff predicted by our empirical model.

Based on our baseline IV specifications (2) and (6), we compare, for each 6-digit product, the negotiated and potential tariffs with the noncooperative tariff. We take the average of these differences across products and countries and divide it by the average noncooperative tariff. The results are reported in Table 2. Using the average over all countries and products, we find that the internalization of terms-of-trade effects reflected in the negotiated tariff makes the average applied MFN tariff lowe than the noncooperative level by about 17% for the Rauch measure and 20% for the HIEE measure. The potential tariff reductions are 27% and 25%, respectively. Thus, depending on the measure, between 63% and 80% of all the potential terms-of-trade-driven tariff liberalization

[29] As far as the first stage is concerned, the correlation coefficient between the instrument and the HHI is 0.50 (significant at the 1% level) in the 6-digit HS dataset, and 0.48 (significant at the 1% level) in the 4-digit ISIC dataset. As for the exclusion restriction, it is unlikely that a country's political economy dynamics are correlated other countries' HHI.

[30] To see this, suppose there is a linear relationship between the market share of participants Θ and the HHI, $\Theta = \kappa H$. Equation (7) tells us that the coefficient on $1/\xi$ should be equal and opposite that on Θ/ξ, which implies that $\beta_2 = -\beta_1\kappa$. We know that $\Theta = 1$ corresponds to complete internalization, leaving the tariff to be determined solely by domestic political-economy and FTA considerations. Thus, the HHI at which full internalization occurs is $H^* = 1/\kappa = -\beta_1/\beta_2$.

has been realized through negotiations. That is the good news. The bad news is that, short of an exogenous increase in the average HHI (or some other exogenous source of gradualism), the remaining 20 to 37 percent cannot be realized by negotiations, so long as members are constrained by MFN but cannot force non-participants to reciprocate.

For the nine developed countries in our sample plus the EU the negotiated tariff is 26% below the noncooperative level for the Rauch measure and 30% for the HIEE measure, whereas for developing countries it is 15% and 17%, respectively. This difference largely reflects the fact that noncooperative applied tariff levels are considerably higher for developing countries, due to domestic factors. It is interesting to note, however, that our model predicts that developing countries have realized a larger fraction of the potential reductions (between 68 and 85 percent) than have developed countries (between 53 and 68 percent), which is due to the fact that developing countries face higher HHIs on average (0.62 versus 0.49) and thus confront less of a free rider problem in negotiations. An important caveat here is that we are only measuring potential terms-of-trade-driven tariff liberalization. There is considerable scope for liberalization through reduction in domestic motives for protection. Moreover, by giving governments a credible commitment device vis-a-vis domestic political actors, GATT/WTO negotiations may be instrumental in reducing tariffs along this dimension (see, e.g., Maggi and Rodriguez-Clare, 1998). However, this is beyond the scope of our model.

To put the above estimates in context, we can ask how much of the post-war liberalization of our sample countries is due to the internalization of terms-of-trade effects through GATT/WTO negotiations. While our data cover only the 1990s, Clemens and Williamson (2004) present historical data on applied tariffs, measured as tariff revenue divided by dutiable imports, for 35 countries of which 25 overlap with our sample.[31] They put the simple average tariff across these 25 countries at 14.1% in 1945. To construct a comparable measure of our predicted tariffs, we compute the trade-weighted average negotiated and noncooperative tariffs for each country, using as trade weights import shares from 1993, and take the simple average across the same 25 countries. Using the *Diff* measure of market power, we find an average noncooperative tariff of 13.1% and an average negotiated tariff of 11.2%. Thus, we conclude that of the 3 percentage points drop in average tariffs

[31] Argentina, Australia, Brazil, Canada, Chile, Colombia, Indonesia, India, Japan, Mexico, Norway, New Zealand, Peru, Sri Lanka, Thailand, United States and 9 members of the EU – Austria, Denmark, France, Germany, Italy, Portugal, Spain, Sweden, and United Kingdom.

between the 1945 actual and the 1995-2000 negotiated levels, two thirds may be attributed to the internalization of terms-of-trade effects according to our model estimates. The remainder may be attributed to diminishing unilateral motives for protection.

Table 2 also shows how the internalization effect varies by HS section. While the two measures of market power give different results, they agree on the main points: food, textiles and clothing are predicted to experience the smallest tariff reductions, while instruments, arms, machines, and transport equipment are predicted to experience the largest. The ranking is driven by a combination of differences in HHI, market power and noncooperative tariff levels. For example, instruments (Section 19) and footwear (Section 12) have approximately the same levels of product differentiation and export elasticity; however, footwear has a much lower HHI (0.4 compared to 0.7 for instruments) leading to far lower internalization. In addition, footwear has a higher average predicted noncooperative tariff (20% compared to 17% for instruments) probably reflecting domestic political pressure, and since we compute percentage changes in relation to the noncooperative tariff, this further drives down the percentage difference for footwear. The lower HHI in footwear also explains why so little of the sector's *potential* tariff liberalization has been realized. This sets footwear apart from other low-liberalization sectors, such as animal and vegetable fats, which have very little liberalization potential, because of low levels of product differentiation and low inverse export supply elasticities.

4.4 Robustness Checks

Table 3 shows the results of estimating equation (9) on MFN bound tariffs. The table is patterned after Table 1, with baseline OLS and IV results shown in columns (1)-(2) for the Rauch proxy and (5)-(6) for the HIEE dummy, while columns (3)-(4) and (7)-(8) add industry fixed effects. The results are largely unchanged from the applied tariff regressions, though β_1 and β_2 are consistently greater in absolute value, and β_3 is positive and significant in the case of the Rauch proxy.[32]

Table 4 tests the robustness of our findings for both applied and bound rates. Here we add, as controls, the share of each importing country's total exports (i.e., of all products) to the top five exporters of each product (*Share of IC's exports to top 5 exporters*) and *Non-GATT market share*. In considering the impact of these two controls, we account for cross-product variation in monopoly

[32]The finding of positive β_3 is only in the case of bound tariffs under the Rauch market power proxy and is not robust to adding more disaggregated fixed effects, e.g., 2-digit HS fixed effects.

power by interacting them with the market power variables. The reason for the first control is reciprocity. Our theory assumes that exporting countries have the option to reciprocate with transfers in addition to trade barrier reductions. This ensures that a country would never distort its tariff choice relative to the optimum in equation (2) for the purpose of achieving reciprocity. If transfers were ruled out, however, it could be that importing country c would be more inclined to reduce its tariff toward countries that represent a large market for c's exports. One might be concerned that the products principally supplied by such countries have high HHI, thus causing a negative correlation between the HHI and the MFN tariff rate unrelated to MFN. *Share of IC's exports to top 5 exporters* thus represents a measure of importing country c's overall export dependence on the principal suppliers of each product it imports.[33]

The logic behind non-GATT market share is that we include non-GATT countries receiving MFN treatment (e.g., China) in the denominator of the HHI but exclude them from the numerator, because they are not potential participants. Therefore, the higher the non-GATT market share the lower our measure of the HHI. By controlling for the non-GATT market share, we can check whether the negative impact of the HHI is mostly driven by countries that cannot participate in negotiations (because they are not GATT/WTO members) as opposed to being driven by countries that decide not to (although they are members of the GATT/WTO system). For the most part, the additional control variables are themselves statistically insignificant and have little effect on our main findings.

4.5 Estimation based on the 4-digit ISIC data set

Recall that the main advantage of the 4-digit ISIC dataset is that it contains information on production levels by sector, which enable us to control explicitly for the inverse import penetration ratio and thus capture a key domestic political economy determinant of the negotiated tariff in our theory. Using this data set, we follow the same steps as in the previous section.

We first investigate the role of country size. We estimate country-specific regressions of the average MFN applied tariff rate (over the years 1995-1999) on the 1993 HHI. The estimated coefficient on the HHI is indeed negative for most countries in the sample. It is plotted against the country's

[33] 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.

log GDP in Figure 3. The slope of the fitted line, estimated using WLS, is negative (-0.7443), but unlike before it is highly significant (at the 1% level, with robust standard error of 0.2384). The reason for this difference may be the country sample, which contains fewer very small countries or poor countries. Nonetheless, the regression confirms that the negative impact of the HHI on the MFN tariff rate is more pronounced for larger countries.

We next estimate the model pooling the data across countries. The specification we use resembles equation (9):

$$\tau_{ck} - 1 = \alpha + \beta_1 H_{ck} + \beta_2 H_{ck} \cdot MP_{ck} + \beta_3 MP_{ck} + \sum_l \eta_l I_l \frac{X_{ck}}{M_{ck}} + \beta_4 \Phi_{ck} + \sum_c \gamma_c I_c + \varepsilon_{ck} \tag{10}$$

where again $\tau_{ck} - 1$ is the ad-valorem MFN tariff rate on product k of importing country c averaged over the years 1995-1999, MP_{ck} is one of our two proxies for product-specific market power (*Diffshare* or *HIEE*), $\frac{X_{ck}}{M_{ck}}$ is the inverse import-penetration ratio in 1993 (ratio of domestic total output to imports) and Φ_{ck} is importing country c's imports from FTA partners as a share of total imports of product k in 1993. Equation (10) differs from equation (9) in a few respects. First, we control explicitly for the inverse import penetration ratio. Helpman (1997) shows that the optimal tariff depends on this ratio for a wide variety of political economy models. Moreover, Grossman and Helpman (1994), Goldberg and Maggi (1999) and Gawande and Bandyopodhayay (2000) show that the sign of the effect of the inverse import-penetration ratio on import protection varies by sector, depending on the sector's political organization. In addition, the impact of $\frac{X_{ck}}{M_{ck}}$ should also depend on the import demand elasticity, but in the ISIC analysis, we cannot use import demand elasticities without an unacceptable drop in sample size. Thus, the industry dummy variables (I_l) in the political-economy term capture the impact of each industry's political power and import demand elasticity, which are assumed to be constant across all sectors within an industry and the same across importing countries.[34] In addition, the FTA share variable is not divided by the import demand elasticity. Therefore the coefficients on the political economy and FTA terms are not comparable in magnitude across the HS vs. ISIC regressions. The last difference between the two specifications is that the Rauch proxy for market power used in the ISIC regressions is *Diffshare*, which is the share of the 4-digit SITC products within each 4-digit ISIC category that are classified as differentiated.

[34] To relax the assumption that each industry's political power and import demand elasticity are the same across importing countries, we also consider country-specific industry dummy variables in additional regressions (see below).

Tables 5 and 6 present the estimates using the 4-digit ISIC dataset. These results are qualitatively very similar to the 6-digit HS findings. While the OLS results are generally weaker in terms of statistical significance, the IV results show a positive and significant direct effect of market power β_1 and a negative and significant effect of the HHI for high market power products, β_2, even in the most demanding specifications.[35] Contrary to expectations, the direct effect of HHI is also positive and marginally significant in the case of the Rauch proxy, but again this is not robust to the measure of market power or the addition of industry fixed effects. The effect of *FTA share* is now strongly negative and significant in most specifications.[36] The interpretation of this result is that importing countries do not fully internalize the effect of their tariffs on their FTA partners (i.e., $\phi < 1$). In particular, the higher the FTA share, the smaller the terms-of-trade gain for an importing country from setting a high tariff (as the price of products coming from FTA partners equals the domestic price), and therefore the lower the MFN tariff.[37] Finally, in additional regressions (not shown), we estimate a modified version of equation (10) where we replace the industry dummy variables with importing-country-specific industry dummy variables. We find very similar results.

To conclude, we believe we have found remarkably robust evidence that the MFN tariffs of WTO countries are driven by terms-of-trade considerations and that the degree of success in reducing tariffs through negotiations depends on the concentration of exporters in combination with market power in a manner consistent with our theory. Our results are even stronger in light of the following consideration. Participants in the negotiations may try to constrain the MFN externality via reciprocity and their determination to do so might be greater when the participation problem is more severe (i.e., the HHI is low). This would imply that when the HHI is low (and our model predicts that the tariff should be high, assuming high market power), endogenous mitigation of the MFN externality should increase the internalization of terms of trade effects, thereby lowering the tariff relative to our prediction. In other words, the presence of this effect should bias the coefficient on the interaction towards zero.

[35] Note that the instrument for the HHI is slightly different from the one used in the 6-digit HS regressions. For each country c, we find the other country in our sample with HHI most highly correlated with that of c and use its HHI as an instrument for c's HHI.

[36] Note that, while FTA share could be endogenous due to reverse causality, this is likely to create a positive bias in the estimate of the coefficient, as higher MFN tariff rates should increase import shares from FTA partner countries.

[37] Given our earlier results on the FTA share in the HS6 regressions, and the possibility of reverse causality, our evidence on the building-block-stumbling-block question is mixed, as in the existing literature (Limão, 2006; Estevadeordal, Freund and Ornelas, 2008).

5 Conclusion

The main findings of this paper are twofold. First, the MFN tariffs of WTO countries are higher in the presence of market power, controlling for factors affecting domestic politics and international negotiations. This result generalizes to WTO countries the evidence on optimal tariffs found by Broda, Limão and Weinstein (2008) who use a sample of non-WTO countries. Second, and arguably more important, we find a country's MFN tariff is decreasing in the Herfindahl-Hirschman index for products over which it has high market power. Thus, we generalize to existing WTO countries the findings of Bagwell and Staiger (2011) for accession countries that indeed trade agreements are intended to mitigate terms-of-trade effects. Moreover, we generalize the evidence on the MFN free rider problem found by Ludema and Mayda (2009) using U.S. data and provide clear evidence that the MFN free rider problem is driven by terms-of-trade effects.

The broader implications of these findings are threefold. First, if terms of trade effects drive trade agreements, then the principles of reciprocity and nondiscrimination on which so much of the WTO seemingly depends are indeed valuable, and the attempts of economists and legal scholars to understand the WTO in these terms should prove fruitful. Second, if a lack of participation due to the MFN free rider problem exists and is widespread, then it suggests that the principle of nondiscrimination is not without its drawbacks. There are many benefits to MFN discussed in the literature, so it would be premature to advocate the elimination of MFN based on our results. The solution to the MFN free rider problem is to provide greater inducements for participation and/or isolate free riders from the benefits of liberalization. The principal supplier rule, reciprocity, the use of formula negotiations and the single undertaking can all be seen as attempts to combat the MFN free rider problem along one or both of these dimensions. At this point, all we know is that they have not eliminated the problem. More study is required to determine what effects these approaches have had and to suggest preferable alternatives.

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A Appendix on Reciprocity

In the model of Section 2, we assumed any exporter that does not request negotiations on a product (or alternatively requests negotiations but fails to reach agreement with the importer) pays no compensation for tariff reductions the importer makes resulting from negotiations with other countries. Such an exporter is a pure free rider, contrary to the principle of reciprocity. In this appendix, we relax this assumption by assuming that each exporter must pay a minimum compensation equal to $\hat{c}_{jg} = \rho(v_{jg} - \hat{u}_{jg})$, where $\rho < 1$ and $\hat{u}_{jg}$ is an exogenous reference value. That is, each exporter pays at least a fraction ρ of the gain it obtains from the importers tariff choice, relative to $\hat{u}_{jg}$. It follows that for every $g \in \Gamma_i$, the tariff chosen by importer i in the final stage becomes $\tau_g^n(A_g) = \arg\max v_{ig}(\tau_g) + \sum_{j \in A_g} c_{jg}(\tau_g) + \sum_{j \notin A_g} \hat{c}_{jg}(\tau_g)$, resulting in,

$$\tau_g^n(A_g) = \frac{1 + \frac{1-\rho}{\xi_g}(1 - \Theta_{A_g})}{1 - \frac{\lambda_{ig}}{\tilde{\mu}_g}\frac{X_g}{M_g} + \frac{1-\phi_{ig}}{\tilde{\mu}_g}\Phi_g}. \tag{11}$$

Equation (11) shows that the negotiated tariff will continue to be increasing in the market power of the importer, so long as there is less-than-full participation, i.e., $1 - \Theta_{A_g} > 0$, and less-than-full reciprocity from non-participants, i.e., $1 - \rho > 0$. We can interpret the term $\frac{1-\rho}{\xi_g}$ as the "effective" market power of the importer. As long as it is positive, there is no substantive change in the negotiated tariff equation, and in particular, there is in no change in our estimating equations (9) and (10), as $1 - \rho$ gets absorbed into the parameters β_1, β_2 and β_3.

It remains to show how partial reciprocity affects participation decisions. The critical constraint that must be satisfied by any set participants A_g is (5), which ensures that each requested good is included in the importer's offer list. Under partial reciprocity this becomes,

$$(1-\rho)\sum_{j \in A_g} v_{jg}(\tau_g^n(A_g)) - v_{jg}(\tau_g^n(A_g/j)) - \frac{1}{2}\left[W_{A_g}(\tau_g^n(A_g)) - W_{A_g}(\tau_g^n(A_g/j))\right] \geq \bar{v}_{ig} - v_{ig}(\tau_g^n(A_g)) \tag{12}$$

Note that to obtain (12) we have used the assumption that if the importer does not include g its offer list, it can nevertheless obtain minimum reciprocal compensation by unilaterally lowering its tariff. Thus, $\bar{v}_{ig}$ refers to the importer's payoff from its optimal tariff using effective rather than true market power. Again equation (12) is nearly identical to (5), and thus all the qualitative conclusions regarding the principal supplier rule and the effect of H remain changed. Further, it is interesting to note that if we hold effective market power constant while increasing ρ, it becomes more difficult to satisfy (12). That is, greater reciprocity actually makes it harder to obtain participation *ceterus parabis*. The intuition is that the more the importer can rely on reciprocity from non-participants to obtain compensation for its tariff reductions, the less it needs participation.

Table 1: Regression Results for Applied Tariffs (6-digit HS data)

	1	2	3	4	5	6	7	8
Method	OLS	IV	OLS	IV	OLS	IV	OLS	IV
Dependent variable	Applied MFN tariff							
Differentiated Product (Diff)	2.72***	4.30***	2.92***	4.07***				
	(0.56)	(1.05)	(0.59)	(1.04)				
Herfindhal-Hirschman index*Diff	-1.67**	-4.94***	-1.35**	-3.85**				
	(0.66)	(1.72)	(0.63)	(1.77)				
High Inverse Export Elasticity					1.77***	2.92***	1.69***	2.45**
					(0.58)	(0.99)	(0.60)	(0.99)
Herfindhal-Hirschman index*HIEE					-1.81***	-4.15***	-1.41**	-3.05**
					(0.56)	(1.25)	(0.555)	(1.236)
Herfindhal-Hirschman index	0.61	-1.57	0.38	-1.96	0.60	-2.51	0.29	-3.04*
	(0.58)	(1.80)	(0.54)	(1.86)	(0.68)	(1.63)	(0.65)	(1.66)
FTA share/Import demand	2.28	2.50*	1.75	1.99	2.41	2.63*	2.04	2.27
elasticity	(1.50)	(1.48)	(1.61)	(1.57)	(1.56)	(1.55)	(1.69)	(1.67)
Constant	12.8***	14.2***	13.3***	11.2***	13.2***	15.2***	9.8***	12.0***
	(0.58)	(1.17)	(2.05)	(1.53)	(0.74)	(1.26)	(0.96)	(1.47)
HS section dummy variables/ Import demand elasticity	yes	yes	yes	yes	yes	yes	yes	yes
HS section dummy variables	no	no	yes	yes	no	no	yes	yes
Observations	111,738	109,675	111,738	109,675	111,923	109,675	111,923	109,675
R-squared	0.37	0.37	0.39	0.39	0.37	0.36	0.39	0.38

Source: WITS plus additional data sources (see text). Robust standard errors, clustered by importing country, in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%. Importing country fixed effects are included in each regression. The Herfindhal-Hirschman index equals the sum of squared import shares from each exporting country to each importing country, excluding exporters which are part of a preferential trade agreement with the importing country and excluding countries without MFN treatment. Countries which do not belong to the WTO but receive MFN treatment by the importing country are included in the denominator of the Herfindhal-Hirschman index, but not in the numerator. Differentiated products are classified according to Rauch. The High Inverse Export Elasticity is equal to 1 if the inverse export elasticity of the product is above the 33rd percentile of elasticities of that country. The FTA Share gives the overall import share (by sector) from countries which are part of a preferential trade agreement with the importing country. EC countries are considered as one block. In regressions (2), (4), (6) and (8), we instrument the Herfindahl-Hirschman index: For each country c, we find the three other countries in our sample with Herfindahl-Hirschman index most highly correlated with that of c and use the average of their Herfindahl-Hirschman indices as an instrument for c's Herfindahl-Hirschman index.

Table 2: Negotiated and Potential Reductions in Applied Tariffs Relative to Noncooperation

Market Power Measure	Diff		HIEE	
Percentage Difference	Negotiated	Potential	Negotiated	Potential
All products by country:				
All Countries	-17.3	-27.3	-19.7	-24.7
Developed Countries	-26.3	-49.9	-30.1	-44.4
Developing Countries	-15.2	-22.1	-17.2	-20.0
All countries by product:				
Section XVIII: Instruments	-27.8	-44.2	-27.7	-35.7
Section XIX: Arms and ammunition	-25.8	-32.6	-24.4	-25.3
Section XVI: Machinery & electrical equipment	-25.5	-39.4	-26.2	-32.9
Section XVII: Transportation equipment	-22.0	-32.6	-21.7	-26.0
Section XIII: Stone, plaster, cement, ceramic, glass	-21.9	-33.3	-20.2	-24.8
Section XIV: Pearls, precious stones and metals	-19.6	-31.8	-29.8	-35.6
Section IX: Wood and wood products	-19.6	-28.8	-22.6	-25.9
Section V: Mineral products	-19.3	-25.3	-29.0	-31.0
Section VIII: Raw hides and skins, leather, fur	-18.0	-33.7	-18.1	-27.4
Section VI: Chemical and allied products	-17.3	-24.7	-24.0	-27.7
Section XX: Miscellaneous manufactured articles	-16.4	-33.0	-16.0	-26.1
Section VII: Plastics and rubber products	-15.9	-26.3	-16.8	-21.9
Section X: Pulp and paper	-15.9	-22.9	-20.4	-23.3
Section XV: Base metal and articles of base metal	-15.3	-25.9	-19.1	-25.0
Section XI: Textiles and textile articles	-13.4	-22.9	-14.2	-19.2
Section XII: Footwear, headgear, etc.	-13.2	-28.3	-12.3	-21.3
Section II: Vegetable products	-11.7	-16.1	-18.9	-20.7
Section I: Live animals, animal products	-10.8	-15.5	-18.0	-19.1
Section IV: Prepared foodstuffs	-10.4	-14.5	-13.3	-14.8
Section III: Animal or vegetable fats and oils	-9.6	-12.2	-17.1	-17.6

Data sources: 6-digit HS data. The percentage differences relative to the noncooperative applied tariff are computed as average differences - as predicted by the empirical model in regressions (2) (Diff) and (6) (HIEE), Table 1 - as a percentage of the average noncooperative predicted tariff. Reported values are simple averages over the groups indicated.

Table 3: Regression Results for Bound Tariffs (6-digit HS data)

	1	2	3	4	5	6	7	8
Method	OLS	IV	OLS	IV	OLS	IV	OLS	IV
Dependent variable	Bound MFN tariff							
Differentiated Product (Diff)	3.51***	8.31***	4.14***	8.06***				
	(0.83)	(1.64)	(0.79)	(1.57)				
Herfindhal-Hirschman index*Diff	-6.38***	-14.3***	-5.63***	-12.3***				
	(1.25)	(2.70)	(1.15)	(2.53)				
High Inverse Export Elasticity					1.19*	3.53**	1.49**	3.46**
					(0.64)	(1.58)	(0.61)	(1.47)
Herfindhal-Hirschman index*HIEE					-3.25***	-7.22**	-2.80***	-6.32**
					(0.94)	(2.89)	(0.842)	(2.59)
Herfindhal-Hirschman index	3.21***	8.23***	2.50***	6.32***	1.49	3.50	0.83	1.95
	(0.93)	(2.60)	(0.82)	(2.29)	(0.92)	(2.76)	(0.86)	(2.42)
FTA share/Import demand	4.15*	3.97*	3.80*	3.85*	4.14*	4.03*	3.94*	4.04*
elasticity	(2.20)	(2.08)	(2.10)	(2.02)	(2.17)	(2.05)	(2.134)	(2.06)
Constant	30.2***	26.8***	26.4***	23.8***	31.9***	30.5***	27.9***	27.1***
	(0.65)	(1.48)	(1.44)	(2.04)	(0.74)	(1.40)	(1.49)	(1.97)
HS section dummy variables/ Import demand elasticity	yes	yes	yes	yes	yes	yes	yes	yes
HS section dummy variables	no	no	yes	yes	no	no	yes	yes
Observations	109,365	107,211	109,365	107,211	109,550	107,211	109,550	107,211
R-squared	0.61	0.61	0.63	0.63	0.61	0.61	0.63	0.63

Source: WITS plus additional data sources (see text). Robust standard errors, clustered by importing country, in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%. Importing country HS section fixed effects are included in each regression. The Herfindhal-Hirschman index equals the sum of squared import shares from each exporting country to each importing country. The Herfindhal-Hirschman index is calculated excluding countries which are part of a preferential trade agreement with the importing country and excluding countries without MFN treatment. Countries which do not belong to the WTO but receive MFN treatment by the importing country are included in the denominator of the Herfindhal-Hirschman index, but not in the numerator. See the definition of the additional variables and of the instrument for the Herfindhal-Hirschman index at the end of Table 1.

Table 4: Extended Results (6-digit HS data)

	1	2	3	4	5	6	7	8
Method	OLS	IV	OLS	IV	OLS	IV	OLS	IV
Dependent Variable	Applied MFN tariff		Bound MFN tariff		Applied MFN tariff		Bound MFN tariff	
Differentiated Product (Diff)	2.48**	3.34**	3.38**	9.03***				
	(0.91)	(1.57)	(1.42)	(2.54)				
Herfindhal-Hirschman index*Diff	-1.65**	-4.03*	-5.62***	-14.6***				
	(0.68)	(2.08)	(1.14)	(3.31)				
High Inverse Export Elasticity					2.41**	3.51**	1.51	4.09*
					(0.95)	(1.34)	(1.04)	(2.01)
Herfindhal-Hirschman index*HIEE					-1.74***	-3.97***	-3.39***	-7.85**
					(0.59)	(1.34)	(0.90)	(3.15)
Herfindhal-Hirschman index	0.69	-2.61	2.60***	8.55**	0.68	-2.92	1.37	3.46
	(0.59)	(2.35)	(0.84)	(3.31)	(0.70)	(1.83)	(0.89)	(3.06)
FTA share/Import demand	1.51	2.54	3.68*	3.17*	1.53	2.60	3.72*	3.65**
elasticity	(1.48)	(1.52)	(1.89)	(1.70)	(1.54)	(1.58)	(1.93)	(1.74)
Share of IC's exports to top 5	-0.075	-1.97	-3.62	-2.70	1.86	-0.081	-3.27	-3.27
exporters	(1.07)	(1.30)	(2.23)	(2.38)	(1.21)	(1.41)	(2.05)	(1.95)
Non-GATT market share	0.25	-1.20	0.66	3.80*	0.11	-0.15	0.52**	0.73
	(0.27)	(1.21)	(0.78)	(2.23)	(0.10)	(0.22)	(0.23)	(0.49)
Share of IC's exports to top 5	0.86	1.15	0.33	0.15				
exporters*Diff	(1.56)	(1.73)	(2.22)	(2.44)				
Non-GATT market share*Diff	-0.069	1.21	-0.29	-3.50				
	(0.24)	(1.14)	(0.74)	(2.22)				
Share of IC's exports to top 5					-1.66	-1.69	-0.40	-0.24
exporters*HIEE					(2.00)	(2.06)	(1.98)	(2.00)
Non-GATT market share*HIEE					0.09	0.12	-0.17	-0.46
					(0.08)	(0.11)	(0.17)	(0.49)
Constant	12.8***	14.2***	30.2***	26.8***	13.2***	15.2***	31.9***	30.5***
	(0.58)	(1.17)	(0.65)	(1.48)	(0.74)	(1.26)	(0.74)	(1.40)
HS section dummy variables/ Import demand elasticity	yes	yes	yes	yes	yes	yes	yes	yes
Observations	111,738	109,675	109,365	107,211	111,923	109,675	109,550	107,211
R-squared	0.37	0.37	0.61	0.61	0.37	0.36	0.61	0.61

Source: WITS plus additional data sources (see text). Robust standard errors, clustered by importing country, in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%. Importing country fixed effects are included in each regression. The Herfindhal-Hirschman index equals the sum of squared import shares from each exporting country to each importing country. The Herfindhal-Hirschman index is calculated excluding countries which are part of a preferential trade agreement with the importing country and excluding countries without MFN treatment. Countries which do not belong to the WTO but receive MFN treatment by the importing country are included in the denominator of the Herfindhal-Hirschman index, but not in the numerator. See the definition of the additional variables and of the instrument for the Herfindhal-Hirschman index at the end of Table 1.

Table 5: Regression Results for Applied Tariffs (ISIC Rev.2 data)

	1	2	3	4	5	6	7	8
Method	OLS	IV	OLS	IV	OLS	IV	OLS	IV
Dependent variable	Applied MFN Tariff							
Diffshare	1.89**	5.06***	3.92***	5.74***				
	(0.82)	(1.24)	(0.91)	(1.54)				
Herfindhal-Hirschman index*	-7.54***	-17.9***	-2.86	-8.36*				
Diffshare	(2.42)	(3.65)	(2.36)	(4.30)				
High Inverse Export Elasticity					0.62	2.57***	1.57**	2.98***
					(0.61)	(0.88)	(0.66)	(1.00)
Herfindhal-Hirschman index*HIEE					-4.43**	-11.3***	-2.05	-6.98**
					-1.94	(2.83)	(2.04)	(3.17)
Herfindhal-Hirschman index	3.75*	9.07**	1.11	4.29	1.5	1.85	0.82	1.19
	(2.07)	(3.90)	(2.04)	(4.35)	-1.8	(3.43)	(1.85)	(4.41)
FTA share	-4.37***	-3.92***	-2.42***	-2.23***	-4.94***	-5.19***	-2.9***	-3.12***
	(1.15)	(0.89)	(0.57)	(0.52)	-1.44	(0.93)	(0.90)	(0.76)
Constant	8.79***	7.05***	12.4***	11.4***	9.7***	9.57***	12.8***	12.7***
	(0.63)	(1.23)	(0.89)	(1.40)	-0.49	(1.09)	(1.01)	(1.53)
Inverse import penetration ratio* industry DVs	yes	yes	yes	yes	yes	yes	yes	yes
Industry DVs	no	no	yes	yes	no	no	yes	yes
Observations	2417	2417	2417	2417	1932	1932	1932	1932
R-squared	0.56	0.55	0.69	0.68	0.55	0.54	0.67	0.67

Source: World Bank's Trade & Production Database plus additional data sources (see text). Robust standard errors, clustered by importing country, in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%. Importing country fixed effects are included in each regression. Outliers (MFN tariff rates higher than 50) are excluded. MFN tariff rates (in percentage points) are simple averages at the 4 digit level ISIC. Industries are defined as 3-digit ISIC codes. For each sector, the Herfindhal-Hirschman index equals the sum of squared import shares from each exporting country to each importing country, excluding countries which are part of a preferential trade agreement with the importing country and excluding countries without MFN treatment. Countries which do not belong to the WTO but receive MFN treatment by the importing country are included in the denominator of the Herfindhal-Hirschman index, but not in the numerator. The *Diffshare* is the share of 5-digit US SIC products in each 4-digit ISIC category that are classified as differentiated according to Rauch. The High Inverse Export Elasticity is equal to 1 if the inverse export elasticity of the product is above the 33rd percentile of elasticities of that country. The inverse import penetration ratio equals the ratio of output value to imports in each sector. The FTA Share gives the overall import share (by sector) from countries which are part of a preferential trade agreement with the importing country. EC countries are considered as one block. In regressions (2) and (4), we instrument the Herfindhal-Hirschman index: For each country c, we find the other country in our sample with Herfindahl index most highly correlated with that of c, and we use that value as an instrument for c's Herfindahl index.

Table 6: Extended Results (ISIC Rev.2 data)

	1	2	3	4
Method	OLS	IV	OLS	IV
Dependent Variable	Applied MFN tariff		Applied MFN tariff	
Diffshare	0.49	5.2**		
	(0.83)	(2.12)		
Herfindhal-Hirschman index*Diffshare	-5.35**	-17.81***		
	(2.46)	(5.22)		
High Inverse Export Elasticity			-0.59	2.57**
			(0.85)	(1.07)
Herfindhal-Hirschman index*HIEE			-2.6	-11.46***
			(2.21)	(3.35)
Herfindhal-Hirschman index	4.9**	10.86**	2.52	2.54
	(2.11)	(4.62)	(2.13)	(4.76)
Share of IC's exports to top 5 exporters	-4.86	-7.03	-8.74	-7.78
	(7.38)	(8.14)	(14.1)	(15.8)
Non-GATT market share	2.87	7.13	1.94	1.8
	(2.67)	(4.8)	(2.53)	(3.54)
Share of IC's exports to top 5 exporters*Diffshare	24.64	26.63		
	(15.13)	(16.52)		
Non-GATT market share*Diffshare	4	-4.52		
	(3.48)	(5.69)		
Share of IC's exports to top 5 exporters*HIEE			21.13	21.64
			(16.1)	(18.03)
Non-GATT market share*HIEE			4.27	-1.13
			(3.56)	(3.07)
FTA share	-2.55	-2.98*	-3.25*	-4.87***
	(1.6)	(1.51)	(1.88)	(1.50)
Constant	8.6***	6.24***	9.51***	9.28***
	0.66**	1.64**	0.71**	1.54**
Inverse import penetration ratio*industry DVs	yes	yes	yes	yes
Observations	2417	2417	1932	1932
R-squared	0.56	0.56	0.56	0.54

Source: World Bank's Trade & Production Database plus additional data sources (see text). Robust standard errors, clustered by importing country, under each estimated coefficient. * significant at 10%; ** significant at 5%; *** significant at 1%. Importing country fixed effects are included in each regression. Outliers (MFN tariff rates higher than 50) are excluded. MFN tariff rates (in percentage points) are simple averages at the 4 digit level ISIC. Industries are defined as 3-digit ISIC codes. EC countries are considered as one block. See the definition of the additional variables and of the instrument for the Herfindhal-Hirschman index (regressions (2) and (4)) at the end of Table 4.

Table 7: Summary Statistics of variables by GDP (6-digit HS data)

GDP in 1993	Variable	N	mean	sd	min	max
smaller than 25th percentile	Applied MFN tariff rate (1995-2000)	20410	12.07	13.68	10.41	154.16
	Bound MFN tariff rate (1995-2000)	22397	43.97	26.40	0.00	257.00
	Herfindahl-Hirschman index (1993)	22685	0.71	0.28	0.00	1.00
	FTA Share (1993)	22685	0.13	0.26	0.00	1.00
	Import demand elasticity	22685	9.12	23.11	1.10	759.95
	Diff	22685	0.69	0.46	0.00	1.00
	High Inverse Export Elasticity	22685	0.69	0.46	0.00	1.00
	Share of IC's exports to top 5 exporters (1993)	22685	0.38	0.21	0.00	0.93
	Non-GATT market share (1993)	19672	0.15	1.92	0.00	118.88
between 25th and 50th percentile	Applied MFN tariff rate (1995-2000)	32472	13.84	13.66	0.00	416.08
	Bound MFN tariff rate (1995-2000)	32284	24.89	21.34	0.00	315.00
	Herfindahl-Hirschman index (1993)	32686	0.60	0.32	0.00	1.00
	FTA Share (1993)	32686	0.17	0.33	0.00	1.00
	Import demand elasticity	32686	9.03	96.28	1.16	16808.04
	Diff	32686	0.63	0.48	0.00	1.00
	High Inverse Export Elasticity	32686	0.70	0.46	0.00	1.00
	Share of IC's exports to top 5 exporters (1993)	28817	0.34	0.17	0.00	0.76
	Non-GATT market share (1993)	32686	0.10	0.21	0.00	1.00
between 50th and 75th percentile	Applied MFN tariff rate (1995-2000)	29728	11.74	13.42	0.00	644.88
	Bound MFN tariff rate (1995-2000)	26665	25.17	20.14	0.00	800.30
	Herfindahl-Hirschman index (1993)	29796	0.48	0.28	0.00	1.00
	FTA Share (1993)	29796	0.03	0.12	0.00	1.00
	Import demand elasticity	29796	4.56	8.02	1.15	131.50
	Diff	29611	0.59	0.49	0.00	1.00
	High Inverse Export Elasticity	29796	0.66	0.47	0.00	1.00
	Share of IC's exports to top 5 exporters (1993)	29796	0.32	0.16	0.00	0.64
	Non-GATT market share (1993)	29796	0.11	0.20	0.00	1.00
greater than 75th percentile	Applied MFN tariff rate (1995-2000)	29313	10.81	12.43	0.00	299.59
	Bound MFN tariff rate (1995-2000)	28204	15.66	18.30	0.00	350.00
	Herfindahl-Hirschman index (1993)	29545	0.52	0.30	0.00	1.00
	FTA Share (1993)	29545	0.18	0.30	0.00	1.00
	Import demand elasticity	29545	5.41	11.20	1.07	195.95
	Diff	29545	0.59	0.49	0.00	1.00
	High Inverse Export Elasticity	29545	0.68	0.47	0.00	1.00
	Share of IC's exports to top 5 exporters (1993)	29545	0.40	0.30	0.00	0.91
	Non-GATT market share (1993)	29545	0.12	0.30	0.00	25.68

Table 8: Summary Statistics of variables by GDP (ISIC Rev.2 data)

GDP in 1993	Variable	N	mean	sd	min	max
smaller than 25th percentile	MFN tariff rate (1995-1999)	567	10.54	5.86	0.00	37.16
	Herfindahl-Hirschman index (1993)	567	0.32	0.17	0.00	1.00
	FTA Share (1993)	567	0.00	0.00	0.00	0.00
	Inverse Import Penetration Ratio (1993)	566	31.64	266.13	0.00	4478.44
	Diffshare	567	0.69	0.41	0.00	1.00
	High Inverse Export Elasticity	391	0.71	0.46	0.00	1.00
	Share of IC's exports to top 5 exporters (1993)	567	0.01	0.02	0.00	0.28
	Non-GATT market share (1993)	566	0.09	0.13	0.00	0.91
between 25th and 50th percentile	MFN tariff rate (1995-1999)	636	14.71	9.48	0.00	39.11
	Herfindahl-Hirschman index (1993)	636	0.25	0.24	0.00	1.00
	FTA Share (1993)	636	0.17	0.32	0.00	1.00
	Inverse Import Penetration Ratio (1993)	635	136.18	1999.06	0.00	48437.63
	Diffshare	636	0.70	0.40	0.00	1.00
	High Inverse Export Elasticity	542	0.74	0.44	0.00	1.00
	Share of IC's exports to top 5 exporters (1993)	636	0.01	0.03	0.00	0.45
	Non-GATT market share (1993)	635	0.10	0.14	0.00	0.96
between 50th and 75th percentile	MFN tariff rate (1995-1999)	586	16.04	12.34	0.00	49.85
	Herfindahl-Hirschman index (1993)	586	0.31	0.20	0.00	1.00
	FTA Share (1993)	586	0.01	0.05	0.00	0.85
	Inverse Import Penetration Ratio (1993)	584	91.74	1143.91	0.00	26992.78
	Diffshare	586	0.69	0.41	0.00	1.00
	High Inverse Export Elasticity	376	0.73	0.45	0.00	1.00
	Share of IC's exports to top 5 exporters (1993)	586	0.01	0.02	0.00	0.21
	Non-GATT market share (1993)	586	0.12	0.15	0.00	0.93
greater than 75th percentile	MFN tariff rate (1995-1999)	634	11.89	11.00	0.00	48.69
	Herfindahl-Hirschman index (1993)	634	0.29	0.21	0.00	0.98
	FTA Share (1993)	634	0.12	0.23	0.00	0.98
	Inverse Import Penetration Ratio (1993)	632	86.38	1119.43	0.00	26971.63
	Diffshare	634	0.70	0.40	0.00	1.00
	High Inverse Export Elasticity	625	0.73	0.44	0.00	1.00
	Share of IC's exports to top 5 exporters (1993)	634	0.01	0.02	0.00	0.19
	Non-GATT market share (1993)	633	0.14	0.16	0.00	0.97

Figure 1: The Effect of HHI on the Export Share of Participants

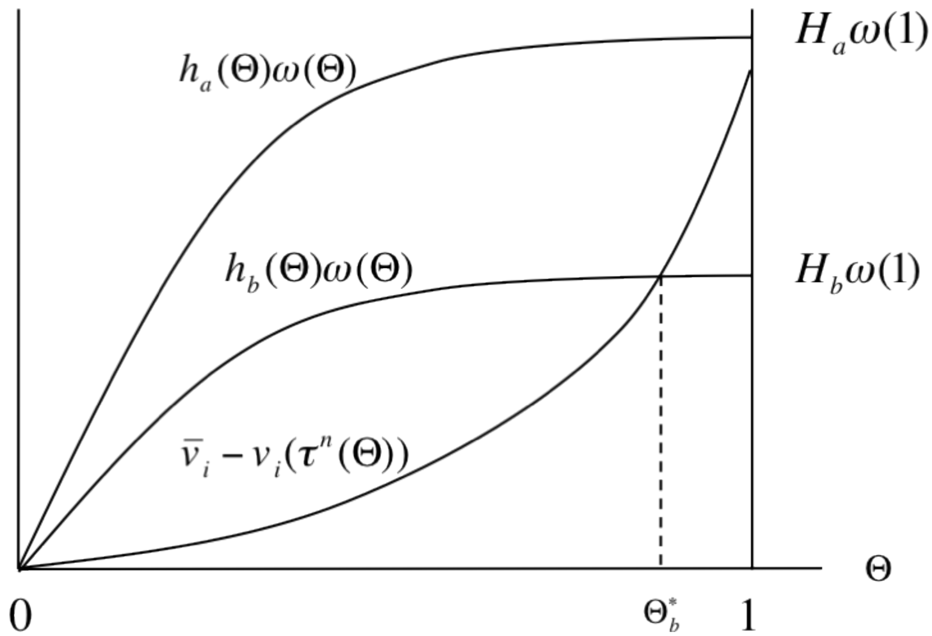
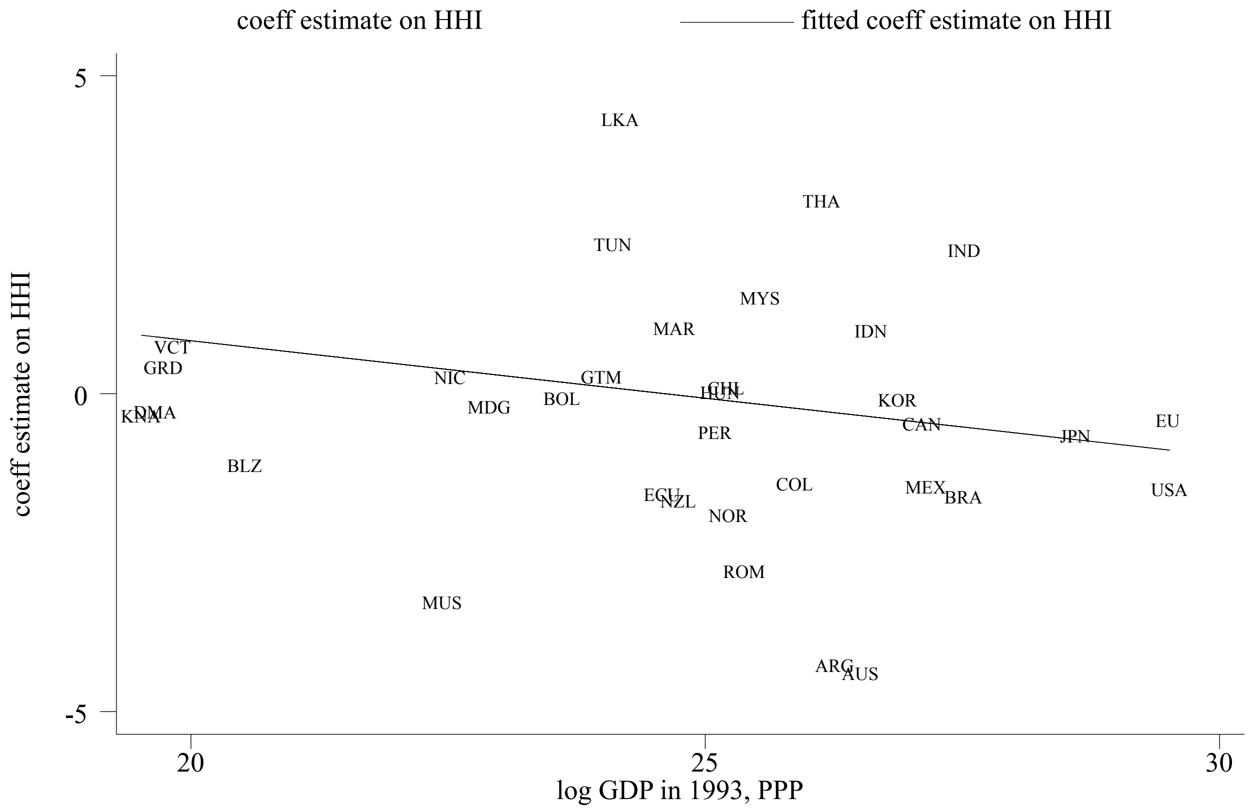
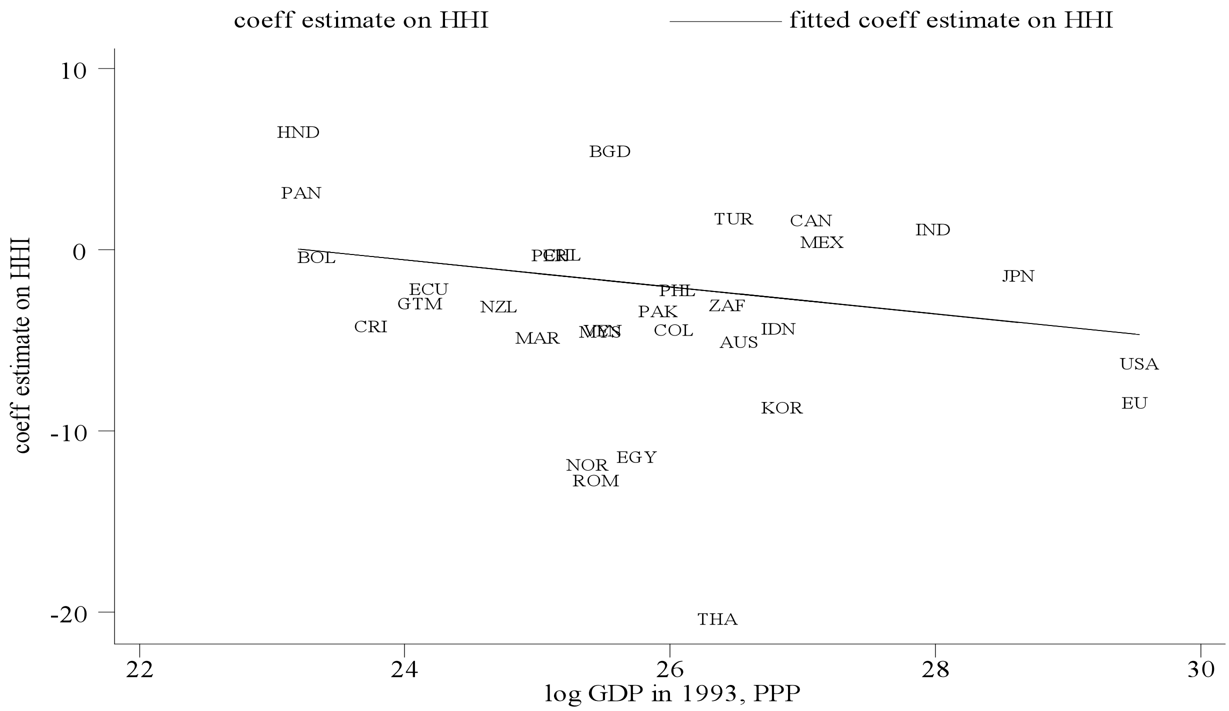


Figure 2: The coefficient estimate on the HHI as a function of GDP of the importing country (HS6)



Data source: 6-digit HS data set. The slope of the line is -0.18, significant at the 10% level (robust standard error of 0.1036). The regression line is estimated with weighted least squares (WLS) using as weights the inverse of the variance of the coefficient estimates (on the HHI) from the first stage. WLS puts more weight on countries with smaller variance of the estimated coefficients. Two outliers are dropped from the graph: Iceland, Gabon.

Figure 3: The coefficient estimate on the HHI as a function of GDP of the importing country (ISIC)



Data source: 4-digit ISIC (Rev.2) data set. The slope of the line is -0.7443, significant at the 1% level (robust standard error of 0.2384). The regression line is estimated with weighted least squares (WLS) using as weights the inverse of the standard errors of the coefficient estimates (on the HHI) from the first stage. WLS puts more weight on countries with smaller variance of the estimated coefficients.