Tariff Binding and Overhang: Theory and Evidence

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Abstract

We characterize the optimal tariff bindings in a trade agreement among asymmetric countries that are subject to idiosyncratic political-economy shocks. We find that the optimal tariff binding is decreasing in the relative size of the importing country and its degree of comparative disadvantage. Moreover, under an optimal agreement a smaller country is more likely to apply a tariff that is substantially below its tariff binding. Using applied and bound tariff data from WTO member countries, we find strong empirical support for our predictions.

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1 Introduction

Most market access commitments under the GATT and the WTO are in the form of bound tariffs, i.e., caps on applied tariff rates. The data on tariff binding commitments and applied tariffs displays two important regularities. First, as indicated in Table 1, applied tariffs are often lower than the bound tariffs. The large size of the 'binding overhang', defined as the excess of tariff binding over the applied tariff, in many sectors suggests that governments have retained substantial flexibility in adopting their import tariffs.

The extent of flexibility provided by tariff binding schedules, however, is significantly different across countries. In particular, we observe that the size of binding overhang (in terms of absolute size and percentage of applied tariff) is smaller for larger countries. This second observation suggests that smaller countries are given more flexibility in setting their tariffs unilaterally.

A demand for flexibility may arise in situations where governments experience shocks to their preferences regarding openness to international trade. However, if there is asymmetric information about the occurrence and size of these shocks, the trading partners have an incentive to use the flexibility measures as a cover for their beggar-thy-neighbor policies that pursue domestic goals at the expense of foreign countries. Therefore, in designing an optimal trade agreement, there is a trade-off between "flexibility" to respond to shocks and "discipline" on opportunistic use of trade policy.

On the theoretical level, this paper contributes to the existing literature on flexible trade agreements by examining the optimal tariff caps for asymmetric countries and provides prediction regarding the choice of applied tariffs, and the resulting binding overhang, by different countries.

In summary, we show that a jointly optimal agreement provides less flexibility to larger trading partners. For a broad intuition for this general result, note that the trade policy of larger countries generates larger terms-of-trade externality on their trading partners. As a result, providing flexibility to large countries through higher tariff bindings will cause a relatively greater efficiency loss. We show that as a

Table 1: Tariffs and Trade Summary Statistics

Binding Status	Num. of sector	Share(%)	Import	Share (%)
Applied Tariff below BInding	112,540	63.75	1.35e+12	23.64
Strong Binding (Applied Tariff at Binding)	29,176	16.53	3.72e+12	65.15
Unbound	34,810	19.72	6.40e+11	11.21
Total	176,526	100	5.72+12	100

result of this effect, under an efficient agreement with tariff bindings, larger countries are more likely to be at the binding than small countries. As a related result, we also show that under optimal tariff bindings, the binding overhang is decreasing in country size.

Different aspects of flexibility in trade agreements have been studied in the literature. Most of this literature, however, formulate the problem of optimal tariff agreements in a way that no binding overhang is theoretically generated. Instead, these works focus on contingent flexibility measures such as escape clauses or safeguards (GATT Article XIX), antidumping measures and countervailing duties.[1]

Our paper is most closely related to the nascent literature on the use of tariff bindings as a flexibility measure.[2] Bagwell and Staiger (2005) analyze the role of

[1] Such papers include Bagwell and Staiger (1990), Feenstra and Lewis (1991), Sykes (1991)Ludema (2001), Beshkar (2011), Beshkar (2010a), Beshkar (2010b), Maggi and Staiger (2011b), Maggi and Staiger (2011a)

[2] There is an emerging theoretical literature that explores the role of tariff bindings at the presence of trade policy uncertainty and risk aversion on behalf of producers. Under various modeling assumptions, Francois and Martin (2004), Handley (2010), and Handley and Limão (2010) show that the benefit of tariff bindings is to reduce uncertainty by censoring the range of observable applied tariffs and limiting losses in the worst case scenario. Sala, Schröder, and Yalcin (2010) show that while a tariff binding that is higher than the applied tariff does not affect the intensive margin of trade, it can increase trade through extensive margin as it reduces the risk of exporting, which attracts more firm to the export market. These papers, however, do not propose an explanation of why tariff overhang exists.

The literature provides at least two other explanations for the use of tariff ceilings in trade agreements. Horn, Maggi, and Staiger (2010) show that at the presence of contracting costs, instead of writing a fully contingent agreement it may be optimal to specify tariff bindings to save on contracting costs. Maggi and Rodriguez-Clare (2007), on the other hand, study trade agreements when governments have a domestic commitment problem. They show that giving discretion to governments to choose a tariff below the binding reduces the inefficiency due to domestic commitment problem. In Maggi and Rodriguez-Clare (2007), however, the governments always apply a tariff

tariff bindings when countries have private information. Bagwell (2009) extends the analysis to the case of a repeated game where tariffs must be self-enforcing. Among other results, Bagwell (2009) finds that optimally-chosen tariff bindings improve the welfare of governments compared to a no-agreement case. Amador and Bagwell (2010) advance this result by finding conditions under which a tariff binding is the best mechanism among those that restrict the set of tariffs from which governments can choose. While sharing some basic elements of these two papers, our theory introduces country-specific parameters that enables us to study the asymmetry of obligations under an optimal agreement.[3]

Our empirical work is related to the economic literature that tests the terms-of-trade theories of optimal trade policy (Broda, Limão, and Weinstein 2008) and optimal trade agreements (Bagwell and Staiger 2011). Following the tradition in the trade agreement literature, these papers assume that once governments enter into a trade agreement they are unable to exercise their market power in setting trade policy. As a result, the two important inquiries of the terms-of-trade literature (namely, optimum tariff and optimal agreements) are pursued independently. Our theoretical framework, however, enables us to analyze how countries utilize their market power in setting trade policy *while* they are restricted by tariff binding agreements. That is because under tariff binding agreements governments will have the opportunity to set their tariffs unilaterally in sectors with positive tariff overhang. Therefore, in addition to analyzing the relationship between market power and optimal tariff commitments (as in Bagwell and Staiger 2011), we are also able to study the relationship between applied tariffs and market power (as in Broda, Limão, and Weinstein 2008).

Since testing these theories requires observing non-cooperative behavior, Broda,

equal to binding and, thus, no overhang is predicted by the theory.

[3]These papers as well as the current paper focus on tariff bindings, while in practice tariff bindings and contingent protection measures are both included in the agreement. In an ongoing research, Beshkar and Bond (2011) study optimal trade agreements when tariff bindings and contingent protection measures are both available. Bagwell and Staiger (2005) also introduce a model of tariff bindings with contingent protection in which incentive compatibility is ensured by a dynamic constraint on the use of contingent protection. Finally, Prusa and Li (2009) argue that due to the flexibility provided by tariff binding overhangs, the use of antidumping measures as a contingent protection measure is less critical for the governments. Based on this argument, Prusa and Li (2009) call for a reform in antidumping's "vague and economically illogical rules."

Limão, and Weinstein (2008) and Bagwell and Staiger (2011) are forced to focus on countries that are not in the WTO or have recently joined the WTO.[4] In contrast, our recognition of tariff binding overhangs enables us to observe non-cooperative behavior of the GATT/WTO member countries in sectors where tariff overhang is positive. This increases the number of countries that can be included in the sample from around 16 countries (all of which are developing countries) in Broda, Limão, and Weinstein (2008) and Bagwell and Staiger (2011) to 40 countries (which includes both developed and developing countries) in this paper.

Moreover, previous attempts to test terms of trade theory of trade agreements assume that governments negotiate their applied tariffs, while in reality governments negotiate their bound tariffs. This generates a mismatch between the theory and the empirical observations in sectors where there is positive tariff overhang. This problem is avoided in our paper by modelling negotiations on bound tariffs explicitly.

In the next section we introduce the basic model. In Section 3, we characterize optimal tariff binding as a function of country size and other parameters of the model. Section 4 provides empirical evidence regarding the relationship between binding overhang and country size for WTO members.

2 The Basic Model

We examine a two country, three good trade model in which countries are asymmetric in size. We assume that industries are perfectly competitive, and that governments choose tariff policy to maximize a weighted social welfare function that reflects the political influence of producers in the import-competing sector. In this setting, the motivation for forming a trade agreement is to solve the Prisoner's dilemma created by the terms of trade externality from tariffs as in Bagwell and Staiger (1999). The

[4] Bagwell and Staiger (2011) focus on new WTO members who presumably agreed to reduce their tariffs from non-cooperative to cooperative levels in one round of negotiations. Old GATT members are excluded from their study since the pre-WTO applied tariffs of the old members were not set unilaterally. Broda, Limão, and Weinstein (2008), on the other hand, have to focus on countries that are not member of a major trade agreement so that their applied tariffs reflect their unilaterally optimal policy.

asymmetry in country size is introduced in a manner similar to that in Bond and Park (2002).

The home country is assumed to have a measure N of identical households, with a home country household having a utility function $U = \sum_{i=1,2} d_i(1 - .5d_i) + d_0$, where d_i denotes consumption of good i. Households in the home country have an endowment of labor that can be allocated to production of the three goods. Letting l_i denote the quantity of labor per household devoted to good i and x_i the output per household, the home country production functions are assumed to have the form $x_0 = l_0$ and $x_i = (2b_i l_i)^{.5}$ for $i = 1, 2$. Assuming perfect competition in production and choosing good 0 as numeraire, these assumptions about production and technology yield per household demands of $1 - p_i$ and supplies of $b_i p_i$ for goods $i = 1, 2$. Autarky prices in the home country will be $p_i^A = 1/(1 + b_i)$.[5].

The foreign country has a measure N^* of households, with households preferences identical to those of home households. Foreign country production functions are given by $x_0^* = l_0^*$ for the numeraire good and $x_i^* = (2b_i^* l_i)^{.5}$ for $i = 1, 2$. Autarky prices in the foreign country will be $p_i^{*A} = 1/(1 + b_i^*)$. We assume that $b_1 = b_2^* = 1$ and $b_2 = b_1^* = \beta > 1$, so that the home country has comparative advantage in good 2 and the foreign country a symmetric advantage in good 1. Letting t (t^*) be the ad valorem tariff imposed by the home (foreign) country on imports of good 1 (2), we have $p_1 = p_1^* (1 + t)$ and $p_2^* = p_2 (1 + t^*)$ with trade. In light of the separability and symmetry of markets, we can focus our analysis on the market for the home importable. The characterization of the market for the foreign importable follows immediately. The home excess demand function for good 1 is $m = N(1 - 2p_i)$, and foreign excess demand is $m^* = N^*(1 - (1 + \beta)p^*)$. Since equilibrium prices are homogeneous of degree 0 in N and N^*, we can normalize country size by choosing $N = \lambda \in (0, 1)$ and $N^* = 1 - \lambda$. The market clearing price of good 1 in the respective

[5] We assume that the endowment of home labor per household is sufficiently large that some of good 0 gets produced in equilibrium. The differences in b_i across countries can be interpreted as differences in the quantities of sector-specific factors, with the sectoral profits reflecting returns to sector specific capital. Under the assumptions above, the allocation of ownership of capital across households does not affect demands for goods 1 and 2.

countries will be market price of

$$p^*(t) = \frac{1}{2\lambda(1+t)+(1+\beta)(1-\lambda)} \quad p(t) = \frac{1+t}{2\lambda(1+t)+(1+\beta)(1-\lambda)} \tag{1}$$

The relative size of the countries determines the magnitude of the terms of trade externality resulting from the home country tariff, with $dp^*/dt \to 0$ as $\lambda \to 0$ and $dp^*/dt \to -1$ as $\lambda \to 1$. The prohibitive tariff will be $t^{pro} = \frac{\beta-1}{2}$.

We assume that the government's preference over tariffs can be described by a weighted social welfare function, where the government puts a weight of $\theta \geq 1$ on the welfare of producers in the import-competing sector and a weight of 1 on the welfare of all other agents. Home country consumer surplus is given by $C(t) = \lambda(1-p(t))^2/2$, producer surplus by $\pi(t) = .5\lambda p(t)^2$, and tariff revenue by $tp^*m(t) = tp^*\lambda(1-2p)$. For the foreign country, consumer surplus is $C^*(t) = (1-\lambda)(1-p^*(t,\lambda))^2/2$ and producer surplus is $\pi^*(t) = .5(1-\lambda)\beta p^*(t)^2$. Letting $V(V^*)$ denote the home (foreign) country welfare attributed to the importable (exportable) sector, the respective welfare functions will be

$$V(t,\theta) = C(t) + \theta\pi(t) + tp^*m(t) \tag{2}$$

$$V^*(t) = C^*(t) + \pi^*(t) \tag{3}$$

The foreign country welfare function is decreasing and in t because of the adverse effect of the home country tariff on good 1 on the the foreign country's terms of trade, which is proportional to the level of foreign exports. Foreign welfare is convex in t, because the magnitude of the terms of trade effect declines as the volume of trade declines.

In the absence of political economy considerations (i.e. $\theta = 1$), home country welfare will be strictly concave in t, reflecting the terms of trade and trade volume effects of an increase in the home country tariff. Increases in t improve the home country terms of trade, but the marginal benefits decline with t due to declining trade volume and increasing trade distortions. The presence of political economy effects introduces a convex element into this problem, since profits of import-competing producers are increasing and convex in t. However, it can be shown that the home country welfare function is strictly concave in t over the relevant range at which trade occurs. Therefore, there will be a unique optimal tariff that maximizes $V(t)$, which is given by

$$t^N(\theta) = \frac{(\theta-1)(1+\beta)+2(\beta-1)\lambda}{(3-\theta)(1+\beta)+4\lambda} \tag{4}$$

As a result of the separability assumption, this tariff is a dominant strategy for the home country and will be the Nash equilibrium tariff. We let $\theta^{\max} \equiv (3\beta\text{-}1)/(1+\beta)$ denote the value of the political shock at which the home country's optimal tariff eliminates trade, $t^N(\theta^{\max},\lambda) = t^{pro}$. For $1 \leq \theta < \theta^{\max}$ and $\lambda \in (0,1)$, the optimal tariff is positive and increasing in λ, β, and θ. A larger home country size and a greater degree of comparative disadvantage for the home country will decrease the elasticity of the export supply function facing the home country, resulting in a larger optimal tariff. A greater valuation on the profits of import competing producers will also raise the optimal tariff.

World welfare is the sum of home and foreign country welfare, $W(t,\theta) = V(t,\theta) + V^*(t)$. For $\theta = 1$, world welfare is quasiconcave in t and is maximized at free trade. The political economy component introduces an additional convex element into world welfare for $\theta > 1$, but it can be shown that world welfare will be quasiconcave in t for $\theta \in [1,\theta^{\max}]$.[6] Therefore, there will be a unique tariff that maximizes world welfare

$$t^E(\theta,\lambda) = \frac{\theta-1}{3-\theta}. \tag{5}$$

The efficient tariff will be positive for $1 < \theta \leq \theta^{\max}$, since world welfare incorporates the importing country's preference to protect its producers. For $\theta^{\max}$, the weight on producer interests is sufficiently high that the efficient tariff eliminates trade. Note also that $t^N(\theta,\lambda) - t^E(\theta,\lambda) > 0$ for $\theta \in [1,\theta^{\max})$ The Nash tariffs exceed the tariffs that maximize world welfare when the home country has market power, because

[6] Derivative of the world welfare with respect to tariff is $W_t = \lambda(1+\beta)(1-\lambda)\frac{\theta-1-t(3-\theta)}{(\beta(1-\lambda)+\lambda(1+2t)+1)^3}$. As is clear from this expression, world welfare is increasing for $t < \frac{3-\theta}{\theta-1}$ and decreasing for $t > \frac{3-\theta}{\theta-1}$. Therefore, W is quasiconcave and $t = \frac{3-\theta}{\theta-1}$ is the jointly optimal tariff.

the home country fails to internalize the terms of trade externality it imposes on the foreign country. The Nash and efficient tariffs are only equal in the absence of market power effects, which occurs when the country is infinitesimally small or trade is eliminated (i.e. $t^N(\theta^{\max}, \lambda) = t^E(\theta^{\max}, \lambda)$ and $t^N(\theta, 0) = t^E(\theta, 0)$).

The analysis for good 2 can be derived in a similar fashion, with the symmetry insuring that the efficient tariff for good 2 will be $t^E(\theta, 1-\lambda)$ and the Nash equilibrium tariff will be $t^N(\theta, 1-\lambda)$. The Nash equilibrium clearly represents a prisoner's dilemma, since countries ignore the adverse terms of trade effect on the foreign country in setting their tariffs. If the level of the political shock is observable to all parties and lump sum transfers can be made between countries, then an efficient trade agreement will be one that maximizes world welfare. With observable political shocks, the efficient agreement will call for setting the state contingent efficient tariffs from (5) for each country.

3 Optimal Tariff Bindings

We now turn to the derivation of the efficient trade agreement for the case where the magnitude of the political shocks is the private information of the importing country. The distribution of the political shock for the home country is denoted by the pdf $f(\theta)$ that has compact support $\Theta = [\underline{\theta}, \overline{\theta}]$, where $\underline{\theta} \geq 1$ and $\overline{\theta} \leq \theta^{\max}$.We will assume that a trade agreement takes the form of a tariff binding, t^B, such that a country can choose any tariff $t \leq t^B$ without violating the agreement.

Letting $\theta^B = \min[\underline{\theta}, t^{N^{-1}}(t^B)]$, a tariff binding t^B can be represented by the following incentive-compatible tariff schedule

$$t(\theta) = \begin{cases} t^B \equiv t^N\left(\theta^B\right) & \text{if } \theta \geq \theta^B, \\ \\ t^N(\theta) & \text{if } \theta < \theta^B. \end{cases} \tag{6}$$

This tariff schedule is incentive compatible for the home country, since $V(t(\theta), \theta) \geq V(t(r), \theta)$ for all $r \in \Theta$. Therefore, expected welfare under the tariff binding, t^B, can be written as

$$E\left[W\right]=\int_{\underline{\theta}}^{\theta^{B}}W(t^{N}(\theta);\theta)f(\theta)d\theta+\int_{\theta^{B}}^{\bar{\theta}}W(t^{B};\theta)f(\theta)d\theta. \tag{7}$$

An analogous expression can be derived for the tariff binding for the foreign country. The optimal tariff binding is obtained by choosing t^B to maximize expected world welfare as given by (7).[7,8]

Noting that $W\left(t;\theta\right)=W\left(t;1\right)+\left(\theta-1\right)\pi\left(t\right)$, the first-order condition for optimality is given by

$$\int_{\theta^{B}}^{\bar{\theta}}\left[W_{t}\left(t^{B};1\right)+\left(\theta-1\right)\pi_{t}\left(t^{B}\right)\right]f\left(\theta\right)d\theta=0.$$

Rearranging this condition yields

$$-\frac{W_{t}\left(t^{B},1\right)}{\pi_{t}\left(t^{B}\right)}=E\left[\theta-1|\theta>\theta^{B}\right]. \tag{8}$$

This expression indicates that under an optimal agreement the deadweight loss per dollar of profit generated for import-competing producers, $-W_t(t^B,1)/\pi_t(t^B)$, must be equal to the expected political premium from raising an additional dollar for producers, $E\left[\theta-1|\theta>\theta^{B}\right]$.

The optimization problem (7) can have three types of solutions: 1) a corner solution in which $\theta^B=\underline{\theta}$; 2) an interior solution with $\theta^B\in(\underline{\theta},\overline{\theta})$; and 3) a corner solution in which $\theta^B=\overline{\theta}$.

For $\theta^B=\underline{\theta}$, we have $t^B\leq t^N(\underline{\theta})$ and the applied tariff is at the binding for all realizations of the political shock. In this case, the necessary optimality condition

[7] This objective function is appropriate if lump sum transfers can be made between countries at the time that the agreement is signed.

[8] We will limit attention to tariff binding agreements, since this is the form that has been adopted by the GATT/WTO.

(8)can be written as

$$-\frac{W_t(t^B,1)}{\pi_t(t^B)} = \frac{2t^B}{1+t^B} = E\left[\theta - 1\right] \text{ for } t^B < t^N(\underline{\theta}). \tag{9}$$

The deadweight loss per dollar of profit generated is increasing in t^B, so this condition will also be sufficient for the corner solution to be a local optimum. The bound tariff at a corner solution will be higher the greater is the expected value of the political shock, but it will be independent of the market power of the country as reflected in β and λ. In order for (9) to be a local optimum, it must satisfy $t^B = \frac{E[\theta]-1}{3-E[\theta]} < t^N(\underline{\theta})$. Substituting from (4), we will have an interior for countries sufficiently large that

$$\lambda \geq \tilde{\lambda} = \frac{E\left[\theta\right] - \underline{\theta}}{\theta^{\max} - E\left[\theta\right]} \tag{10}$$

Note that since $\theta^{\max}$ is increasing in β, the corner solution is more likely the greater is a country's comparative disadvantage in a product. This condition reflects the fact that providing flexibility to countries with a greater degree of market power is more costly, because the terms of trade externality from allowing flexibility to large countries is greater.

For the interior solution case, $\theta^B \in (\underline{\theta}, \overline{\theta})$, the necessary optimality condition (8) can be written as

$$R(\theta^B, \lambda) \equiv E[\theta - 1 | \theta \geq \theta^B], \tag{11}$$

where,

$$R(\theta^B, \lambda) \equiv \frac{-W_t(t^N(\theta^B), 1)}{\pi_t(t^N(\theta^B))} = \theta^{\max} - 1 - \frac{\theta^{\max} - \theta^B}{1+\lambda}. \tag{12}$$

The welfare cost of raising the binding is increasing in θ^B, because a higher value of the political shock results in a higher tariff binding and hence a greater marginal deadweight loss. This is shown by the $R(\theta^B, \lambda)$ line in Figure 1. The $R(\theta^B, \lambda)$ line must also go through the point $(\theta^{\max} - 1, \theta^{\max})$, which reflects the fact that the efficient tariff coincides with the importer's optimal tariff at $\theta^{\max}$.

The conditional mean for the political shock is also increasing in θ, as illustrated in Figure 1. In order for (11) to represent an optimal binding, it must be the case that

$$E_{\theta^B}[\theta|\theta \geq \theta^B] < 1/(1+\lambda). \tag{13}$$

A sufficient condition for this to hold for all $\theta^B \in \Theta$ is that $f'(\theta) \geq 0$. If (13) is satisfied for all $\theta^B \in \Theta$, then there will be a unique value of t^B that maximizes (7).

Proposition 1 *For $\lambda \leq \tilde{\lambda} \equiv \frac{E[\theta]-\underline{\theta}}{\theta^{\max}-E[\theta]}$, optimal tariff binding is decreasing in λ and β. For $\lambda \geq \tilde{\lambda}$, the optimal tariff binding is independent of λ and β.*

Proposition 1 can be illustrated using Figure 1. An increase in county size will cause the $R(\theta, \lambda)$ line to rotate upward around the point $(\theta^{\max} - 1, \theta^{\max})$, because a larger country imposes greater marginal deadweight loss form raising the binding due to its larger optimal tariff. This results in a lower value of θ^B in the neighborhood of an interior solution. The critical level of country size, $\tilde{\lambda}$, is the value at which $R(\underline{\theta}, \tilde{\lambda}) = E(\theta) - 1$.

The terms of trade externality disappears as countries become arbitrarily small, so bindings become unnecessary (i.e. $R(\theta^B, \lambda) \to \theta^B - 1$ as $\lambda \to 0$). An increase in the importing country's degree of comparative disadvantage will also increase $R(\theta^B, \lambda)$, since it increases $\theta^{\max}$, so the effect is similar to an increase in country size.

8The probability that a country's tariff is at the binding is $1 - F(\theta^B)$, so we can use comparative statics results from (11) and (10) to obtain predictions about the probability that a country's applied tariff is at the binding, i.e., there is zero binding overhang. This analysis yields

Proposition 2 *Under the optimal tariff binding agreement, the likelihood of a positive overhang is decreasing in λ and β for $\lambda < \tilde{\lambda}$. For $\lambda > \tilde{\lambda}$, the overhang is always zero.*

We can also examine the effect of country size on the average tariff charged, $E[t] = \int_{\underline{\theta}}^{\theta^B} t^N(\theta, \lambda) f(\theta) d\theta + (1 - F(\theta^B)) t^N(\theta^B)$. Differentiating with respect to λ

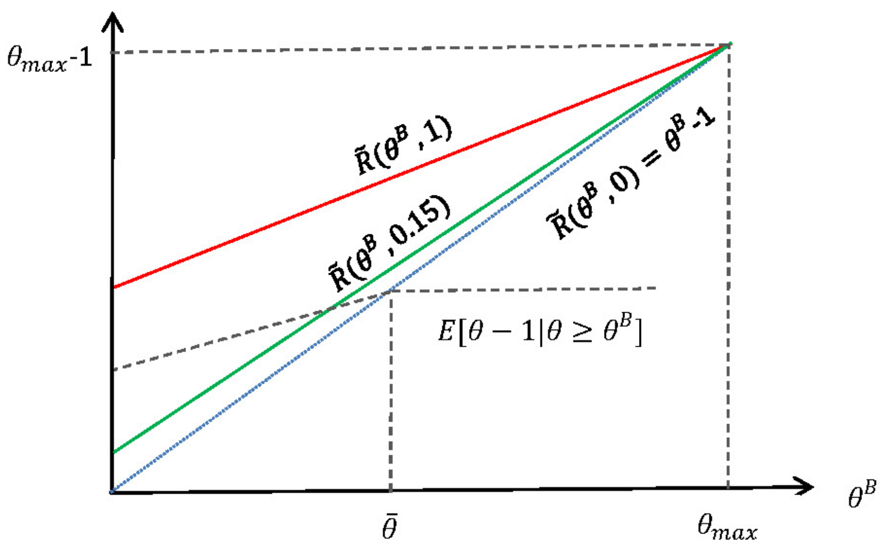

Figure 1: An interior solution for the optimal binding problem.

yields

$$E_\lambda\left[t\right] = \int_{\underline{\theta}}^{\theta^B} t_\lambda^N(\theta,\lambda) f(\theta) d\theta + \left(1 - F(\theta^B)\right) \frac{dt^B}{d\lambda}. \tag{14a}$$

The first term must be positive, because an increase in country size must raise the tariff in the region where the binding does not hold. The second term will be negative by Proposition 1. The former effect must dominate in the neighborhood of $\lambda = 0$, since $\theta^B \to \bar{\theta}$ as $\lambda \to 0$. The latter effect will dominate in the neighborhood of $\lambda = \tilde{\lambda}$, since $\theta^B \to \theta$ as $\lambda \to \tilde{\lambda}$. A similar argument applies for changes in β, which

Proposition 3 *The average applied tariff is increasing in λ and β in the neighborhood of $\lambda = 0$ and decreasing in λ and β in the left-neighborhood of $\lambda = \tilde{\lambda}$.*

The discussion so far has focused on the effects of country size and comparative advantage on tariff bindings and tariff overhang. A related question of interest is how politics affects these variables. It is clear from (11) and (4) that a country with a higher conditional mean for the political shock for all θ^B will have both a higher threshold for the binding and a higher tariff at the binding. Thus, we can order countries on the basis of $E[\theta|\theta \geq \theta^B]$, to determine the importance of political factors. The ranking on the basis of conditional means is known as the mean residual lifetime (mrl) order. Müller and Stoyan (2002) show that the ordering of distributions on the hazard rate order, which is ordering distributions on the basis of stochastic dominance of $f(\theta)/(1-F(\theta))$,implies mrl order dominance and first order stochastic dominance. However, first order stochastic dominance is not sufficient to guarantee dominance on mrl..Higher tariff bindings and a higher probability of overhang are thus associated with distributions that put a greater weight on the extreme values of the political shock.

4 Empirical Evidence

In this Section we use data on tariff binding commitments and applied tariffs of the WTO member countries to test three predictions of the model. First we test the prediction of Proposition 2 that members with greater international market power are more likely to apply a tariff at their binding. The basic estimation equation that we use is given by

$$\Pr\left(t = t^B\right) = g(Y), \tag{15}$$

where Y denotes a vector of explanatory variables representing the various market power and political economy factors and fixed effects. We will use a Probit model to estimate this equation.

Second, we test the prediction from Proposition 1 that the tariff binding commitments are negatively correlated with the measures of a country's international market power in the concerned sector. The theoretical relationship between the optimal binding and Y has the following form

$$t^B = t^N\left(\theta^B\left(Y\right); Y\right). \tag{16}$$

For the purpose of the empirical test, we approximate the t^N function with a linear expression so that we can employ the OLS method.

Finally, we test the prediction of Proposition 3 that applied MFN tariffs, t^{MFN}, will be increasing (decreasing) in market power for the smallest (largest) members. The basic estimation equation that we will use is given by

$$t^{MFN} = \alpha Y_1 + \gamma Y_1^2 + \eta Y_2, \tag{17}$$

where, Y_1 is a measure of market power and Y_2 is a vector of other variables. If Proposition 3's prediction is to hold, α must be positive while γ must be negative. Moreover, given the estimates of α and γ, we must observe that $\alpha Y_1 + \gamma Y_1^2 > 0$ for the smallest values of Y_1 and $\alpha Y_1 + \gamma Y_1^2 < 0$ for the largest values of Y_1 in our sample.

4.1 Data

Data on Tariff Bindings and MFN-Applied Tariffs for WTO members is available from WTO (2010) for the period 1995-2009. The number of years for which applied tariff data is available varies substantially across members. Most members report applied tariff data for at least one year during this period, but a complete time series is available for only 14 countries. The current tariff bindings were set at the time of the WTO agreement in 1995, and have remained essentially unchanged since that time. Applied tariffs,on the other hand, show considerable variation. This adjustment falls into two parts. In the period immediately following the agreement, there was significant reduction in applied tariff rates as countries reduced their tariffs to meet their new binding obligations, Interestingly, these reductions included both reductions in tariffs that were over the binding as well as reductions in tariffs that were already under the binding. Once the phase-in period ended, adjustments in applied rates have continued, but the frequency of adjustments varies substantially across countries and does not show a significant upward or downward trend.

Since our model does not attempt to address the phase-in of tariff rates following the negotiation of a trade agreement, a panel analysis of the entire time period would require additional modeling to incorporate the adjustment of tariff rates. Therefore, we will focus primarily on using a cross section for a particular year to estimate the relationships in (16) and (17). We chose to use 2007 as the year to study, because the phase-in period for original WTO members was completed by that time. Virtually all of the phase-in periods for countries that were members in 1995 were completed by 2003-2005.[9] Applied tariff data for 60 members accounting for 91% of world trade is available for 2007.

We run our regressions on different subsamples of the WTO members, namely, members that joined at the time of WTO's inception in 1995, members who joined later. These additional regressions will serve as a robustness check for two reasons. First, for countries that joined after 1995 the adjustment of tariffs to the new levels may not be completed by 2007 (the year of our applied tariff data). Moreover, it is possible that the bargaining associated with the accession process resulted in a different relationship between tariff bindings and applied tariffs than did the Uruguay round negotiations.

[9] In addition, the data for 2007 was not affected by the financial crisis. Since our model focuses on sector specific and country-specific shocks, we avoided the financial crisis years where there were significant systemic shocks.

Our selection criteria resulted in a total of 54 WTO members, including 40 original members and 14 new members. The data on applied tariff provides tariff information on approximately 5,200 sectors at the six-digit HS level for each of the members, resulting in a sample of over 176,526 tariff lines.

Table 2 reports the fraction of all tariff lines and the fraction of all imports that fall under one of three categories with respect to the tariff binding: strong binding (the applied rate equals the bound rate), tariff overhang (applied rate strictly less than bound rate) and unbound (no tariff binding negotiated). Although tariff lines with a strong tariff binding account for only 16.53% of all tariff lines, they account for 65% of world imports. Thus, strong tariff bindings are much more likely to be found in the tariff lines that account for the largest fractions of world trade.

A summary of tariff binding status by countries for the entire set of 54 countries is provided in the Appendix. It should be noted that there is substantial cross member variations with regard to binding status. More than 95% of the applied tariffs are at their bindings for 5 members (EU,China, Japan, Switzerland, and the US), while there are less than 5% of tariff lines at their binding for 25 members.[10]

Our theory suggests the importance of international market power, as reflected in a country's size and degree of comparative advantage, and the strength of political factors as determinants of tariff bindings and applied tariffs. We used two proxies of market power for our analysis. The first is the country's GDP, which provides a measure of the overall size of the market. This variable, however, is a crude measure of market power as it does not vary across sectors, and, hence does not reflect the sectoral differences in the international market power. It is preferable to have a measure of export supply elasticities at the industry level, which are inversely related to the optimal tariff. We proxy export supply elasticities using the member's imports as a share of world imports in the product, which will be inversely related to the country's export supply elasticity.[11]

[10]These countries include Brazil, India, Columbia, Philippine, Chile, Peru, Bangladesh, Kuwait, Dominican Republic, Uruguay, Guatemala, Costa Rica, Kenya, El Salvador, Trinidad and Tobago, Bahrain, Jamaica, Honduras, Ghana, Mauritius, Madagascar, Zambia, Mongolia, and Guyana.

[11]It can be shown that import shares are related to export supply elasticities. Letting W_{ij} denote country i's share of world imports of good j, the elasticity of export supply faced by country i for

While the import ratio has the advantage of varying at the tariff line level, it is also an endogenous variable in our regressions because it is related to the applied tariff. We therefore take an instrumental variable approach by using per-capita endowment of several productive resources of the economy, including productive capital, natural (agricultural) capital, natural minerals, and intangible capital as instruments for import ratio.[12] This choice of instrumental variables is motivated by the Heckscher–Ohlin framework in which relative resource endowment determines comparative advantage and, hence, the direction of trade in the world.[13]

Broda, Limão, and Weinstein (2008) have constructed measures of export supply elasticities, but these are available for only 5 WTO member countries in our data set. We use these as a robustness check for our analysis.

Political factors also play a role through their impact on the conditional mean of the political shock, $E[\theta - 1 | \theta \geq \theta^B]$. Unfortunately, we do not have a good measure of political influence at the sectoral level that is available across countries. A potential proxy for the importance of political shocks at the country level is an index of political instability that is constructed by the the Economist Intelligence Unit. This index ranks countries on a scale of 0 to 10, with 10 being the highest level of instability. The index is constructed using factors such as the number of outbreaks of violent conflicts, type of regime, and level of economic development. Our hypothesis is that countries that are politically unstable are more likely to suffer from extreme values of the political shocks, and thus should have a greater demand for flexibility to deal with those shocks.

Table 2 reports summary statistics for our key explanatory variables. GDP is highly skewed, reflecting the presence of a few members with very large markets (United States, European Union, and Japan) among the 40 countries. We also

good j can be expressed as $\varepsilon_{ij}^W = \left(\varepsilon_j^X + \sum_{k \neq i} W_{kj} \varepsilon_{kj}\right) / W_{ij}$, where ε_j^X is the supply elasticity of the exporting country and ε_{kj} the import demand elasticity for country k. This expression is decreasing in country i's share of world imports. Moreover, if the import demand elasticities are constant across importing countries, then the export supply elasticity simplifies to $\left(\varepsilon_j^X + (1 - W_{ij})\varepsilon_j\right) / W_{ij}$, which varies across countries within a given sector only due to differences in import shares.

[12] The date on productive resources of the member countries is obtained from World-Bank (2010)

[13] Fitted values of import ratio is calculated for two-digit product category of the Harmonized System. This entails running 97 separate regressions in the first stage.

Table 2: Descriptive Statistics

Name	Average	Median	Min.	Max.
GDP (mil.$)	7.11e+11	1.01e+11	8.18e+08	1.15e+13
per capita GDP($)	10871.53	4634	260	42065
Bound tariff rate (%)	32.29389	30	0	800.3
Applied tariff rate (%) (in bound sectors)	7.095553	5	0	800.3
Tariff Overhang (percentage point)	25.19834	19	0	454.2
Import share(%)	1.771578	0.1116	0	99.8415
Sector ratio(Over=0)	16.53%			
Import ratio(Over=0)	65.15%			

Note: Cross sectional data from year 2007 for 40 original WTO members. Tariff rates are the average of tariff lines at the HS 6-digit level. Number of observations: 176,526. Source: WTO, World Bank, and United Nation.

included GDP per capita as an explanatory variable, as a proxy for an alternative hypothesis that poor countries are generally given high bindings and not expected to make significant market access concessions. Since GDP and other market power variables are correlated with GDP per capita in the data, we want to ensure that the significance of international market power measures in our estimation is robust to inclusion of GDP per capita. Table 2 also provides some summary statistics for GDP, per capita GDP, share of world imports, and a political instability index for the sample of WTO members that we analyze.

4.2 Results

Table 3 reports the result of a Probit analysis of (15) in which the dependent variable is a dummy variable that takes a value of 1 if the applied tariff in the HS 6 digit category is equal to the bound tariff, i.e., if there is a strong binding. Column 1 reports the results for the case in which international market power is represented by the country's average share of world imports at the 2-digit HS level. This effect is positive and statistically significant, which is consistent with our result from Proposition 2 that countries with greater market power are more likely to be at the binding. The political instability index is negatively related to the probability of being at the binding, as would be expected to be the case if political instability is associated with more extreme political shocks. GDP per capita is also positively related to the probability of being at the binding.

Column 2 of Table 3 reports the results when the observed value of the import ratio is replaced by the fitted value, $\tilde{W}_{ij}$, which is based on an OLS regression of the import ratio on the log of GDP and endowments. The coefficients for all variables in this regression are quite similar to those obtained with the use of the actual values of the import shares. Column 3 provides results for a similar regression where the fitted values are calculated using an OLS model with $\log \frac{W_{ij}}{1-W_{ij}}$, rather than W_{ij}, as the dependent variable. This logistic transformation ensures that the fitted values of import share, $\tilde{W}_{ij}$, are between zero and one.[14]

Columns 4-7 of Table 3 repeat the basic exercises with the data divided between agricultural and manufacturing sectors. There are a couple of reasons to believe that there are significant differences between the political economy of manufacturing and agricultural sectors. First, a greater variability in output levels and prices is likely to be observed in agriculture than in manufacturing, which is likely to lead to more extreme political shocks in agriculture. Furthermore, the trade liberalization process in manufacturing has generally made far more progress than in agriculture. Using the W_{ij} to measure market shares, our results indicate support for the role of market power for explaining the probability of being at the binding both for the agricultural and manufacturing sectors.

The comparison of the coefficients for agriculture and manufacturing is consistent with the notion that political shocks may play a more significant role in agriculture than in manufacturing. An implication of our model is that the responsiveness of the optimal bound rate to measures of international market power is decreasing in the average political pressure. As expected, the coefficient of the import share has a smaller absolute value in agricultural sectors than in manufacturing sectors.

Table 4 provides a robustness check for our estimation of equation 15. Column 1 (2) provides the results when all (only new) members are included in the sample. Finally, column 3 (4) provides the result with export supply elasticity (GDP) as the measure of international market power.

[14] We also calculate the fitted values with a Tobit regression but do not report the results, as they are essentially similar to those in columns 2 and 3.

Table 5 reports the result of the regression of the tariff binding on the same explanatory variables as in previous regressions. As predicted by the theory, the coefficient of the import ratio is negative and significant. We also estimated this equation using a Tobit model, to allow for the truncation of tariff rates at zero, and obtained similar results. Table 6 reports the result of the same regression on different subsamples of WTO members. It also reports the results for the cases where export supply elasticity and GDP are used instead of import ratio as the measure of market power. The negative correlation between the binding and international market power is significant for all of these alternative specifications.

Finally, Table 7 reports the result of the linear regression 17. In the first three columns of this table, we report a statistically significant positive relationship between the applied tariff and import ratio, while the relationship with the squared of the import ratio is negative and significant. This observation supports the hypothesis that the applied tariff has a hump-shape relationship with the measure of market power under an optimal trade agreement.

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Table 3: Likelihood of Strong Binding and Market Power

Dependent Variable	Dummy variable equal to 1 if strong binding, zero otherwise.						
Sectors	All Sectors			Manufacturing		Agriculture	
Estimation Method	Probit	IV(OLS) Probit	IV(OLS-Logistic) Probit	Probit	IV(Tobit) Probit	Probit	IV(OLS-Logistic) Probit
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Import ratio	0.1728	0.2122	0.2911	0.1758	0.3388	0.1407	0.2822
	(0.0023)	(0.0020)	(0.0074)	0.0024	(0.0051)	(0.0059)	(0.02055)
Log GDP per capita	0.2831	0.2202	0.3061	0.2858	0.2104	0.2886	0.3135
	(0.0052)	(0.0056)	(0.0053)	(0.0056)	(0.0061)	(0.0138)	(0.0130)
Pol. Inst. Index	−0.1727	−0.1848	−0.1433	−0.1602	−0.1831	−0.2538	−0.2300
	(0.0041)	(0.0043)	0.0043	(0.0045)	(0.0048)	(0.0091)	(0.0095)
WTO members (#)	Original (40)	Original (40)	Original (40)	Original (40)	Original (40)	Original (40)	Original (40)
Pseudo R-squared	0.4218	0.4135	0.4320	0.4219	0.4200	0.4237	0.4141
# of observations	176350	176350	176350	154109	154109	22236	22236

Note: All regressions include three-digit HS fixed effects (173 categories). Robust standard errors in parentheses. Standard errors are clustered by 6-digit HS sectors (5224 clusters). GDP is for 2007. We delete 176 sectors whose import ratio is greater than 59.34% that is 1% upper quatile of total sample.

Table 4: Likelihood of Strong Binding and Market Power: Robustness Check

Dependent Variable	Dum. variable equal to 1 if strong binding			
Sectors	All Sectors			
Estimation Method	IV Probit	IV Probit	IV Probit	Probit
	(1)	(2)	(3)	(4)
Import ratio	.3328	.8097		
	(.0073)	(.0229)		
Log Inv. Exp. Elas.			.0161	
			(.0045)	
Log GDP				.2069
				(.0015)
Log GDP per capita	−.0523	−.0972	−.7816	−.1116
	(.0026)	(.0041)	(.0138)	(.0025)
Pol. Inst. Index	.3328	−.0608	−.3082	−.2332
	(.0073)	(.0043)	(.0075)	(.0025)
WTO members (#)	All (54)	New (14)	New (5)	Original (54)
Pseudo R-squared	0.2419	0.1408	0.1703	0.1806
# of observations	239577	63254	18129	239577

Note: All regressions include three-digit HS fixed effects (173 categories). Robust standard errors in parentheses. Standard errors are clustered by 6-digit HS sectors (5224 clusters). GDP is for 2007.

Table 5: Tariff Binding Commitments and Market Power

Dependent Variable	Bound Tariff Rate						
Sectors	All Sectors			Manufacturing		Agriculture	
Estimation Method	OLS	IV(OLS) OLS	IV(OLS-Logistic) OLS	OLS	IV(OLS-Logistic) OLS	OLS	IV(OLS-Logistic) OLS
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Import ratio	−1.342	−2.6949	−1.3988	−1.4784	−1.6691	−1.256705	−1.359882
	(.0113)	(.0223)	(.0164)	(.0106)	(.01560)	.0363503	.0584038
						()	()
Log GDP per capita	−5.6131	−3.6648	−6.2487	−1.3579	−1.912	−18.0752	−18.5778
	(.1497)	(.1622)	(.151)	(.0462)	(.0477)	(0.2157)	(0.2094)
Pol. Inst. Index	2.0418	2.2419	1.8255	3.4749	3.2067	−1.8814	−1.8577
	(.0557)	(.0584)	(.0541)	(.0261)	(.0258)	(.1324)	(.1340)
WTO members (#)	Original (40)	Original (40)	Original (40)	Original (40)	Original (40)	Original (40)	Original (40)
R-squared	0.3024	0.3349	0.2899	0.2757	0.2558	0.2835	0.2784
# of observations	141560	141560	141560	119347	119347	22211	22211

Note: All regressions include three-digit HS fixed effects (173 categories). Robust standard errors in parentheses. Standard errors are clustered by 6-digit HS sectors (5224 clusters). GDP is for 2007.

Table 6: Tariff Binding Commitments and Market Power: Robustness Check

Dependent Variable	Bound Tariff Rate			
Sectors	All Sectors			
Estimation Method	IV (OLS-Logistic) OLS	IV (OLS-Logistic) OLS	OLS	OLS
	(1)	(2)	(3)	(4)
Import ratio	−1.4108	−.5971		
	(.0140)	(.0201)		
Log Inv. Exp. Elas.			−.1074	
			(.0326)	
Log GDP				−1.5526
				(.0270)
Log GDP per capita	−.5103	−3.5124	−6.028519	.277376
	(.0858)	(.0669)	(.08676)	(.1030)
Pol. Inst. Index	3.744	2.740	−.3108	4.0384
	(.0276)	(.0287)	(.0469)	(.0291)
WTO members (#)	All (54)	New (14)	New (5)	Original (54)
R-squared	0.1889	0.2564	0.3390	0.1837
# of observations	204615	63080	18128	204615

Note: All regressions include three-digit HS fixed effects (173 categories). Robust standard errors in parentheses. Standard errors are clustered by 6-digit HS sectors (5224 clusters). GDP is for 2007.

Table 7: Applied Tariff and Market Power

Dependent Variable	Applied Tariff Rate			
Sectors	All Sectors		Manufacturing	Agriculture
Estimation Method	OLS	IV(OLS-Logistic)OLS	IV(OLS-Logistic) OLS	IV(OLS-Logistic) OLS
	(1)	(2)	(3)	(4)
Import ratio	0.2498	0.3526	0.3317	0.5101
	(0.0128)	(0.0152)	(0.0133)	(0.1152)
Import ratio squared	−0.0114	−0.0171	−.0164	−0.0252
	(0.0005)	(0.0008)	(0.0008)	(0.0055)
Log GDP per capita	−1.8145	−1.8023	−1.6222	−3.0226
	(0.0195)	(0.0200)	(0.0163)	(0.0958)
Pol. Inst. Index	0.5302	0.5579	0.6295	.0651
	(0.0142)	(0.0144)	(0.0120)	(0.0795)
WTO members (#)	Original (40)	Original (40)	Original (40)	Original (40)
R-squared	0.2508	0.2511	0.4084	0.0884
# of observations	176350	176350	154109	22236

Note: All regressions include three-digit HS fixed effects (173 categories). Robust standard errors in parentheses. Standard errors are clustered by 6-digit HS sectors (5224 clusters). GDP is for 2007.

Table 8: Binding Status Across WTO Members in the Sample

Member	# Bound	# Unbound	# Strong Binding	% Strong Binding	Member	# Bound	# Unbound	# Strong Binding	% Strong Binding
US	4022	0	3943	98%	Vietnam	3042	0	1478	49%
EU	4014	0	3963	99%	Dominican	4476	0	38	1%
Japan	4105	17	3926	95%	Croatia	4271	0	2846	67%
China	4351	0	4156	96%	Oman	4681	0	421	9%
Canada	4333	15	2072	48%	Uruguay	4476	0	9	0%
Brazil	4460	0	45	1%	Guatemala	4476	0	6	0%
India	3034	1170	112	3%	Costa Rica	4449	0	88	2%
Korea	4091	230	1497	35%	Ecuador	4885	1	441	9%
Mexico	4816	0	345	7%	Panama	4145	0	376	9%
Australia	4307	141	1173	26%	Kenya	681	3512	1	0%
Switzerland	909	11	909	99%	El Salvador	4475	0	102	2%
Saudi Arabia	4623	0	343	7%	Trin. & Tob.	4429	0	59	1%
Hong Kong	2076	2619	2076	44%	Jordan	3893	0	1289	33%
Norway	4074	0	2063	51%	Bahrain	3458	1260	61	1%
South Africa	4205	154	965	22%	Jamaica	4769	0	24	1%
Thailand	2432	1141	581	16%	Honduras	4783	0	87	2%
Israel	2953	1125	597	15%	Ghana	736	4474	0	0%
Singapore	3532	1581	763	15%	Mauritius	772	3862	60	1%
Malaysia	3886	801	930	20%	Georgia	5206	0	1461	28%
Columbia	4476	0	1	0%	Albania	4929	0	2038	41%
Philippine	3237	1630	125	3%	Madagascar	1421	3327	36	1%
Pakistan	4680	66	508	11%	Zambia	762	3902	0	0%
Chile	4470	0	0	0%	Niger	4466	173	479	10%
Peru	4792	0	61	1%	Moldova	4808	0	3047	63%
Bangladesh	694	3764	7	0%	Mongolia	5174	0	36	1%
New Zeal.	4437	3	1873	42%	Guyana	4786	0	69	1%
Kuwait	4732	5	1	0%	Cape Verda	4642	0	737	16%

Note: Members are ranked based on their GDP in 2007.