Tariff Binding and Overhang: Theory and Evidence*

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September 2012

Abstract

We study optimal tariff binding agreements among asymmetric countries that are subject to idiosyncratic political-economy shocks. We find that the optimal tariff binding of a sector is decreasing in the importing countries international market power in that sector. Moreover, under an optimal agreement, a tariff binding overhang is on average greater in sectors with lower international market power. Using the WTO tariff bindings and the applied tariffs of the WTO member countries, we find strong empirical support for our predictions.

*We are grateful to Kyle Bagwell, Chad Bown, Emily Blanchard, Karen Conway, Meredith Crowley, Nuno Limao, Michael Moore, Jee-Hyeong Park, and seminar participants at the American Economic Association Annual Meeting (Chicago, 2012), George Washington University, Stanford Institute for Theoretical Economics, Stanford University, and Seoul National University, for their useful comments and suggestions. We are also grateful to Christian Broda and David Weinstein for providing us with their estimated trade elasticities.

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1 Introduction

Following the original proposition by Bickerdike (1906) that for a nation, "advantage is always possible in normal circumstances from either import or export taxation," the question of optimum tariff has become the subject of an intensive literature. Bickerdike's insight was based on the premise that the incentive to tax imports is heightened if the cost of such policies can be shifted to foreigners. This idea was later formalized in the optimal tariff theory, which suggested that a country's tariffs should be positively related to their market power, as reflected by the inverse of the elasticity of export supply it faces. Thus, one would expect larger countries to have higher tariffs than small countries under the optimal tariff theory.

Of course, the optimal tariff policy creates a prisoner's dilemma for governments. A nation's gains from shifting the cost of taxation to other countries are most likely reversed if other nations pursue similar policies to their own advantage.[1] Trade agreements can be viewed as a means of escape from this terms-of-trade-driven prisoner's dilemma among governments, with all countries able to benefit from reciprocal tariff reductions. Bagwell and Staiger (1999) show that under a fairly general set of government objective functions, "it is the terms of trade–and this externality alone–that creates an inefficiency when governments set their trade policies unilaterally." Thus, an optimal trade agreement should preclude governments from using their international market power to manipulate their terms of trade. Similarly, the 'Trade Talk' result of Grossman and Helpman (1995) indicates that efficient tariffs are independent of the countries' international market power. In these political economy models of trade agreements, departures from free trade reflect the preferences of governments that are maximizing a weighted social welfare function, rather than the market power of the country involved.

The theory we develop in this paper argues that in fact we should see an inverse relationship between a country's market power and its tariff binding under the World Trade Organization (WTO), given the political influence of the sector involved. This

[1] The seminal treatment isJohnson (1953). Syropoulos (2002) provides a recent treatment focusing on the role of country size.

result follows from a trade-off between flexibility and discipline in the setting of tariff bindings. We argue that the key to explain this pattern of tariff binding commitments is the fact that governments value flexibility in setting their trade policy, so that they can respond to shocks to their preferences regarding openness to international trade. The WTO, which aggregates the preferences of the member countries, will thus want to incorporate mechanisms which allow governments to respond to preference shocks (while incorporating the externalities on other countries). However, an optimal agreement will not provide full flexibility to countries to respond to shocks when governments have private information about the magnitude of these shocks, because there is an incentive for the importing country to misrepresent the magnitude of the shock in order to take advantage of its market power. Providing flexibility to more powerful trading partners through higher tariff bindings will thus cause a relatively greater efficiency loss, so they will be given lower tariff bindings under an optimal agreement. This is the essence of the trade-off between "flexibility" to respond to shocks and "discipline" on opportunistic use of trade policy.[2]

Table 1: Tariffs and Trade Summary Statistics

Binding Status	Num. of sector	Share(%)	Import(bil.$)	Share (%)
Applied Tariff below Binding	196,062	65.32	1,760	24.14
Strong Binding (Applied Tariff at Binding)	51,680	17.22	4,410	60.48
Applied Tariff over Binding	8,301	2.76	413	5.66
Unbound	44,136	14.70	709	9.72
Total	300,129	100	7,292	100

Note: Applied tariff data is from 66 WTO members in 2007.

The data on tariff binding commitments in Table 1 illustrate the magnitude of flexibility that is present in the WTO agreements. These data show that for 66 WTO member countries, 65% of the tariff lines at the HS 6-digit level had applied MFN tariff rates that were below their tariff binding. The average tariff overhang in these sectors, which is the difference between the binding and the applied rate, was more

[2] In general, relative bargaining power of the parties in negotiations may also cause variation in tariff commitments across countries. However, if parties have access to side payments at the time of negotiating the agreement, bargaining power will not impact the choice of tariff commitments.

than 20 percentage points. The prevalence of sectors with tariff binding overhang suggests that many governments have retained substantial flexibility in adopting their import tariffs. A second observation from this data is that the fraction of tariff lines which are below their bindings varies substantially across sectors and across countries. The members in the sample with the largest economies (US, EU, Japan, and China) all have more than 90% of tariff lines at the binding, while 25 members with smaller economies had 5% or less of their tariffs at the binding. The share of imports which are in tariff lines where there is a positive binding overhang is only 24% of all imports. Both of these observations are consistent with the prediction that flexibility will be lower where there is a greater degree of market power.[3]

Our theory also provides predictions about the relationship between market power and the pattern of applied tariffs and binding overhang under an optimal tariff binding agreement. The fact that bindings are lower for countries with greater market power, given the distribution of political power, means that there is a higher probability that a country with greater market power will be at its binding. For countries with sufficiently large market power, the tariff will always be at its binding. As a result, the expected binding overhang will be a decreasing function of a country's market power.

We also find that the relationship between average applied tariffs and import market power is non-monotonic. For low levels of import market power we find that this relationship coincides with the optimum tariff result, i.e., applied tariffs (on average) are increasing in import market power. This occurs because countries will impose their optimal tariff when the tariff is below the binding. However, as market power increases, the fraction of the time at which the tariff is constrained by the binding increases. This must result in a negative relationship between market power and the average applied tariff for countries in the neighborhood of the threshold level

[3] Bagwell and Staiger (2011) find empirical evidence for the hypothesis that countries with greater import market power have agreed to greater *tariff cuts* under the WTO. This hypothesis, however, is weaker than the central prediction of conventional terms-of-trade theories, which maintain that an optimal agreement should prevent governments from using their market power to manipulate their terms of trade.

of market power at which the tariff is always at its binding. [4]

Our theory provides a useful framework for an empirical analysis of tariff commitments. Previous attempts at testing the terms-of-trade theory of trade agreements assume that governments negotiate tariff cuts. In reality, however, governments negotiate their bound tariffs and as a result, due to existence of overhang in many sectors/countries, GATT/WTO commitments do not necessarily constitute a tariff cut. By generating a mismatch between the theory and the empirical observations, this assumption has imposed unnecessary limitations on previous empirical studies in this area. For example Bagwell and Staiger (2011) focus their empirical study of negotiated tariffs under the WTO on new WTO members for which tariff cuts can be reasonably calculated.[5] This reduces the total number of countries in their study to 16, all of which are developing countries.

Previous empirical tests of terms of trade theories 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. 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). Moreover, our approach allows us to increases the number of countries that can be included in the study from 16 countries (all of which are developing countries) in Broda, Limão, and Weinstein (2008) and Bagwell and Staiger

[4] This result may be better understood in light of our first result regarding optimal tariff bindings and the conventional optimum tariff result. On one hand the unilaterally optimal tariff is increasing in market power and, on the other hand, the maximum tariff that may be chosen by a government under an optimal agreement is decreasing in the level of market power. Our analysis shows that the former (latter) effect dominates for low (high) levels of import market power.

[5] Pre-agreement applied tariffs are needed to calculate the size of tariff cuts in the accession process. As a result, 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, as opposed to old GATT members who reduced their tariffs through several negotiation rounds that took place over 4 decades.

(2011) to 66 countries (which includes both developed and developing countries) in this paper.

We find strong empirical support for our theoretical predictions. First, we observe that the levels of tariff binding rates under the WTO are inversely related to measures of import market power.[6] This relationship is both statistically and economically important. In particular, we find that a one-standard-deviation increase in a country's share of the world import in a given industry, reduces the tariff binding rate of the country in that industry by 3.5 to 4.46 percentage points.

We also find a statistically-significant negative relationship between the size of tariff binding overhang and the importing country's international market power in the concerned sector. This relationship is also substantial since a one-standard-deviation increase in the share of world import in a given sector reduces the size of tariff binding overhang by around 8-17 percentage points in different empirical specifications. As a related result, we find that it is substantially more likely to observe a zero overhang in sectors with greater international market power.

Political environment also plays a role in determining the size of optimal tariff binding in our theory, such that a greater volatility in political pressure parameter increases the level of optimal binding. Using a country-level variable for political instability, we find strong cross-country evidence for this relationship.

Our empirical study also sheds light on Subramanian and Wei's (2007) finding that membership in the WTO increases a country's import volume substantially only if the member under consideration is a developed country. Their finding may be better understood in light of our observation that under an optimal agreement, less important import markets are given more discretion and flexibility in setting their trade policies.

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 safe-

[6] As measures of market power, we use inverse export elasticities and the country's share of the world import in the concerned sector.

guards (GATT Article XIX), antidumping measures and countervailing duties.[7]

The theoretical part of our paper is closely related to the nascent literature on the use of tariff bindings as a flexibility measure.[8] Bagwell and Staiger (2005) analyze the role of 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.[9]

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

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

[9]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 (2012) 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)

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In the next section we introduce the basic settings for our model. In Section 3, we characterize optimal tariff binding as a function of import market power and other variables of interest. Section 3.1 studies the implications of our model regarding the applied tariffs and overhang under the optimal agreement. In sections 4 and 5 we discuss our empirical model and results, respectively. We provide concluding remarks and more discussion of the existing literature in Section 6.

2 The Basic Setting

We consider a two-country $(n+1)$-good world economy. Letting good 0 to be the numeraire, we assume that preferences in country i are given by

$$U_i = q_{0i} + \sum_{j=1}^{n} u_{ji}\left(q_{ji}\right),$$

for $i = 1, ..., n$ and $j = 1, 2$. These preferences induce a demand function for good i in country j that can be expressed as $d_{ij}(p_{ij})$. On the supply side, we assume that the numeraire good is produced one-for-one from labor so that the wage is equal to one. Each of the other goods is produced with a sector-specific factor and labor, which is mobile between sectors. We let $y_{ij}(p_{ij})$ denote the supply function of industry i in

call for a reform in antidumping's "vague and economically illogical rules."

country j as a function of the local price.

We assume that the only trade policy at governments' disposal is ad valorem import tariffs, denoted by t_{ij}. The world price is denoted by p_i^*. We assume that a government's preferences over tariffs can be described by a weighted social welfare function in which the producers' surplus in the import-competing sector receives a weight of $\theta_{ij} \geq 1$. This weight may vary across sectors and importing countries. In the subsequent discussion we focus on one good that is imported to country 1 and, hence, drop the country and industry subscripts.[10] Formally, letting V denote the importing country's political welfare attributed to the importable sector, we assume that

$$V(p, p^*, \theta) = S(p) + (1+\theta)\,\pi(p) + tp^* m(p), \tag{1}$$

where, $S(p) \equiv \int_p^\infty d(\widetilde{p})\, d\widetilde{p}$ is consumer surplus, $\pi(p) \equiv \int_0^p y(\widetilde{p})\, d\widetilde{p}$ is producer surplus, $m = d - y$ is the import volume, and θ is the extra weight given by the government to the profits of the import-competing sector. Moreover, the welfare of the foreign government from its respective exportable sector is given by

$$V^*(p^*) = S^*(p^*) + \pi^*(p^*).$$

The non-cooperative tariff of the importing country, t^N, may be obtained by setting $\frac{dV}{d\tau} \equiv 0$. Solving for this optimality condition yields

$$t^N = \omega + \theta\left(\frac{1+t^N}{\varepsilon \frac{m}{y}}\right), \tag{2}$$

where, ω, ε, and $\frac{m}{y}$ are inverse export elasticity, import elasticity, and import penetration ratio, respectively.[11] The first term is the inverse of the foreign export supply function which reflects the part of optimal tariff that is due to the terms-of-trade motive. The second term in (2) captures the political benefit of raising the tariff.

[10] Focusing on one good is without loss of generality within our framework in which a numeraire good is available.

[11] Equation 2 is essentially equivalent to Grossman and Helpman's (1995) formula for non-cooperative tariff, although in their model the political weight, θ, is common across sectors.

This term is increasing in the weight placed on political interests, but decreasing in η. The term η reflects the domestic resource distortion per dollar of profits transferred to domestic producer, since a more elastic import demand raises the deadweight loss of raising the tariff and a larger import penetration ratio reduces the gain in profit obtained from an increase in the tariff.[12]

In the analysis that follows, we assume that the inverse elasticity of export supply can be expressed as a function of the foreign country's export price, $p^*(t)$, and exogenous factors z_ω reflecting the technology, factor endowments and preferences of the foreign country in that sector. A similar assumption will be made regarding the domestic elasticity and import penetration ratio. With a slight abuse of notation, we will perform comparative statics exercises using $d\omega$ and $d\eta$ to denote the effect of changes in these exogenous factors. Assuming that the second order conditions are satisfied, it is shown in the Appendix that we can use (2) to express the optimal tariff as a function of three key parameters[13],

$$t^N = \tilde{t}^N(\theta, \omega, \eta), \tag{3}$$

such that $\tilde{t}^N_\theta > 0$, $\tilde{t}^N_\omega > 0$, $\tilde{t}^N_\eta < 0$. Greater market power and a larger political shock will make the home country more protectionist, while a large domestic cost of tariff distortions will reduce the optimal tariff.[14]

Defining the joint political welfare of the two governments as $W(t, \theta) \equiv V(t, \theta) + V^*(t)$, the necessary condition of world welfare maximization is given by $\frac{\partial W}{\partial t} \equiv 0$.

[12] Solving for t in 2 yields the non-cooperative tariff $t^N(\theta) = \frac{\eta\omega+\theta}{\eta-\theta}$,where $\eta \equiv \varepsilon \frac{m}{y}$. We assume throughout the paper that $\theta < \eta$ such that the Nash ad valorem tariff does not prohibit trade.

[13] Details of derivations are provided in the Appendix.

[14] As an example, consider the asymmetric country model of Bond and Park (2002) with linear supply and demand functions in each country: $d(p) = \lambda(1-p)$, $d^*(p^*) = (1-\lambda)(1-p^*)$, $s(p) = \beta p$ and $s(p^*) = p^*$. Here $\lambda \in (0,1)$ may be interpreted as the relative size of the home country and $\beta > 1$ as the measure of the degree of foreign comparative advantage. In this case, $\omega = \frac{\lambda(1+\beta-2t)}{1+\beta}$ and $\eta = 2$, which implies that the inverse export supply elasticity is increasing in the home country's relative size and the degree of foreign comparative advantage. These parameters would represent the exogenous factors determining the home country's optimal tariff in (3).

Solving for t in this equation yields the politically efficient tariff

$$t^E(\theta) = \frac{\theta}{\eta - \theta}. \tag{4}$$

where $\eta > \theta$ must hold at an interior maximum. The politically efficient tariff is increasing in the value of protection and decreasing in the cost of protection, η. The difference between the importer's optimal tariff and the efficient tariff will be $t^N(\theta) - t^E(\theta) = \frac{\omega\eta}{\eta-\theta}$, which is positive as long as the importer has positive market power. The difference between the importer's unilaterally optimal tariff and the efficient tariff reflects the terms of trade externality.

2.1 Information Structure

We will assume that the political weight, θ, is a random variable that has a pdf $f(\theta)$ with compact support $\Theta = [\underline{\theta}, \overline{\theta}]$. The home government is thus uncertain about its future preferences regarding tariffs, and expected world welfare is $\int_{\underline{\theta}}^{\overline{\theta}} W(t(\theta), \theta) f(\theta) d\theta$. If the realization of θ is publicly observable, then a complete trade agreement that specified tariffs $t^E(\theta)$ would maximize expected world welfare. Such an agreement would involve reciprocal trade liberalization, since it would reduce tariffs by an amount $t^N(\theta) - t^E(\theta)$ in state θ for each imported good in each country, while allowing governments the flexibility to respond to domestic political shocks.

Our analysis of trade agreements will focus on the case in which θ is not observable to other countries. We will also assume that state-contingent transfers between countries are not possible. With these assumptions, a trade agreement $t(\theta)$ will be incentive compatible if the importing country not prefer the tariff assigned in state θ to that in any other state,

$$V(t(\theta), \theta) - V(t(r), \theta) \geq 0 \text{ for all } r, \theta \in \Theta \tag{5}$$

The full information agreement, $t^E(\theta)$, will not be incentive compatible for the importing country for $\theta < \overline{\theta}$, since the importing country would report the state to be the value $r > \theta$ for which $t^E(r) = t^N(\theta)$.

3 Optimal Tariff Bindings

An optimal trade agreement in the presence of private information is one that maximizes expected world welfare subject to the incentive compatibility constraint (5). In our analysis, we will limit attention to agreements that take the form of a tariff binding, which allows a country to impose any tariff that is less than or equal to its tariff binding. We make this restriction because tariff bindings are the mechanism used in the GATT/WTO agreements, and because they are incentive compatible. Furthermore, it has it has been shown by Alonso and Matouschek (2008) and Amador and Bagwell (2010) in models similar to ours that this restriction is without loss of generality under certain conditions on preferences and the distribution of the political shocks.

Letting t^B denote the tariff binding assigned to the importing country under a trade agreement, the importer will choose its optimal tariff in any state where its optimal tariff is below the tariff binding, and will choose the binding otherwise. Since the importer's optimal tariff is increasing in θ, we can invert (3) to obtain the threshold value of the political shock at which the tariff is at the binding as

$$\theta^B(t^B, \omega, \eta) = \max[\underline{\theta}, \tilde{t}^{N^{-1}}(t)], \tag{6}$$

$$\tilde{t}_t^{N^{-1}} > 0, \quad \tilde{t}_\omega^{N^{-1}} < 0, \quad \tilde{t}_\eta^{N^{-1}} > 0 \ .$$

Increasing the tariff binding will raise the threshold at which the given tariff binding will bind more frequently for a country with a larger optimal tariff, so the threshold (at an interior solution) will be decreasing in market power The incentive compatible tariff schedule under the tariff binding can be expressed as

$$t(\theta) = \begin{cases} t^B & \text{if } \theta \geq \theta^B(t^B, \omega, \eta), \\ \\ \tilde{t}^N(\theta, \omega, \eta) & \text{if } \theta < \theta^B(t^B, \omega, \eta). \end{cases} \tag{7}$$

We refer to the outcome $t^B > t^N(\underline{\theta})$ as one with tariff overhang, since there will exist states of the world for which the tariff is strictly less than the binding.

Given the schedule of applied tariff in (7) and the distribution of political parameters, the expected joint welfare of the importing and exporting countries under the tariff binding, t^B, is given by

$$E[W] = \int_{\underline{\theta}}^{\theta^B} W(t^N(\theta);\theta)f(\theta)d\theta + \int_{\theta^B}^{\bar{\theta}} W(t^B;\theta)f(\theta)d\theta. \tag{8}$$

Assuming that the objective of the negotiators is to maximize their expected joint welfare, the optimal tariff binding is obtained by choosing t^B to maximize the expression given by (8).[15]

Noting that $W(t;\theta) = W(t;0) + \theta\pi(t)$, the first-order condition for optimality at an interior solution is given by

$$\int_{\theta^B}^{\bar{\theta}} \left[W_t\left(t^B;0\right) + \theta\pi_t\left(t^B\right)\right] f(\theta)\, d\theta = 0.$$

Rearranging this condition and using the properties of the world welfare function, we can express the necessary condition as

$$\left(\frac{t^B}{1+t^B}\right)\eta = E\left[\theta|\theta > \tilde{\theta}^B(t^B,\omega,\eta)\right]. \tag{9}$$

The left hand side of this expression is the deadweight loss per dollar of profit generated for import-competing producers, $-W_t(t^B,0)/\pi_t(t^B)$, which is proportional to the size of the tariff wedge and the domestic import elasticity. The right hand side must be equal to the expected political premium from raising an additional dollar for producers, $E\left[\theta|\theta > \theta^B\right]$.

The solution for the optimal binding is illustrated in Figure 1, which plots the left and right hand sides of (9) against t^B. The cost of raising the binding, $\left(\frac{t^B}{1+t^B}\right)\eta$ will be increasing in t^B as long as η does not decline too rapidly in t^B. The $E\left[\theta|\theta > \tilde{\theta}^B(t^B,\omega,\eta)\right]$ locus has range $[E(\theta),\overline{\theta}]$, and is non-decreasing in t^B. For $t^B < t^N(\underline{\theta})$, the importing country will keep its tariff at the binding for all θ and the

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

expected benefit locus is horizontal at $E(\theta)$ over this interval. For $t \in (t^N(\underline{\theta}), t^N(\overline{\theta}))$, increases in the binding raise the threshold, $\frac{\partial E\left[\theta|\theta>\tilde{\theta}^B\right]}{\partial t^B} = \left(\frac{f(\tilde{\theta}^B)}{1-F(\tilde{\theta}^B)}\right)\frac{\partial\tilde{\theta}^B}{\partial t^B} > 0$, and thus raise the expected value of the shock above the threshold. An intersection in this region yields an agreement with tariff overhang. For $t^B > t^N(\overline{\theta})$, the tariff binding will never constrain the tariff policy of the home country because it exceeds the maximum the home country would impose. In order for a solution to the necessary conditions to represent a local maximum, the slope of the $\left(\frac{t^B}{1+t^B}\right)\eta$ locus must exceed that of the expected benefit locus at an intersection.

A solution for a maximum with a bound tariff in the interval $[0, t^N(\overline{\theta}))$ exists under fairly weak conditions.[16] Assuming these conditions are satisfied, we can derive the relationship between the model's parameters and the optimal binding. A corner solution with no tariff overhang arises if (9) is satisfied at $t^B < t^N(\underline{\theta})$. Substituting from (2) and (9) into this condition yields a corner solution if

$$\omega \geq \frac{E[\theta] - \underline{\theta}}{\eta - E[\theta]}. \tag{10}$$

This condition will be satisfied if a country's market power, as measured by ω, is sufficiently high relative to the expected value of the political shock when evaluated at $\underline{\theta}$. In order to provide flexibility, the bound tariff must be sufficiently high that it exceeds $t^N(\underline{\theta})$.For countries with significant market power, this cost is too high to justify allowing flexibility through the use of tariff overhang.

If the condition in (10) fails when evaluated at $\underline{\theta}$, then the necessary conditions will have an interior solution on $(t^N(\underline{\theta}), t^N(\overline{\theta}))$. Figure 1 can be used to illustrate the model's predictions about the relationship between country characteristics and the level of the tariff binding in a world welfare maximizing agreement. First consider the effect of an increase in a country's market power, i.e., an increase in ω. This has

[16] If $E(\theta) \geq 0$ and $\eta < \infty$, the expected benefit of raising the binding will be no less than the cost at $t^B = 0$. A solution to (9) with $t^B < t^N(\overline{\theta})$ will then exist if $\left(\frac{t^B}{1+t^B}\right)\eta - E\left[\theta|\theta > \tilde{\theta}^B(t^B)\right]$ is continuous in t^B and is positive when evaluated at $t^N(\overline{\theta})$. Noting that $t^N(\theta) = \frac{\eta\omega+\theta}{\eta-\theta}$, this latter condition requires $\left(\frac{\eta-\bar{\theta}}{1+\omega}\right)\omega > 0$. The existence of an interior solution for the efficient tariff with $t^E(\bar{\theta}) > 0$ requires $\eta > \overline{\theta}$, so this condition will be satisfied if $\omega > 0$.

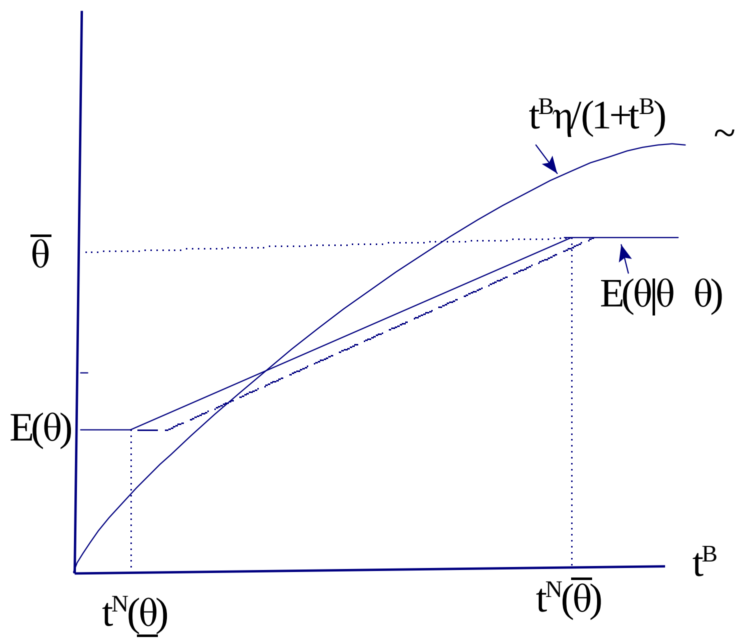

Figure 1: Expected Benefit and Cost of Raising a Tariff Binding

the effect of raising the Nash tariff and lowering $\theta^B(t^B)$ for $t^B \in (t^N(\underline{\theta}), t^N(\overline{\theta}))$, which shifts the expected benefit locus as illustrated by the dotted line in Figure 1. An increase in the market power of the importing country reduces the expected benefit of raising the binding, and thus reduces the optimal binding.

A reduction in η will have a similar effect on the expected benefit locus as an increase in market power, because it also raises the Nash tariff and reduces the threshold at which the binding holds. However, it also has the effect of reducing the cost of raising the binding, which shifts the cost locus downward proportionally. If the solution is a strict binding with no overhang (i.e. $t^B < t^N(\underline{\theta})$), only the latter shift applies and the tariff binding will raise. If the solution is an interior solution with tariff overhang, the effect on the binding will be ambiguous. Finally, note that a shift in the distribution of political shocks that raises $E(\theta|\theta \geq \theta^B)$ will raise the tariff binding at all solutions for t^B.

The following proposition summarizes our results thus far:

Proposition 1 (Optimal Binding) *(i) If $\omega > \frac{E[\theta]-\underline{\theta}}{\eta-E[\theta]}$, there will exist a local optimum at which there is no tariff overhang. The optimal tariff binding is $t^B = \frac{E(\theta)}{\eta-E(\theta)}$, which is increasing in $E(\theta)$ and decreasing in η.*

(ii) If $\omega \leq \frac{E[\theta]-\underline{\theta}}{\eta-E[\theta]}$, there exists a local optimum at which there is tariff overhang for some states of the world. The optimal tariff binding is decreasing in ω and increasing in $E(\theta|\theta \geq \theta^B)$. The effect of η on the binding is ambiguous.

Proposition 1 establishes comparative statics results in the neighborhood of a local maximum. If the solution to this problem is unique, it provides testable implications about the relationship between market power and the level of the tariff binding. In particular, it predicts that a country's tariff binding is non-increasing in its market power, and strictly decreasing if there is tariff overhang. [17]

[17] Since both the cost and benefit loci in Figure 1 are positively slope, this stronger result requires additional restrictions on the behavioral parameters and the distribution of political shocks. In the special case of linear supply and demand discussed above, $f'(\theta) \leq 0$ is a sufficient condition for uniqueness for all values of country size and comparative advantage. With $f'(\theta) > 0$, uniqueness requires that the country not be too large. Our empirical predictions thus also require that conditions of this type be satisfied.

Proposition 1 also yields a prediction about the relationship between market power and the probability that a country's applied tariff is at the binding. The probability that a country's applied tariff is at the binding is given by $1-F(\tilde{\theta}^B(t^B,\omega,\eta))$. Therefore, in the region that t^B is decreasing in the inverse export elasticity, the likelihood of a zero overhang should be increasing in ω because both the direct and indirect (through the change in tariff binding) effects of an increase in market power will reduce θ^B.

Corollary 1 *Under the optimal tariff binding agreement with tariff overhang, the likelihood of zero overhang is increasing in* ω*. For* $\omega > \frac{E[\theta]-\underline{\theta}}{\eta-E[\theta]}$*, we always have zero overhang under the optimal agreement.*

3.1 Tariff Binding Overhang

Optimum tariff theories predict that absent international trade policy commitments, i.e., when countries have 'full' flexibility in choosing their trade policies, the adopted import tariff is an increasing function of a countries international market power in the concerned sector. What is the relationship between applied tariff and international market power when countries are subject to tariff binding commitments that may provide a 'limited' flexibility? Since in practice a large fraction of tariff lines are below their bindings, it would be useful to have predictions regarding applied tariffs and market power. The results above provide us with a framework in which we can address this question.

We start by considering the magnitude of tariff binding overhang, which is one of the most interesting features of applied tariffs under the WTO agreement. Given a tariff binding, t^B, the size of a tariff binding overhang as a function of the state of the world, denoted by $g(\theta)$, is given by

$$g(\theta) = \begin{cases} t^B - t^N(\theta) & \text{if } \theta < \theta^B \equiv \min[\underline{\theta}, t^{N^{-1}}(t^B)], \\ 0 & \text{if } \theta \geq \theta^B, \end{cases}$$

where, θ^B was defined in (6), i.e., θ^B. The average overhang, g, can be written as

$E(g) = \int_{\underline{\theta}}^{\theta^B} \left[t^B - t^N(\theta)\right] f(\theta)\, d\theta$, with the impact of the importing country's market power, as measured by ω, on the average size of overhang given by

$$\begin{aligned} \frac{dE(g)}{d\omega} &= \int_{\underline{\theta}}^{\theta^B} \left[\frac{dt^B}{d\omega} - \frac{dt^N(\theta)}{d\omega}\right] f(\theta)\, d\theta + \left[t^B - t^N\left(\theta^B\right)\right] f\left(\theta^B\right) \\ &= \int_{\underline{\theta}}^{\theta^B} \left[\frac{dt^B}{d\omega} - \frac{dt^N(\theta)}{d\omega}\right] f(\theta)\, d\theta. \end{aligned}$$

But since $t_\omega^N(\theta) > 0$ and $\frac{dt^B}{d\omega} < 0$ for $\omega < \frac{E[\theta]-\underline{\theta}}{\eta - E[\theta]}$, it must be the case that $\frac{dg}{d\omega} < 0$. Formally,

Proposition 2 (Overhang) *Under an optimal tariff binding agreement, the average size of overhang is strictly decreasing in the international market power if and only if* $\omega < \frac{E[\theta]-\underline{\theta}}{\eta - E[\theta]}$. *For* $\omega > \frac{E[\theta]-\underline{\theta}}{\eta - E[\theta]}$, *the overhang is always zero*

Figure 2 illustrates this point for two levels of international market power parameters ω_0 and ω_1, such that $\omega_0 < \omega_1$. In this example the optimal binding for either market power level allows for overhang, i.e., $\theta^B(\omega_0), \theta^B(\omega_1) > \underline{\theta}$. As seen in this figure, an increase in the market power parameter from ω_0 to ω_1 lowers the binding and increases the applied tariff in states where there is overhang. As a result, the average overhang under the optimal tariff binding agreement decreases as ω increases. Figure 2 also shows that there will be conflicting effects of international market power on the average level of the tariff, which is given by

$$E\left[t^A\right] = \int_{\underline{\theta}}^{\theta^B} t^N(\theta) f(\theta) d\theta + (1 - F(\theta^B)) t^B.$$

The applied tariff of the larger country is higher in the region where both countries have overhang, but is lower in the region where both countries are at the binding.[18]

[18] We refer to the case where the market power paramter is given by ω_1 (ω_0) as the large-country (small-country) case.

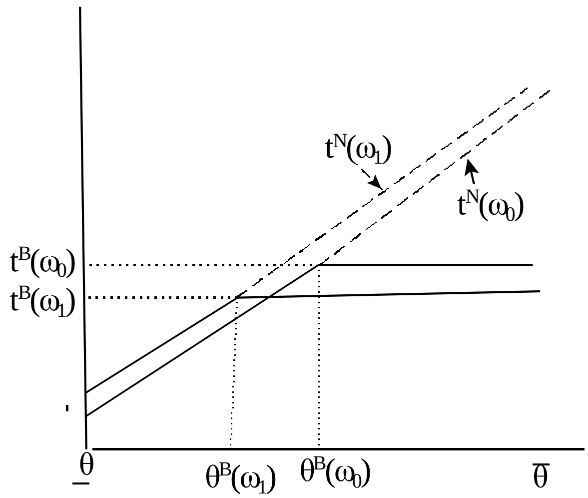

Figure 2: Agreement Tariff Schedules (Solid Lines) and Market Power: $\omega_1 > \omega_0$

Differentiating this expression with respect to ω yields

$$\frac{d}{d\omega}E\left[t^A\right] = \int_{\underline{\theta}}^{\theta^B} t_\omega^N(\theta)f(\theta)d\theta + \left(1 - F(\theta^B)\right)t_\theta^N\left(\theta^B\right)\frac{d\theta^B}{d\omega}. \tag{11}$$

The first term must be positive, because an increase in the market power increases the Nash tariff. The second term will be negative by Proposition (1). The former effect must dominate in the neighborhood of $\omega = 0$, since $\theta^B \to \bar{\theta}$ as $\omega \to 0$. The latter effect will dominate in the neighborhood of $\omega = \frac{E[\theta]-\underline{\theta}}{\eta-E[\theta]}$, since $\theta^B \to \underline{\theta}$ as $\omega \to \frac{E[\theta]-\underline{\theta}}{\eta-E[\theta]}$. Formally,

Proposition 3 (Applied Tariff) *The average applied tariff is an increasing (decreasing) function of ω for sufficiently small (large) values of ω.*

The non-monotonicity result of this paper may be understood by noting two conflicting forces that determine the size of the applied tariffs under an optimal agreement. On one hand, greater international market power increases the size of unilaterally optimal tariff, which tends to increase the average applied tariff. On the other hand, as shown in Proposition (1) and depicted in Figure (2), the optimal agreement features a lower binding for sectors with greater international market power, which reduces the maximum allowed tariff under the agreement. The former effect dominates when market power is small and the tariff binding is very high, while the latter effect dominates for sufficiently large levels of market power.

4 Data and The Empirical Model

In the rest of the paper we provide empirical observations regarding the main predictions of our theory. To study tariff bindings and overhang, we utilize data on Tariff Bindings and MFN-Applied Tariffs for WTO members that 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.

Our theoretical model does not attempt to address the phase-in of applied tariff rates following the negotiation of a trade agreement. Therefore, we will focus primarily on using a cross section for a particular year in our estimations. We use cross sectional data from year 2007, because the phase-in period for original WTO members was completed by that time.[19] Applied tariff data for 66 members accounting

[19] Virtually all of the phase-in periods for countries that were members in 1995 were completed by 2003-2005. In addition, the data for 2007 was not affected by the financial crisis. Since our

for 76% of world import is available for 2007.[20] Our selection criteria resulted in a total of 66 WTO members, including 52 original members and 14 new members. The data on applied tariff provides tariff information on approximately 5,200 sectors at the HS 6-digit level for each of the members, resulting in a sample of over 300,000 tariff lines.

Table 1 (in the introduction) reports the fraction of all tariff lines and the fraction of all imports that fall under one of three categories with respect to the overhang and tariff binding: zero overhang (the applied rate equals the bound rate), tariff overhang (applied rate strictly less than bound rate) and unbound (no tariff binding negotiated).[21] Although tariff lines with a zero overhang account for only 16.53% of all tariff lines, they account for 65% of world imports. Thus, a zero overhang is much more likely to be found in tariff lines that account for the largest fractions of world trade. Table 3 (in Appendix A) provides a summary of tariff binding status across countries. This table shows a substantial cross-country variations in the binding status: more than 90% 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.[22]

We test the predictions of Proposition 1 using the following Tobit model:[23]

---

model focuses on sector-specific and country-specific shocks, we avoided the financial crisis years where there were significant systemic shocks.

[20] We used data from 2006 for Belize, Nicaragua, Turkey, and 2008 for Morocco, Sri-Lanka, and Tunisia, as these countries did not report their applied tariffs in 2007.

[21] Table 1 also reports the fraction of tariff lines in which applied tariff is greater than the binding. These cases, which account for less than 3 percent of tariff lines (less than 6 percent of world trade), are related to the breach of the agreement or the use of contingent protection measures such as safegards.

[22] 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.

[23] According to the theory, at a corner solution, which prevails if $\omega > \frac{E[\theta]-\theta}{\eta - E[\theta]}$, the optimal binding is given by $t^B = \frac{E[\theta]}{\eta - E[\theta]}$. Therefore, contrary to the underlying assumption in this Tobit model, the corner solution for t^B is not necessarily zero and it is a function of η. In fact, the Tobit specification presumes that any observation with $t^B > 0$ represents an interior solution in which case t^B must depend negatively on ω. Therefore, if the theory is true, the Tobit specification will be biased against the prediction of our theory by making the parameter estimates smaller and less statistically-significant.

$$
\begin{aligned}
t_{ij}^{B*} &= \alpha_1 \omega_{ij} + \beta_1 \eta_{ij} + X_j \boldsymbol{\gamma}_1 + \varepsilon_{ij}, \\
t_{ij}^{B} &= t_{ij}^{B*} \text{ if } t_{ij}^{B*} > 0, \\
t_{ij}^{B} &= 0 \text{ if } t_{ij}^{B*} \leq 0.
\end{aligned} \tag{12}
$$

In this model, i and j are sector and country subscripts, t^B and t^{B*} are the observed tariff binding and its associated latent variable, ω is international market power, η is the product of import elasticity and import penetration ratio, and X_j is a vector of country-level variables that we discuss below. Proposition 1 implies that $\alpha_1 < 0$, while the sign of β_1 is ambiguous.

In cases where we have explanatory variables that are available at the HS 6-digit level, the dependent variable is the bound tariff from the WTO database.[24] In cases where we have variables that are only available at the HS 3-digit level, the dependent variable is the simple average of the bound tariffs over the 6-digit HS lines within the relevant 3-digit HS category.[25]

We also use a Tobit model to test whether there is a negative relationship between the size of the overhang observed in the data and the measure of international market power as predicted by Proposition 2:

$$
\begin{aligned}
g_{ij}^{*} &= \alpha_2 \omega_{ij} + \beta_2 \eta_{ij} + X_j \boldsymbol{\gamma}_2 + \varepsilon_{ij}, \\
g_{ij} &= g_{ij}^{*} \text{ if } g_{ij}^{*} > 0, \\
g_{ij} &= 0 \text{ if } g_{ij}^{*} \leq 0.
\end{aligned} \tag{13}
$$

In this model $g = t^B - t^A$ is the observed overhang and g^* is the associated latent variable. The explanatory variables are the same variables that were included in 12. Proposition 2 implies that $\alpha_2 > 0$, but no clear prediction is established for β_2.

[24] As will be discussed below, we use two alternative measures of international market power, namely, import ratio and inverse export elasticity. The former (latter) is available at the 6-digit (3-digit) HS tariff lines.

[25] Similar results were obtained when we used trade weighted tariff binidngs as the dependent variable.

A final testable prediction is that of Corollary 1 that the likelihood of zero overhang is increasing in the measure of international market power. In cases where we have a market power measure that is available at the HS 6-digit level, the prediction can be tested a Probit model, where the dependent variable is a dummy variable whose value is equal to one if the applied tariff equals (or is greater than) the bound tariff.[26] The probit model can be expressed as

$$\Pr\left(t_{ij}^{A} \geq t_{ij}^{B} | \omega_{ij}, \eta_{ij}, X_j\right) = \Phi\left(\alpha_3 \omega_{ij} + \beta_3 \eta_{ij} + X_j \boldsymbol{\gamma}_3\right). \tag{14}$$

Corollary 1 implies that $\alpha_3 < 0$. In cases where some explanatory variables are available only at the HS 3-digit level, we aggregated the 6-digit HS data by calculating the share of the 6-digit HS lines in the 3-digit HS category that were at the binding. We then used OLS to estimate the effects of the explanatory variables on the share of 3-digit HS lines that were at the binding.

4.0.1 International Market Power Measure

International market power plays a central role in our theory. We use two measure of market power: the inverse of the export supply elasticity and the member's import volume as a share of world imports in the sector. There are advantages and disadvantages to each of these measures, so we chose to use both in testing the role of market power.

Broda and Weinstein provide estimations of export supply elasticity using a methodology derived by Feenstra (1994) and extended by themselves in Broda and Weinstein (2006). Although the export supply elasticity is the market power measure suggested by our theory, there are two limitations in the use of these measures. First, these estimated elasticities are only available at the HS 3 variable level and for only 42 of the countries in our sample. Second, as noted by Broda, Limão, and Weinstein (2008), by construction, much of the variation in the estimated elasticities is across goods. In other words, the estimated inverse export elasticities mostly cap-

[26] As was shown in Table 1, in 2.76% percent of tariff lines the applied tariff is greater than the binding. We include such cases in the zero-overhang category.

ture variations of market power across sectors within each country. Therefore, when we use inverse export elasticity as the measure of market power, we will focus on a cross-sector and within-country analysis by including country fixed effects.

As an alternative measure of international market power, we will also use the member's import volume as a share of the world imports in the concerned sectors. As is well known, the true elasticity of export supply faced by country i for a given good can be expressed as[27]

$$\varepsilon_i^* = \left(\varepsilon^X + \sum_{k \neq i} \varepsilon_k W_k\right) / W_i,$$

where, W_i is country i's share of world imports in that good, ε^X is the world export supply elasticity, and ε_k the import demand elasticity for country k. Therefore, a country's share of the world import is inversely related to that country's true export supply elasticity.[28] This measure has the advantage of being available at the HS 6-digit level for all of the countries in our data set, and also provides a measure that can better capture the variation in market power across countries.

A concern about the use of market share data is that it is also an endogenous variable in our regressions because it is related to the applied tariffs. We therefore take an instrumental variable approach by using GDP and per-capita endowment of several productive resources of the economy, including productive capital, intangible capital, natural (agricultural) capital, and natural minerals as instruments for import ratio.[29] This choice of instrumental variables is motivated by the factor-content-of-trade methodology developed by Romalis (2004), in which relative resource endowment determines comparative advantage and, hence, the structure of trade in the world. Fitted values of import ratio are calculated for six-digit product category of

[27] Letting X and X_i denote the world export supply and the export supply function facing country i, we have $X_i = X - \sum_{k \neq i} m_k$, which implies $\frac{dX_i}{dp^*} = \frac{dX}{dp^*} - \sum_{k \neq i} \frac{dm_k}{dp^*}$. This can be written as $\varepsilon_i^* \frac{X_i}{p^*} = \varepsilon^X \frac{X}{p^*} + \sum_{k \neq i} \varepsilon_k \frac{m_k}{p^*}$, or $\varepsilon_i^* = \left(\varepsilon^X + \sum_{k \neq i} \varepsilon_k W_k\right) / W_i$, where W_k is country k's share of the world import.

[28] In our data, as in Broda, Limão, and Weinstein (2008), there is a positive and statistically significant relationship between inverse export elasticity and import share.

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

the Harmonized System. This entails running 4466 separate regressions (one for each HS 6-digit product category) in the first stage. In 97% of these regression there are at least two coefficients with statistically significant estimates. Moreover, the result of an F-test shows that 97.8% of these sectoral regressions are significant at a 10% level.

4.1 Other Explanatory Variables

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. If this hypothesis is correct, our model then implies that a higher political instability number is associated with greater tariff bindings and overhang.

Finally, as suggested by the theory, import demand elasticity and import penetration ratio are other determinants of the optimal tariff. We have data on import demand elasticities, ε in the notation of (2), obtained from Broda and Weinstein (2006) for 42 of the countries at the HS 3-digit level. Unfortunately, production data was available for an even more limited set of industries and countries. Thus, when using the variable of $\eta = \varepsilon m/y$ we were limited to using data from manufacturing sectors only for 24 countries.[30] As noted above, the theory does not establish unambiguous comparative statics results for these variables in most cases. Therefore, we constructed estimates of the model both with and without these variables.

[30] Manufacturing output data is available for 4 digit ISIC categories from UNIDO. These production data were matched to the HS 3-digit categories to obtain the import ratio variable.

Table 2: Descriptive Statistics

Name	Average	Median	Min.	Max.
GDP (bil.$)	528	32	0.8	11,670
per capita GDP($)	8831	3683	171	41904
Political Instability Index	3.95	4.1	0.2	6.8
Bound tariff rate (%)	28.56	25	0	800.3
Applied tariff rate (%) (in bound sectors)	8.165	5	0	800.3
Tariff Overhang (percentage point)	21.41	15	0	454.2
Import share(%)	1.35	0.056	0	99.91
Inverse Export Elasticity	62.39	1.12	0.0004	1645.96
Import Elasticity	8.45	3.27	1.074	821.89

Note: Cross sectional data from year 2007 for 66 WTO members. Tariff rates are the average of tariff lines at the HS 6-digit level. Import and export elasticities are measured at HS 3-digit level. Number of observations: 300179. Source: WTO, World Bank, United Nation, and the Economist Intelligence Unit.

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 66 countries. We also 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 market power variables are correlated with GDP per capita in the data, we check if the significance of the international market power measures in our estimation is robust to inclusion of GDP per capita.

5 Empirical Results

Table 4 shows the results for the Tobit regression (12) of the tariff binding against market power and other variables. The first two columns report results when a country's share of world imports is used as the measure of market power. This measure is available at the HS 6-digit level for all 66 of the WTO members in our sample, resulting in more than 247,000 observations. Our estimation shows a negative and statistically significant relationship (at the 1% level) between import share and the level of the tariff binding, which is consistent with the prediction of Proposition 1. Standard errors were calculated assuming two-way clustering at the country and sectoral level. The impact of international market power, as measured by import share, is also economically significant: a one-standard-deviation, equal to 4.6 percentage points, increase in the import share, reduces the tariff binding by 3.5-4.46 percentage points.[31]

The results also indicate that the political instability measure has a positive and statistically significant relation to the tariff binding, which is also consistent with the theory if political instability is positively related to the conditional mean of the political shock. GDP per capita is also included to control for the possibility that the level of development plays a role in determining bindings.

Column 3 uses the Broda-Weinstein's estimated inverse export elasticities as a measure of international market power. In this specification we also include import demand elasticity, ε, as an explanatory variable.[32] As noted in the discussion above, the use of this measure restricted our analysis to the use of weighted tariff bindings at the HS 3-digit level for 42 countries. Using country fixed effects, we find a negative relationship between the inverse elasticity and the level of the binding that was significant at the 1%-level. The estimated coefficient for ε was not statistically significant, which is in line with lack of an unambiguous theoretical relationship between ε and the level of optimal tariff binding.

The remaining columns in Table 4 report tests on subsets of the sample of countries or industries. These tests serve as robustness checks on our estimates for the entire sample of countries. Columns 4 and 5 report results for the original WTO members (52 countries) and those that were admitted after 1995 (14 countries), respectively. These regressions indicate a negative and statistically significant relationship between market power (measured by import share) and the level of the bindings, although the magnitude is smaller for the new entrants and is only significant at the 10%-level.

Columns 8 and 9 report results where separate equations were estimated for manufactured products and agricultural goods. There are reasons to believe that

[31] Standard deviation of the import share variable is 4.7. Multiplying this number with the coefficient of the import share in column 1 and column 2 of Table 4 yields 3.5 and 4.46, respectively.

[32] In other specifications (not reported) we used η instead of ε. The estimated coefficients have the expected sign but show a lower level of statistical significance.

the political economy of manufacturing and agricultural sectors are substantially different. 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. The results indicate similar negative and statistically significant impacts of import share on the level of bindings in both sectors. One significant difference for the agricultural sectors is that there is a negative and statistically significant effect of GDP per capita on bindings in agriculture. The results using export supply elasticities to measure market power have a negative effect, but the result is not statistically significant.

Table 5 reports the results of the Tobit model (13) for tariff overhang. The results are broadly similar to those obtained for the tariff binding equations, although in this case the significance of the market power effects is even stronger. Both market power measures have coefficients that are negative and significant at the 1% for the equations involving all countries, as well as in the original member/new member subgroups and for the manufacturing sectors. These estimated effects are also economically important. In particular, a one-standard-deviation, equal to 4.6 percentage point, increase in import share results in an 8-17 percentage-point decrease in the magnitude of the tariff binding overhang. The results for the political instability variables are also positive for the equation involving all countries, although the statistical significance is somewhat reduced. GDP per capita also plays a role in the determination of overhang in the agricultural sector, which is also consistent with the findings on tariff bindings.

Table 6 reports the marginal effects of the explanatory variables of the Probit regression (14) of the likelihood of zero overhang against a measure of market power and other explanatory variables. The results for this regression are also consistent with the theory, in that sectors with greater import market power are more likely to have an applied tariff at the binding. This result holds across all specifications when import share is used as the measure of market power (Columns 1, 2, 4-6, and 8). To illustrate the magnitude of these effects, compare the marginal of ω in column 1, which is 0.014 at the mean of import share (1.32%), and 0.013 at the median of import share (0.06%). This numbers indicate that a one-standard-deviation increase in import share makes it 7 percentage-points more likely to have an applied tariff that is at the binding, i.e., a zero overhang.

In columns 3, 7, and 9, we use inverse export elasticity as the measure of international market power. As explained above (subsequent to the Probit model 13), we use an OLS specification when export elasticity is used. Column 3, which reports the result of the OLS regression on the entire sample, shows a statistically and economically significant coefficient for inverse export elasticity. These coefficient estimates, however, are statistically insignificant when the agricultural and manufacturing subsamples are studied separately. As in previous regressions, political instability has a negative and highly significant effect on tariff overhang in the HS 6-digit regressions, which is consistent with the notion that countries with greater variability in political shocks will require greater flexibility in tariff bindings and, as a result, are less likely to be at the binding.

6 Conclusion

The aim of this paper is to derive and examine predictions of the terms-of-trade theory when governments value flexibility in setting their policies. We model the trade-off between curbing beggar-thy-neighbour motivations and flexibility in the design of trade agreements, and argue that recognizing this trade-off is the key to explain the observed patterns in the tariff binding commitments and applied tariffs under the WTO.

We provide a systematic account of the empirical relationship between tariff commitments, applied tariffs, and measures of international market power. As predicted by the theory, the level of tariff binding and the size of tariff binding overhang are both inversely related to measures of import market power.

Our theoretical model abstracts away from some important elements that are relevant in trade agreements. First, we ignore the possibility of including an 'escape clause' in the agreement, which allows the signatories to set tariffs above their committed tariff bindings. There are at least three approaches to introduce an incentive-compatible and welfare-improving escape clause in a trade agreement. In one approach, explored by Feenstra and Lewis (1991), Sykes (1991), Ludema (2001), Beshkar (2011), Beshkar (2010a), Beshkar (2010b), and Maggi and Staiger (2011b), Maggi and Staiger (2011a), parties can breach the contract if they compensate the affected parties according to a pre-specified remedy system. A second approach, which is under study by Beshkar and Bond (2012), assumes the availability of a costly state verification process, in which parties may set tariffs above the binding if the can verify publicly that their current contingency justifies higher tariffs. A third approach is to impose a dynamic constraint on the use of contingent protection, as in Bagwell and Staiger (2005) and Martin and Vergote (2008).

We also abstract from the issues regarding the non-discrimination clause and the related flexibility measures. Nondiscrimination is an important element of the GATT/WTO. However, the member countries are given some flexibility to violate the non-discrimination clause under the anti-dumping agreement. The literature on trade agreements still lacks a convincing model that explains the merits of including a discriminatory flexibility measure such as anti-dumping. In particular, we lack a formal model to study the interaction between discriminatory and non-discriminatory flexibility measures in practice. For example, 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 and, hence, may be excluded from the WTO.

References

Alonso, R. and N. Matouschek (2008). Optimal Delegation. *Review of Economic Studies*, 259–93.

Amador, M. and K. Bagwell (2010). On the Optimality of Tariff Caps. *Working Paper, Stanford University*.

Bagwell, K. (2009). Self-enforcing Trade Agreements and Private Information. *NBER Working Paper*.

Bagwell, K. and R. Staiger (1999). An Economic Theory of GATT. *American Economic Review 89*(1), 215–248.

Bagwell, K. and R. Staiger (2005). Enforcement, Private Political Pressure, and the General Agreement on Tariffs and Trade/World Trade Organization Escape Clause. *The Journal of Legal Studies 34*(2), 471–513.

Bagwell, K. and R. Staiger (2011). What do trade negotiators negotiate about? Empirical evidence from the World Trade Organization.

Bagwell, K. and R. W. Staiger (1990). A Theory of Managed Trade. *The American Economic Review 80*(4), 779–795.

Beshkar, M. (2010a). Optimal Remedies in International Trade Agreements. *European Economic Review 54*(3), 455 – 466.

Beshkar, M. (2010b). Trade Skirmishes and Safeguards: A Theory of the WTO Dispute Settlement Process. *Journal of International Economics 82*(1), 35 – 48.

Beshkar, M. (2011). Arbitration and Renegotiation in Trade Agreements. *Working Paper*.

Beshkar, M. and E. Bond (2012). Cap-and-Escape in Trade Agreements. *Working Paper*.

Bickerdike, C. (1906). The theory of incipient taxes. *The Economic Journal 16*(64), 529–535.

Bond, E. and J. Park (2002). Gradualism in trade agreements with asymmetric countries. *Review of Economic Studies 69*(2), 379–406.

Broda, C., N. Limão, and D. Weinstein (2008). Optimal tariffs and market power: the evidence. *American Economic Review 98*(5), 2032–2065.

Broda, C. and D. Weinstein (2006). Globalization and the Gains from Variety. *Quarterly Journal of Economics 121*(2), 541–585.

Feenstra, R. (1994). New product varieties and the measurement of international prices. *The American Economic Review*, 157–177.

Feenstra, R. C. and T. R. Lewis (1991). Negotiated Trade Restrictions with Private Political Pressure. *The Quarterly Journal of Economics 106*(4), 1287–1307.

Francois, J. and W. Martin (2004). Commercial policy variability, bindings, and market access. *European Economic Review 48*(3), 665–679.

Grossman, G. and E. Helpman (1995). Trade wars and trade talks. *Journal of Political Economy 103*(4), 675–708.

Handley, K. (2010). Exporting Under Trade Policy Uncertainty: Theory and Evidence.

Handley, K. and N. Limão (2010). Trade and Investment under Policy Uncertainty: Theory and Firm Evidence.

Horn, H., G. Maggi, and R. Staiger (2010). Trade agreements as endogenously incomplete contracts. *The American Economic Review 100*(1), 394–419.

Johnson, H. (1953). Optimum tariffs and retaliation. *The Review of Economic Studies 21*(2), 142–153.

Ludema, R. (2001). Optimal International Trade Agreements and Dispute Settlement Procedures. *European Journal of Political Economy 17*(2), 355–376.

Maggi, G. and A. Rodriguez-Clare (2007). A Political-Economy Theory of Trade Agreements. *American Economic Review 97*(4), 1374–1406.

Maggi, G. and R. Staiger (2011a). Optimal design of trade agreements in the presence of renegotiation. *Working Paper, Yale University*.

Maggi, G. and R. Staiger (2011b). The role of dispute settlement procedures in international trade agreements. *The Quarterly Journal of Economics 126*(1), 475–515.

Martin, A. and W. Vergote (2008). On the role of retaliation in trade agreements. *Journal of International Economics 76*(1), 61–77.

Prusa, T. and Y. Li (2009). Trade Liberalization, Tariff Overhang and Antidumping Filings in Developing Countries.

Romalis, J. (2004). Factor proportions and the structure of commodity trade. *American Economic Review*, 67–97.

Sala, D., P. Schröder, and E. Yalcin (2010). Market Access through Bound Tariffs. *Scottish Journal of Political Economy 57*(3), 272–289.

Subramanian, A. and S. Wei (2007). The WTO promotes trade, strongly but unevenly. *Journal of International Economics 72*(1), 151–175.

Sykes, A. (1991). Protectionism as a Safeguard: A Positive Analysis of the GATT Escape Clause with Normative Speculations. *University of Chicago Law Review 58*(1), 255–305.

Syropoulos, C. (2002). Optimal Tariffs and Retaliation Revisited: How Country Size Matters. *The Review of Economic Studies*, 707–727.

World-Bank (2010). The Changing Wealth of Nations. *http://data.worldbank.org/data-catalog/wealth-of-nations*.

WTO (2010). The WTO Tariff Database.

A Proofs

Lemma 1 *Nash and Efficient tariffs are given by* $t^N(\theta) = \frac{\eta\omega+\theta}{\eta-\theta}$ *and* $t^E(\theta) = \frac{\theta}{\eta-\theta}$*, respectively, where* $\eta \equiv \varepsilon\frac{m}{y}$*.*

Proof. The world market clearing condition satisfies

$$m(p^*(1+t)) + m^*(p^*) = 0.$$

Letting $\tau = 1+t$, totally differentiating the world market clearing condition yields

$$\begin{aligned} \frac{dp^*}{d\tau} &= -\frac{m'(p)p^*}{m'(p)\tau + m^{*\prime}(p^*)} = \\ &= -\frac{p^*}{\tau}\frac{\varepsilon}{\varepsilon+\varepsilon^*}, \end{aligned}$$

where $\varepsilon^* = p^*\frac{m^{*\prime}}{m^*}$ is the elasticity of foreign export supply and $\varepsilon = -\frac{pm'}{m}$ is the elasticity of import demand. The home price change can then be written as

$$\frac{dp}{d\tau} = p^*\left(1 + \frac{dp^*}{d\tau}\frac{\tau}{p^*}\right) = p^*\frac{\varepsilon^*}{\varepsilon^*+\varepsilon}.$$

The non-cooperative tariff of the importing country may be obtained by setting $\frac{dV}{d\tau} \equiv 0$. Taking derivative of V in 1 yields

$$\begin{aligned} \frac{dV}{d\tau} &= \frac{\partial V}{\partial p}\frac{\partial p}{\partial \tau} + \frac{\partial V}{\partial p^*}\frac{\partial p^*}{\partial \tau} \\ &= [(p-p^*)m' + \theta y]\frac{\partial p}{\partial \tau} - m\frac{\partial p^*}{\partial \tau} \\ &= [tp^*m' + \theta y]\, p^*\frac{\varepsilon^*}{\varepsilon^*+\varepsilon} + \left(\frac{p^*}{\tau}\right)\frac{m\varepsilon}{\varepsilon^*+\varepsilon} \end{aligned}$$

Thus, importing country's optimality condition, $\frac{dV}{dt} \equiv 0$, may be written as

$$\left[-t\frac{\varepsilon}{1+t} + \theta\frac{y}{m}\right]\varepsilon^* + \frac{\varepsilon}{1+t} = 0$$

Solving for t in this equation yields:

$$t^{N}(\theta) = \frac{1}{\eta - \theta}(\eta\omega + \theta), \tag{15}$$

where, $\eta \equiv \varepsilon\frac{m}{y}$ and $\omega = \frac{1}{\varepsilon^*}$.

Defining the joint political welfare of the two governments as $W \equiv V(p, p^*, \theta) + V^*(p^*)$, the necessary condition of world welfare maximization is

$$\frac{dW}{dt} \equiv \frac{\partial W}{\partial p}\frac{\partial p}{\partial t} + \frac{\partial W}{\partial p^*}\frac{\partial p^*}{\partial t} = 0. \tag{16}$$

As shown by citeNbagwell1999etg, this condition reduces to $\frac{\partial V}{\partial p} = 0$,[33] which implies

$$\frac{t}{1+t}pm' + \theta y = 0,$$

or,

$$-\frac{t}{1+t}\varepsilon + \theta\frac{y}{m} = 0. \tag{17}$$

Rearranging this equation yields the importing country 's politically efficient tariff

$$t^{E}(\theta) = \frac{\theta}{\eta - \theta}.$$

■

B Tables

[33] To obtain this result, note that $\frac{\partial W}{\partial p} = \frac{\partial V}{\partial p}$ and $\frac{\partial W}{\partial p^*} = \frac{\partial V}{\partial p^*} + \frac{\partial V^*}{\partial p^*} = m + m^* = 0$. Therefore, $\frac{dW}{dt} = \frac{\partial V}{\partial p}\frac{\partial p}{\partial t} = 0$ if and only if $\frac{\partial V}{\partial p} = 0$.

Table 3: Binding Status Across WTO Members in the Sample

Member	Average Binding	Average Applied	Zero Overhang	Member	Average Binding	Average Applied	Zero Overhang
US	3.73	3.74	94.1%	Tunisia	58.93	21.49	5.7%
EU	4.16	4.23	92%	Croatia	6.13	4.67	64.5%
Japan	2.91	2.94	89.4%	Oman	12.44	4.60	8.9%
China	10.04	10.03	93.2%	Uruguay	31.56	10.54	0.2%
Canada	5.20	3.72	47.1%	Guatemala	42.40	5.52	0.1%
Brazil	31.40	12.43	1.0%	Costa Rica	43.29	6.43	2.0%
India	50.37	12.95	3.7%	Sri Lanka	29.11	13.04	0.4%
Korea	16.37	11.66	35.4%	Ecuador	21.79	11.92	9.0%
Mexico	34.95	11.94	7.1%	Panama	23.38	7.27	8.9%
Australia	10.09	3.49	27.1%	Kenya	95.01	12.995	0.1%
Turkey	30.35	10.31	18.6%	El Salvador	36.88	7.05	2.3%
Argentina	31.86	11.17	0.7%	Trin. Tob.	55.61	7.19	1.3%
Switzerland	0	0	100%	Jordan	16.34	11.13	28.8%
Saudi Arabia	10.81	4.60	7.3%	Bahrain	34.10	4.60	1.8%
Hongkong	0	0	100%	Iceland	13.25	2.85	42.3%
Indonesia	37.20	6.90	1.6%	Bolivia	39.97	8.29	0%
Norway	3.07	0.684	50.6%	Jamaica	49.73	7.35	0.5%
S. Africa	17.97	7.58	22.7%	Honduras	31.94	5.55	1.8%
Thailand	25.41	8.95	23.6%	Ghana	92.57	13.07	0%
Israel	18.18	5.33	19.7%	Gabon	21.37	17.85	0.2%
Singapore	6.99	0	21.6%	Mauritius	104.88	3.09	7.7%
Columbia	42.84	12.53	0.02%	Georgia	7.20	1.03	28.1%
Malaysia	14.63	7.33	23.4%	Albania	6.98	5.21	39.1%
Philippine	25.57	6.25	3.8%	Nicaragua	40.70	5.57	1.9%
Pakistan	59.68	13.41	10.9%	Madagascar	27.34	12.35	2.5%
Chile	25.07	5.99	0%	Zambia	106.52	13.59	0%
Peru	29.54	8.62	1.3%	Niger	44.57	12.02	9.5%
Bangladesh	162.68	16.98	1.0%	Moldova	6.73	4.38	63.3%
New Zealand	10.17	2.94	42%	Mongolia	17.52	4.96	0.7%
Kuwait	100	4.60	0.02%	Togo	80	12.02	0%
Vietnam	11.43	16.81	28.3%	Belize	57.97	10.38	1.2%
Morocco	41.26	21.45	15.8%	Cape Verde	15.79	10.29	15.4%
Dom. Rep.	34.95	7.19	0.8%	Guyana	56.80	10.73	1.4%

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

Table 4: Tariff Binding Commitments and Market Power

Dependent Variable	Tariff Binding								
Sectors	All Sectors					Manufacturing		Agriculture	
WTO members (#)	All (66)		All (42)	Original (52)	new (14)	All (66)	All(42)	All (66)	All (42)
Estimation Method	Tobit	IV Tobit	Tobit	IV Tobit	IV Tobit	IV Tobit	Tobit	IV Tobit	Tobit
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Import share	-0.76^{***}	-0.95^{***}		-0.93^{**}	-0.37^{*}	-0.91^{***}		-0.94^{**}	
	(0.23)	(0.28)		(0.36)	(0.20)	(0.29)		(0.44)	
$\log(\omega)$			-0.47^{***}				-0.009		-0.42
			(0.15)				(0.04)		(0.49)
ε			0.01				-0.01^{***}		0.003
			(0.01)				(0.004)		(0.04)
$\log\left(\frac{\text{GDP}}{\text{Capita}}\right)$	-2.00	-1.85		-6.95	-3.38	0.72		-10.09^{**}	
	(3.39)	(3.37)		(4.73)	(3.43)	(3.23)		(4.67)	
Pol. Instability	5.01^{**}	4.80^{**}		3.00	2.83	5.19^{***}		3.83	
	(2.04)	(2.00)		(2.62)	(1.51)	1.90		(3.36)	
Country dummy	No	No	Yes	No	No	No	Yes	No	Yes
Two Way Clustering	Yes	Yes	No	Yes	Yes	Yes	No	Yes	No
R-squared	0.0171	0.0170	0.04	0.0289	0.0160	0.0237	0.2032	0.0159	0.0390
# of observations	247742	228481	6050	170649	57832	210107	4443	37635	1607

Note: Robust standard error in the regression with country dummy.

Table 5: Tariff Overhang and Market Power

Dependent Variable	Binding Overhang								
Sectors	All Sectors					Manufacturing		Agriculture	
WTO members (#)	All (66)		All (24)	Original (52)	new (14)	All (66)	All(24)	All (66)	All (24)
Estimation Method	Tobit	IV Tobit	Tobit	IV Tobit	IV Tobit	IV Tobit	Tobit	IV Tobit	Tobit
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Import share	-1.73^{***}	-3.73^{***}		-3.65^{***}	-4.45^{***}	-1.61^{***}		-1.94^{**}	
	(0.52)	(0.95)		(0.92)	(1.59)	(0.52)		(0.49)	
$\log(\omega)$			-0.41^{***}				-0.15***		-0.13
			(0.06)				(0.04)		(0.16)
ε			0.01**				-0.007*		0.01
			(0.006)				(0.004)		(0.01)
$\log\left(\frac{GDP}{Capita}\right)$	-1.15	-0.73		-5.78	-2.78	1.28		-9.37^{*}	
	(3.65)	(3.61)		(4.88)	(3.48)	(3.50)		(4.82)	
Pol. Instability	4.50**	3.98*		2.07	2.16	4.89**		3.20	
	(2.18)	(2.12)		(2.68)	(1.43)	2.11		(3.35)	
Country dummy	No	No	Yes	No	No	No	Yes	No	Yes
Two Way Clustering	Yes	Yes	No	Yes	Yes	Yes	No	Yes	No
Psuedo R-squared	0.0191	0.0216	0.1294	0.0347	0.0225	0.0239	0.2063	0.0182	0.1563
# of observations	247742	228481	6050	170649	57832	210107	4443	37635	1607

Note: Robust standard error in the regression with country dummy.

Table 6: Likelihood of Tariff at the Binding

Dependent Variable	Zero-Overhang Dummy								
Sectors	All Sectors					Manufacturing		Agriculture	
WTO members (#)	All (66)		All (42)	Original (52)	new (14)	All (66)	All(42)	All (66)	All (42)
Estimation Method	Probit	IV Probit	OLS	IV Probit	IV Probit	IV Probit	OLS	IV Probit	OLS
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Import share	0.014***	0.037***		0.019***	0.12***	0.039***		0.023***	
	(0.01)	(0.02)		(0.02)	(0.09)	(0.03)		(0.03)	
$\log(\omega)$			0.002**				0.001		-0.00
			(0.001)				(0.001)		(0.49)
ε			-0.00				0.0003**		-0.00
			(0.00)				(0.0001)		(0.00)
$\log\left(\frac{GDP}{Capita}\right)$	0.015	0.008		0.051***	-0.025	0.006		0.024	
	(0.10)	(0.10)		(0.11)	(0.18)	(0.10)		(0.11)	
Pol. Instability	-0.049***	-0.045***		-0.019*	-0.02	-0.045***		-0.044**	
	(0.06)	(0.06)		(0.07)	(0.11)	(0.00)		(0.08)	
Country dummy	No	No	Yes	No	No	No	Yes	No	Yes
Two Way Clustering	Yes	Yes	No	Yes	Yes	Yes	No	Yes	No
(Psuedo) R-squared	0.1536	0.1891	0.6447	0.3507	0.0721	0.1975	0.6918	0.1444	0.7277
# of observations	291878	269039	6431	211049	57990	235687	4824	33172	1607

Note: Robust standard error in the regression with country dummy. In OLS regression, dependent variable is the ratio of strong binding in HS 3-digit sectors. Marginal effect is reported in the probit regression.