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Tariff binding and overhang: Theory and evidence☆

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ABSTRACT

Most market access commitments under the WTO are in the form of bindings on applied tariff rates. We observe two important regularities in the data. First, applied tariffs are often lower than the bound tariffs, providing governments with substantial policy flexibility. Second, the extent of flexibility varies substantially across sectors and countries. In a sharp contrast to the prediction of standard trade agreement models, we observe a strong negative correlation between tariff commitments and measures of import market power. We model the trade-off between discipline 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.

1. Introduction

Trade agreements are generally viewed as a means of escape from an externality-driven prisoner's dilemma, where the externality is most frequently associated with the negative impact of a tariff on the exporter's terms of trade.[1] Due to the existence of the externality arising from a country's trade policy, noncooperative tariffs are too high from a global efficiency point of view. The central element of trade agreements should then be a commitment to reduce tariffs and other protectionist measures from their current levels.

In light of the importance of tariff cuts in explaining the role of trade agreements, it seems surprising that immediately following the signing of the WTO agreement in 1995, the applied Most-Favored-Nation (MFN) tariffs were below the negotiated bindings in 69% of the six-digit HS tariff lines.[2] It would seem a simple matter to ask countries to reduce their tariff bindings to the level of their current applied tariff, since current tariffs are observable and the adjustment could be implemented with minimal negotiation costs.

The fact that tariff commitments are not strictly binding in many sectors suggests that countries value the flexibility to adjust tariffs unilaterally.[3] An optimal trade agreement will then involve a trade-off between flexibility and commitment, since a reduction in the tariff binding reduces the negative spillover on trading partners but also reduces the ability of the importer to respond to preference shocks.

Our goal in this paper is to develop and test a model of optimal trade agreements that exhibits a flexibility/commitment trade-off. We consider a theoretical model with heterogeneous countries that have private information about the magnitude of sectoral preference shocks. The externality from tariff policy results from the adverse impact of

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[1] The terms-of-trade externality arises in the classical optimal tariff theory. Bagwell and Staiger (1999) have shown that this terms-of-trade externality extends to a broad class of government objective functions that incorporate political economy motives. As a result of this terms-of-trade externality, both countries can gain from a reciprocal trade liberalization from the Nash equilibrium tariffs. Even in models where externalities operate through other channels, such as delocation externality (Venables, 1987; Ossa, 2011), commitments to reciprocal trade liberalization will generally result in a Pareto improvement.

[2] This figure is based on WTO tariff bindings and applied tariff rates for more that 92,000 tariff lines of original WTO members in 1996 for which data is available from the World Bank.

[3] A desire for trade policy flexibility could arise if a country's preferences regarding openness to trade are subject to shocks in the future, so that there is an option value to trade policy flexibility.

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tariffs on the terms of trade of trading partners. The agreements we consider provide flexibility through the use of tariff bindings, so that countries have flexibility to adjust their tariffs to preference shocks as long as the tariff is below the binding. The excess of a country's tariff binding over its applied tariff, called tariff overhang, reflects the amount of flexibility available to a country at a point in time. The model's predictions about the relationship between tariff bindings, tariff overhang, and country characteristics can then be tested empirically.

One prediction of the model is that the optimal agreement will provide less flexibility for trade policy in sectors that have greater import market power. In particular, sectors with greater market power are likely to have less tariff overhang and are more likely to be at the binding at a point in time. We also show that the applied tariffs of sectors with a sufficiently high level of import market power will always be at the binding.

The negative correlation between market power and tariff overhang results from two reinforcing effects. First, a given level of tariff binding entails less flexibility for a sector that has a higher import market power. That is because, as is familiar from the optimal tariff literature, unilaterally optimal tariffs are increasing in import market power. In addition, an optimal agreement assigns a lower tariff binding to sectors with greater import market power. This latter effect is due to the trade-off between flexibility and commitment. In particular, since trade policy flexibility involves a greater terms-of-trade externality in sectors with greater import market power, the optimal tariff binding is a decreasing function of import market power.

The predictions of our model differ in several respects from those that ignore a demand for flexibility on the part of importers. One difference is that models without a demand for flexibility do not provide an explanation of the difference between applied tariffs and bindings. Moreover, there are substantial differences across sectors and countries in the size of tariff overhang. For example, virtually all of the tariff lines in the US, EU, and Japan are at their binding and there is no tariff overhang. On the other hand, no tariff lines are at the binding for 17% of countries.

A second difference from models without a demand for flexibility concerns the relationship between tariff bindings and market power, which is negative in our model. In complete-information models with no bargaining frictions (e.g., Grossman and Helpman, 1995; Bagwell and Staiger, 1999), the only role of trade agreements is to neutralize terms of trade spillover, which implies that the negotiated tariffs should be independent of the importing country's market power. Ludema and Mayda (2013) identify a potential market power effect in trade agreements due to the free rider problem resulting from the MFN clause. They find that market power effects will be eliminated only to the extent that concentration of export interests is sufficiently large that exporters find it worthwhile to negotiate a tariff reduction. Their model suggests a positive relationship between bindings and market power, but a negative relationship between the interaction of market power and exporter concentration. The latter effect captures the notion that tariff cuts will be larger for countries with the larger market power only if the free rider problem is not too strong. Whether there is a positive or negative relationship between tariff bindings and market power, thus, depends on the correlation between a country's market power and the degree of free riding that exists among exporting countries.

Bown and Crowley (2013) also highlight the relevance of the terms-of-trade theory in practice by showing that the likelihood of using contingent protection measures such as anti-dumping and safeguard increases when there is a surge in imports, which increases the ability of the importing country to manipulate the terms of trade. While Bown and Crowley (2013) study the impact of changes in the import market power (as captured by import surges) on the use of contingent protection measures, our focus is on the effect of a country's long term import market power on the level of negotiated tariff bindings. In our setting, an increase in the import market power would increase the applied tariff under the agreement if and only if there is a positive tariff overhang.

Our theoretical model builds on Bagwell and Staiger (2005), who show that a tariff binding arrangement that allows countries to reduce tariffs below the binding is preferred to an inflexible binding when countries have private information about their demand for protection.[4] Amador and Bagwell (2013) 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 how the optimal bindings, the level of tariff overhang, and the probability that a tariff is at the binding vary with country and sectoral characteristics.

Our empirical analysis tests the predictions of the theoretical model using World Bank data on tariff bindings and applied tariffs at the HS six-digit level. We utilize a country's share of world imports and the elasticity of export supply as measures of a country's market power, and a measure of political instability to capture the value of flexibility to policy makers. Our empirical analysis is thus related to several recent empirical studies that find support for the role of market power in trade policy and trade agreements. Broda et al. (2008) find support for the role of market power in determining a country's applied tariff using data from 16 non-WTO members, whose tariffs are presumably unaffected by trade agreements. Bagwell and Staiger (2011) find evidence that tariff cuts of countries acceding to the WTO are largest in sectors where market power is greatest, which is consistent with the role of trade agreements in neutralizing market power effects. Our empirical work differs in that we emphasize the trade-off between these market power effects and the demand for flexibility, so that a central focus is the impact of market power on the difference between the applied tariff and the tariff binding.

We find a number of empirical results that are supportive of 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. This relationship is both statistically and economically important. In particular, we find that increasing a country's market power in a sector (as measured by import share) from the median level to the 75th percentile reduces its binding by 15% when evaluated at the median binding. We also find a statistically-significant negative relationship between the size of tariff binding overhang and the importing country's import market power in that sector. As a related result, we find that it is substantially more likely to observe a zero overhang in sectors with greater import market power.

The political environment also plays a role in determining the size of the 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

[4] 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 et al. (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 et al. (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 (1998, 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 (1998, 2007), however, the governments always apply a tariff equal to binding and, thus, no overhang is predicted by the theory.

light of our observation that under an optimal agreement, smaller import markets are given more flexibility in setting their trade policies, which leads to a lower degree of trade liberalization.

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

2. A political economy model of protection

In order to capture the role of special interest groups in determining the demand for protection, we utilize a two-country specific factor model of the world economy. We assume the existence of $n + 1$ goods, where good 0 is a numeraire good that is produced using labor only and goods 1, ...n are produced using labor and a sector specific factor that is immobile between sectors. Units of the numeraire good are chosen such that its production requires 1 unit of labor in the home country, so the home country wage rate is unity. Assuming the non-numeraire goods are produced under conditions of constant returns to scale and perfect competition, the return to the specific factor associated in good i at home will be given by $\pi_i(p_i)$, which is a strictly convex function of the local price of good i. The local supply of good i is denoted by $y_i(p_{ji}) = \pi_i'(p_i)$. Preferences at home are given by

$$U = q_0 + \sum_{i=1}^{n} u_i(q_i),$$

where $u_i(.)$ is strictly concave. These preferences yield a demand for good i as a function of its local price, $d_i(p_i)$.

The foreign country's production and demand structure in the non-numeraire sectors can similarly be described by sectoral factor return functions, $\pi_i^*(p_i^*)$, and demand functions, $d_i^*(p_i^*)$, respectively.[5] We assume that the only trade policy instrument at governments' disposal is ad valorem import tariffs, denoted by t_i. Denoting foreign variables with an *, the domestic price of a home country importable i will be $p_i = (1 + t_i)p_i^*$. The world market clearing condition for a home importable can then be solved to express home prices as an increasing function of the home country tariff, $\tilde{p}_i(t_i)$, and the foreign price as a decreasing function of the home tariff, $\tilde{p}_i^*(t_i)$. Prices in foreign importable sector can similarly be derived as a function of the foreign tariff.

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 $1 + \theta_i$. In order to capture the demand for flexibility in tariff-setting, we will assume that the political weight in an import-competing sector i, θ_i, is a random variable with compact support $\Theta = [\underline{\theta}, \overline{\theta}]$. The pdf for the political shock, $f_i(.)$, reflects how the value of additional profits in import-competing sector i varies with changes in the political environment. The distribution of political shocks may vary across countries and across import-competing sectors, reflecting differences in the level and variability of political influence of import-competing producers.

Since sectoral demands and supplies are independent of prices in other sectors under our assumptions, there is no loss of generality in analyzing home tariff policy by considering the home country payoff in a representative import-competing sector. Therefore, we drop sectoral subscripts and let V denote the payoff to the home country arising from a representative home importable sector,

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

where $S(p) \equiv \int_p^\infty d(\tilde{p})d\tilde{p}$ is consumer surplus and m is the import volume.

Foreign country policy-makers are also assumed to maximize a weighted social welfare function, where foreign import-competing sectors are assumed to be subject to sector-specific political shocks θ_i^*. Since our analysis centers are on tariff policy in a representative home importable sector, we focus on the welfare of the foreign government derived from exports from that sector,

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

Tariff policy in a foreign country importable sector can be derived in a similar fashion.

The non-cooperative tariff of the importing country, t^N, may be obtained by choosing t to maximize Eq. (1), which yields

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

where, $\omega \equiv \left(p^* \frac{m^{*\prime}}{m^*}\right)^{-1}$ is the inverse of the foreign export supply elasticity and $\eta \equiv -\frac{pm'}{y}$ is the product of the home import demand elasticity and the import penetration ratio. The first term is the part of optimal tariff that is due to the terms-of-trade motive. The second term in Eq. (2) captures the political benefit of raising the tariff. 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.[6]

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^*, and exogenous factors reflecting the technology, factor endowments and preferences of the foreign country in that sector. A similar assumption will be made regarding η. 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 Appendix A that we can use Eq. (2) to express the optimal tariff as a function of three key parameters,

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

such that $\tilde{t}_\theta^N > 0$, $\tilde{t}_\omega^N > 0$, and $\tilde{t}_\eta^N < 0$. 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.[7]

If lump sum transfers between governments are possible and the political shocks are observable, a trade agreement between the countries would choose the state contingent tariff that maximizes

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[5] We assume that both countries produce the numeraire good in equilibrium, so that the foreign wage is also pinned down by productivity in the numeraire sector.

[6] We assume throughout that $\theta < \eta$, which ensures that the optimal tariff does not prohibit trade.

[7] 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 degree of foreign comparative advantage. These parameters would represent the exogenous factors determining the home country's optimal tariff in Eq. (3).

$W(t, \theta) \equiv V(t, \theta) + V^*(t)$. Solving for 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. It is independent of the degree of market power of the importing country.

Such an agreement would involve reciprocal trade liberalization, since it would reduce tariffs by an amount $t^N(\theta) - t^E(\theta) = \frac{\omega\eta}{\eta - \theta}$ in state θ for each imported good in each country. The tariff reduction will be positive as long as the importer has positive market power. However, it will also allow governments the flexibility to respond to domestic political shocks because the participating country governments are maximizing a weighted social welfare function.

3. Optimal tariff bindings with private information

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 once the agreement has been signed. With these assumptions, the state contingent tariff characterized by Eq. (4) is not incentive compatible. An importing country observing state θ has an optimal tariff $t^N(\theta) > t^E(\theta)$, and so would report the state that allowed it to charge its optimal tariff.

For the case of private information, we will treat the trade agreement as choosing tariff bindings to maximize expected world welfare. We will limit attention to agreements that take the form of a tariff binding because tariff bindings are the mechanism used in the GATT/WTO agreements and because they are incentive compatible in the environment we consider. Furthermore, it has been shown by Alonso and Matouschek (2008) and Amador and Bagwell (2013) 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.[8]

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 Eq. (3) to obtain the threshold value of the political shock at which the applied tariff is at the binding, namely,

$$\theta^B(t^B, \omega, \eta) = max\left[\underline{\theta}, \tilde{t}^{N^{-1}}(t)\right], \\ \tilde{t}_t^{N^{-1}} > 0, \quad \tilde{t}_\omega^{N^{-1}} < 0, \quad \tilde{t}_\eta^{N^{-1}} > 0 \cdot \tag{5}$$

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 tariff schedule under the tariff binding can be expressed as

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

[8] A weak binding could also be optimal in other circumstances, such as where the shocks are observable to the participating countries but not verifiable to a third party to enforce the agreement. For example, Horn et al. (2010) consider a similar environment in which states are observable but including them in the contract is costly. A weak binding will dominate a strong binding in their model if writing a state contingent agreement on tariffs is too costly and the binding that would be chosen exceeds the importer's optimal tariff in the lowest state. The intuition for that result is similar to that for our model, and their result also requires that countries not be able to use transfers once the state is realized. One additional consideration that would arise in generating predictions about tariff bindings in their model is whether country characteristics affect the benefits and costs of writing an agreement with state-contingent tariffs.

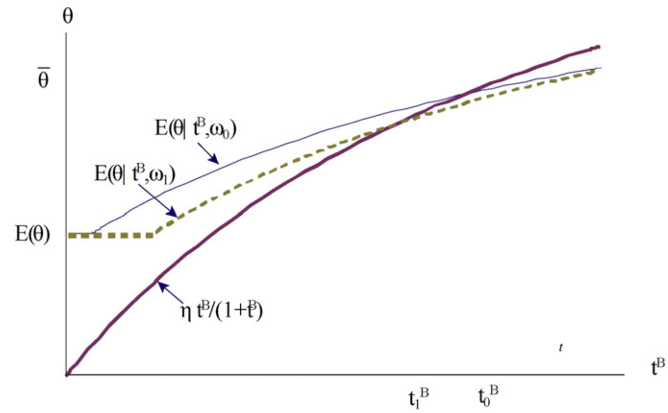

Fig. 1. Expected benefit and cost of raising the binding $\omega_1 > \omega_0$.

The tariff binding is incentive compatible because the importer prefers the tariff assigned in state θ over any other tariff that is no greater than t^B.

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. For a given distribution of political shocks, a higher tariff binding provides the importer with more flexibility to adjust tariffs in response to political shocks. If $t^B \leq t^N(\underline{\theta})$, the tariff will always be at the binding and the importing country has no flexibility to respond to political shocks.

Given the schedule of applied tariff in Eq. (6) 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

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

The optimal tariff binding is obtained by choosing t^B to maximize the expression given by Eq. (7). Noting that $W(t; \theta)W(t; 0) + \theta\pi(t)$, the first-order condition for optimality at an interior solution is

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

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

$$\left(\frac{t^B}{1 + t^B}\right)\eta = E\left[\theta | \theta > \tilde{\theta}^B(t^B, \omega, \eta)\right]. \tag{8}$$

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, $E[\theta | \theta > \theta^B]$.

The solution for the optimal binding is illustrated in Fig. 1, which plots the left and right hand sides of Eq. (8) against the binding. 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 expected value of the political shock above the binding for a given value of the market power, ω_0, is illustrated by the solid locus $E[\theta | t^B, \omega_0)$ in the figure, which has the 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 expected benefit locus is horizontal at $E(\theta)$ over this interval. For $t \in (t^N(\underline{\theta}), t^N\overline{\theta})$, an increase in the binding raises the threshold, $\frac{\partial E\left[\theta|\theta>\tilde{\theta}^B\right]}{\partial t^B} = \left(\frac{f\left(\tilde{\theta}^B\right)}{1-F\left(\tilde{\theta}^B\right)}\right)\frac{\partial\tilde{\theta}^B}{\partial t^B}>0$, and thus raises the expected value of the shock above the threshold. A binding intersection in this region yields an agreement with tariff overhang, since $\theta^B(t^B)\in(\underline{\theta},\overline{\theta})$. 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.[9] 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 Eq. (8) is satisfied at $t^B<t^N(\underline{\theta})$. Substituting from Eq. (2) to (8) into this condition yields a corner solution if

$$\omega\geq\frac{E[\theta]-\underline{\theta}}{\eta-E[\theta]}. \tag{9}$$

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 Eq. (9) fails when evaluated at $\underline{\theta}$, then the necessary conditions will have an interior solution on $(t^N(\underline{\theta}),t^N\overline{\theta})$. Fig. 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 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 Fig. 1. An increase in the market power of the importing country reduces the expected benefit of raising the binding, because the importer's optimal tariff will be higher and hence a given binding will constrain the importer's choice of tariff for lower values of θ. The result is a reduction in the optimal binding as illustrated by the reduction from t_0^B to t_1^B in Fig. 1.

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.[10]

At a corner solution, the tariff binding is positively related to the mean of the political shock. At an interior solution the binding is determined by the conditional mean, which depends on both the mean and the spread of the distribution. A sufficient condition that a distribution $F_1(\theta)$ of the political shock result in a higher binding than $F_2(\theta)$ is that F_1 dominate F_2 by the monotone probability ratio ranking (i.e. $\frac{F_2(\theta)}{F_1(\theta)}$ is non-increasing in θ). This condition is more strict than first order stochastic dominance, and requires that F_1 put relatively greater weight than F_2 on θ relative to all states less than θ.

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 $1-F\left(\tilde{\theta}^B(t^B,\omega,\eta)\right)$. 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.

4. Tariff binding overhang

Optimum tariff theories predict that in the absence of international trade policy commitments, i.e., when countries have full flexibility in choosing their trade policies, applied tariffs are increasing in the international market power of the importing country. On the other hand, theories of trade agreement that ignore flexibility, imply that applied tariffs are independent of the level of import market power. In this section, we investigate the relationship between applied tariff and import 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 a striking feature 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

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

where, θ^B was defined in Eq. (5). The average overhang, g, can be written as $E(g)=\int_{\underline{\theta}}^{\theta^B}\left[t^B-t^N(\theta)\right]f(\theta)d\theta$. Therefore, the impact of the importing

[9] 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 Eq. (8) 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 $\left(\frac{\eta-\overline{\theta}}{1+\omega}\right)\omega>0$. The existence of an interior solution for the efficient tariff with $t^E(\overline{\theta})>0$ requires $\eta>\overline{\theta}$, so this condition will be satisfied if $\omega>0$.

[10] Since both the cost and benefit loci in Fig. 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, $f'(\theta)\leq\theta'$ 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.

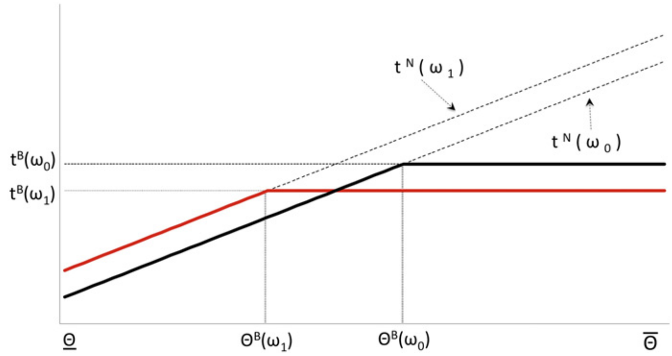

Fig. 2. Agreement tariff schedules (solid lines) and market power: $\omega_1 > \omega_0$.

country's market power, as measured by ω, on the average size of overhang is given by

$$\frac{\mathrm{d}E(g)}{\mathrm{d}\omega} = \int_{\underline{\theta}}^{\theta^B} \left[\frac{\mathrm{d}t^B}{\mathrm{d}\omega} - \frac{\mathrm{d}t^N(\theta)}{\mathrm{d}\omega}\right] f(\theta)\mathrm{d}\theta < 0.$$

Since the non-cooperative tariff is increasing in market power and the binding is decreasing in market power, it must be the case that the expected overhang is decreasing in market power. Formally,

Proposition 2. Overhang

Under an optimal tariff binding agreement, the average size of overhang is strictly decreasing in the import 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.

Fig. 2 illustrates this point for two levels of import 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. Fig. 2 also shows that there will be conflicting effects of import market power on the average level of the tariff, which is given by

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

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.[11] Differentiating this expression with respect to ω yields

$$\frac{\mathrm{d}}{\mathrm{d}\omega} E\left[t^A\right] = \int_{\underline{\theta}}^{\theta^B} t^N_\omega(\theta) f(\theta)\mathrm{d}\theta + \left(1 - F\left(\theta^B\right)\right) t^N_\theta\left(\theta^B\right) \frac{\mathrm{d}\theta^B}{\mathrm{d}\omega}. \tag{10}$$

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 $\theta^B \to \overline{\theta}$ 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,

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

Table 1
Tariffs and trade summary statistics.

Binding status	Num. of sectors	Share (%)	Import (bil.$)	Share (%)
Applied tariff below binding	216,841	52.6	2550	28.0
Strong binding (applied tariff at binding)	63,067	15.3	4630	50.9
Applied tariff over binding	11,854	2.8	636	7.0
Unbound	120,251	29.1	1280	14.1
Total	412,013	100	9100	100

Note: Applied tariff data is from 108 WTO members in 2007. The number of countries in regressions may drop due to data availability.

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 import market power increases the size of the unilaterally optimal tariff, which tends to increase the average applied tariff. On the other hand, as shown in Proposition 1 and depicted in Fig. 2, the optimal agreement features a lower binding for sectors with greater import 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.

5. Data and the empirical model

In the rest of the paper we provide empirical observations regarding the main predictions of our theory. We focus on three predictions from the theory: the relationship between import market power and the level of tariff bindings (Proposition 1), the amount of tariff overhang (Proposition 2), and the probability that the tariff is at the binding (Corollary to Proposition 1). We utilize data on tariff bindings and MFN-applied tariffs for WTO members that is available from WTO (2010) for the period 1995–2009.

Tariff bindings have been essentially unchanged since the inception of the WTO in 1995 for original WTO members, and since the time of accession for new members. Applied tariffs, on the other hand, show considerable variation. This tariff adjustment could be of two types. 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. This transition to the new bindings was supposed to be completed in 5–10 years, depending on the member's level of development. In addition to the downward adjustment of applied tariffs of many sectors during the phase-in period, we also observe both upward and downward movements of applied tariffs below the negotiated bindings.

Our theoretical model does not attempt to address the phase-in of applied tariff rates following the negotiation of a trade agreement. Therefore, in addition to using average applied tariffs of countries over years, we also conduct analysis on a cross section for a particular year in our estimations. We use cross sectional data from 2007, because the phase-in period for virtually all original WTO members was completed by that time. 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 data set contains tariff bindings and applied MFN tariffs for 108 WTO member countries at the HS 6-digit level from 1996 to 2007. Of these countries, 91 were original WTO members and the remainder joined in 2003 or earlier. The data on applied tariffs contains information for more than 4000 sectors at the HS 6-digit level for each of the members, resulting in a sample of over 400,000 tariff lines. Table 1 reports the fraction of all tariff lines and the fraction of all imports that fall under one of four categories with respect to the overhang and tariff binding: zero overhang in 2007 (the applied rate in 2007 equals the bound rate), tariff overhang (applied rate in 2007 strictly less than bound rate), over binding (applied rate exceeds the bound rate), and unbound (no tariff binding negotiated).[12]

Although tariff lines with a zero overhang in 2007 account for only 15.3% of all tariff lines, they account for 50.9% 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.[13] The small fraction of tariffs that are overbinding primarily reflect contingent protection measures and some recent members whose tariffs are still in the phase-in period.

5.1. Independent variables

Import market power plays a central role in our theory. We use two measures 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. Estimates of the foreign export supply elasticities for six-digit HS products were obtained from Nicita et al. (2013).[14]

As an alternative measure of import market power, we use the member's share of world imports in the relevant sectors. As is well known, the true elasticity of export supply faced by country i for a given good can be expressed as[15]

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

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 is the import demand elasticity for country k. Therefore, a country's share of world imports is inversely related to that country's true foreign export supply elasticity.[16]

Import share has a potential endogeneity problem as it is affected by the import tariff rates. We therefore take an instrumental variable approach by using the Rauch product differentiation index (PDI) as an instrument for a country's share of world imports in a given sector.[17] We use a dummy variable, "differentiated product", that is equal to 1 if the product is differentiated and zero otherwise. The level of differentiation of a product category is obviously not affected by the choice of import tariffs. Furthermore, product differentiation is correlated with both measures of market power in our data.[18] As an alternative instrumental variable, we use the interaction of the differentiated product dummy and log of importer's GDP per capita. The latter choice is motivated by the empirical observation that, in comparison to poor countries, rich countries tend to spend relatively more on highly differentiated products. We find a positive and strong correlation between this IV and log of import share. We also construct a categorical variable, "high market power", which is equal to one if the market power measure estimate is in the top two thirds of all estimates and zero otherwise. We then use the average of this categorical variable in other six-digit sectors in the same country under the same two-digit heading as another instrument (IVSC-high). This instrument is employed to deal with sector-specific measurement error.

Political factors also play a role through their impact on the conditional mean of the political shock, $E[\theta|\theta \geq \theta^B]$. 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 Economist Intelligence Unit. This index ranks countries on a scale of 0 to 10, with 10 being the most unstable. The index scores are derived by combining measures of economic distress and underlying vulnerability to unrest. 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. However, this variable does not necessarily distinguish between the mean and variability of the political shock. We also included sectoral dummies, which can capture characteristics of sectors that tend to make them more politically powerful across countries.

We also included explanatory variables to capture alternative explanations of the setting of tariff bindings. A Herfindahl–Hirschman Index of exporter concentration and the interaction of HHI and our measure of import market power were included to capture the potential role of free riding in negotiating for tariff reductions as emphasized by Ludema and Mayda (2013).[19] Their model would suggest a positive coefficient on market power and a negative coefficient on the interaction term, since greater exporter concentration would have a larger impact on tariff reductions.

If inter-governmental transfers are costly, the governments may deviate from the optimal agreement towards a more balanced agreement in order to avoid making costly transfers. As suggested by Ludema and Mayda (2013), an importing country, i, may agree to a lower tariff in a sector where the participating foreign exporters have a surplus in the balance of negotiated tariff concessions with country i. As a robustness check, therefore, we include Ludema and Mayda's (2013) measure of exporter-weighted average deficit ratio interacted with the sectoral market power measure, denoted by b_MP.[20]

A measure of a sector's share of import from the FTA partners is another variable that we include to control for the potential effect of membership in FTAs on multilateral trade negotiations. Limão (2006) finds evidence that the US is less willing to reduce tariffs on sectors where the share of trade from FTA partners is greater, which would predict a positive effect of this variable on the tariff binding.[21]

Table 2 reports the summary statistics for the dependent variables and the key explanatory variables in our analysis. The measures that

[12] In the World Bank data, 26% of the tariff lines are missing data on the binding. It is not appropriate to treat all of the missing bindings as unbound sectors, since some countries do not utilize some of the tariff lines that are reported in the data. Therefore, we treat a sector as unbound if the tariff binding is missing and the country reports a positive level of imports in that sector.

[13] Note that this observation is consistent with the prediction that large countries with greater market power, whose tariff lines will account for a larger fraction of world trade, are more likely to have their applied tariffs at the binding.

[14] In an older version of the paper, we used elasticity estimates of Broda et al. (2006), which are provided at the three-digit HS level. In addition to being at a more disaggregated level, the elasticity estimates of Nicita et al. (2013) are easier to interpret. That is because a three-digit code, as reported by Broda et al., does not refer to a well-defined product category in the Harmonized System. Nevertheless, our regression results are qualitatively similar with either set of estimates.

[15] 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 $\varepsilon_i^* = (\varepsilon^X + \sum_{k \neq i} \varepsilon_k W_k)/W_i$, where W_k is country k's share of the world import.

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

[17] Rauch (1999) categorizes SITC commodities into organized exchange, reference priced, and differentiated. We use the corresponding HS categories that are provided by Lugovskyy and Skiba (2011).

[18] Product differentiation index is used by Ludema and Mayda (2013) as their primary measure of import market power, but we use it only as an instrument since it does not capture the variation of market power across countries.

[19] We exclude within-FTA trade flow from calculating the HHI as in Ludema and Mayda (2013).

[20] For a complete description of this measure, see Ludema and Mayda (2013).

[21] Carpenter and Lendle (2010) show that although around 50% of world trade is between countries that have some sort of preferential trade agreements, only 16% of world trade is eligible for preferences and preferential margins are often very small.

Table 2
Descriptive statistics.
Source: WTO, World Bank, UNComtrade, and the Economist Intelligence Unit.

Name	Average	Median	Min.	Max.	# observations
Tariff binding rate (%)	28.90	25	0	3000	378,903
Applied tariff rate (%)	8.80	5	0	3000	366,292
Tariff overhang (percentage point)	19.70	13	0	2400	366,292
World import share (%) (excluding zero imports)	1.53	0.089	~0	100	305,616
Inverse export elasticity	−2.88	−3.11	−11.87	21.72	181,717
Political instability index	4.20	4.20	0.2	8.8	98
HHI	0.32	0.21	0	1	305,857
Product differentiation index (PDI)	0.62	1	0	1	330,525
GDP per capita ($)	10,935	3794	162.8	83,556	108
GDP (bil. $)	498	24.8	0.41	17,100	108

Note: Cross sectional data from year 2007 or the latest year before 2007 for which data is available for 108 WTO members. All sectoral variables are available at the 6-digit HS level.

are included to reflect market power (GDP, the inverse export supply elasticity, and import share) as well as per capita GDP are all highly skewed. This skewness reflects the presence of a few high income members with very large markets (United States, European Union, and Japan) among the 108 countries.

Before proceeding to the analysis of tariff bindings and tariff overhang at the product level, it is useful to illustrate an aggregate level relationship between flexibility and market power. Fig. 3 plots the percentage of tariff lines that are at the binding for each country against log GDP for 108 member countries. This plot illustrates the large variation in the fraction of lines at the binding. The relationship is highly skewed: five countries have more than 90% of their lines at the binding, while the median country has 5% of its tariff lines at the binding. The plot suggests a strong positive relationship between import market power, as measured by GDP, and trade policy flexibility, as measured by the fraction of lines at the binding. This pattern is consistent with the prediction of Corollary 1.

As a more formal test of Corollary 1, we regress the logit of the fraction of a country's tariff lines that are at the binding, denoted by *P*, against log GDP, political instability index, *POL*, and a dummy variable, *NewMem*, that is equal to 1 if the country was not a GATT member by the end of 1994. The results of the estimation are

$$log\left(\frac{P}{1-P}\right) = \underset{}{-8.75} + \underset{(.10)}{.287} \times log(GDP) \underset{(.125)}{-.301} \times POL \underset{(.54)}{+2.67} \times NewMem. \tag{11}$$

The aggregate market power measure, GDP, is significant at the 1% level. We also find that a 10% increase in GDP would double the fraction of lines at the binding for a country with the median fraction of tariff lines at the binding. The coefficient on political instability is negative and significant at the 5% level, which is consistent with the hypothesis that greater political instability leads to a greater value of flexibility. A reduction in the political instability measure from the median value to the 25th percentile would raise the fraction of lines at the binding from .05 to .07 for a country initially at the median fraction of lines at the binding.

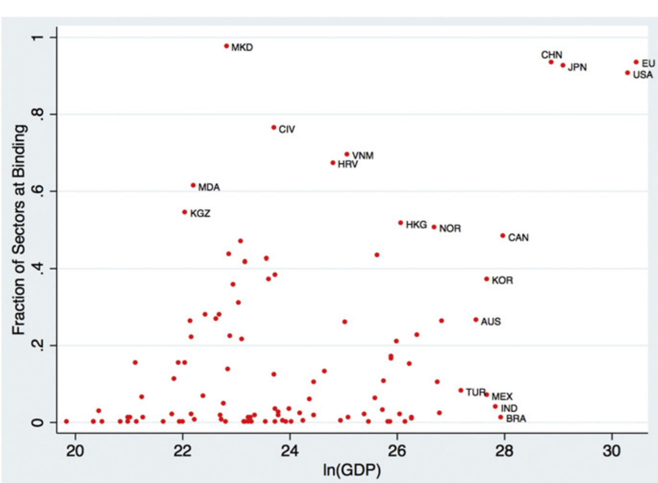

Fig. 3. Fraction of tariff lines with zero overhang in 2007 vs. ln(GDP).

The dummy variable for new members was included to reflect the fact that recently acceding countries may still be in the phase-in period for tariffs, so that tariff lines currently at or above the binding may eventually be reduced to below the binding. This also allows for the possibility that countries entering through the accession process face more stringent tariff bindings. This effect is positive and highly significant. We also ran the regression including log of per capita GDP as an explanatory variable, since per capita GDP is correlated with GDP and political instability and could be the underlying factor determining the relationship. The coefficient on per capita GDP was insignificant in the regression, and its inclusion did not affect the magnitude of the coefficients on the other explanatory variables. These results strongly support the predictions of the model.

5.2. Tariff bindings

We begin our empirical analysis of tariff lines at the HS six-digit level by exploring the effect of market power and political instability on tariff binding. Proposition 1 established that the tariff binding will be a decreasing function of market power and an increasing function of the political shock. We test this relationship by regressing the tariff binding on a measure of market power (log of inverse export elasticity or log of import share), the political instability index, and sectoral dummies.[22] We also included a dummy for new WTO members as a robustness check. We find that, as in the aggregate regression (11), including a dummy variable for new WTO members increases the size and statistical significance of our market power coefficient in all specifications. The coefficient of this dummy variable is negative and highly significant.

Rows 1–7 of Table 3 report the results of these regressions when we use the entire sample of countries and sectors. Rows 1 and 5 report the results of an OLS regression where the market power is measured by import share and export elasticity, respectively. In both regressions, the coefficient of the market power variable is negative and significant at the 1% level, and the coefficient of the political instability measure is positive and significant at the 1% level. Rows 2 and 6 report the results for OLS regressions in which an instrument is used for the market power measures. As a result of including IVs, the coefficient on the market power variable approximately doubles in absolute value, while the

[22] We also confirmed that including a new member dummy does not affect the sign or significance of our estimates. The coefficient of the new member dummy was negative and significant as in the aggregate regressions.

Table 3
Tariff binding vs. import market power.

#	Sample	Model	# countries	World import share (logged)	Inverse export elasticity (logged)	Polit. instability index	# observations
1	Full sample	OLS	97	−1.247*** (0.435)		4.031*** (0.927)	305,616
2		IV-1-OLS	97	−2.614*** (1.014)		3.241*** (1.042)	271,262
3		IV-1-Tobit	97	−2.773*** (1.058)		4.440*** (1.218)	271,262
4	Incl. unbound	IV-1-Tobit	97	−10.00*** (2.882)		10.08*** (3.643)	344,424
5	Full sample	OLS	92		−0.727*** (0.183)	4.087*** (0.815)	181,717
6		IV-3-OLS	92		−3.359*** (1.296)	3.383*** (0.903)	172,981
7		IV-3-Tobit	92		−3.819*** (1.477)	4.451*** (1.092)	172,981
8	Weak binding	IV-1-Tobit	95	−2.858** (1.180)		2.475** (1.241)	210,120
9	Strong binding	IV-1-Tobit	85	−0.115 (1.042)		6.047** (2.369)	60,672

Note: *, **, and *** indicate statistical significance at 10, 5, and 1%, respectively. Clustered standard errors in parenthesis (country and sector clusters for OLS regressions and country clusters for IV Tobit). 96 HS-2 sector dummies included in all regressions. The majority of sector dummies have statistically significant coefficients. Instrumental variables: IV-1 is IVSC-high for import share, and the product differentiation index (PDI). IV-3 is IVSC-high for inverse export elasticity and PDI.

coefficient on political instability is barely affected. All coefficients remain highly significant.[23]

Due to the potential bias introduced by the fact that bindings are truncated at zero, we also estimated a Tobit model for the market power measures. The results, reported in Rows 3 and 7, are similar to those obtained in the OLS model. The coefficients of the instrumental variables in the first stage are all significant, as reported in Table 7 in Appendix B.

In our main analysis we treat unbound sectors as missing.[24] Ignoring unbound sectors could also lead to a bias in our estimation if there is a systematic relationship between market power and whether a sector is bound. We do, in fact, observe that sectors with greater import market power are less likely to be left unbound. To address this potential bias, in Row 4, we report the results in which unbound sectors are included and assigned a tariff of 200%.[25] The inclusion of the unbound sectors results in an increase in the magnitude and statistical significance of the coefficients on market power and political instability.

One feature of Proposition 1 that is not captured by these results is the prediction that market power will have no effect on tariff bindings for countries that are at a corner solution where they are always at the binding. Our theory predicts that when a corner solution arises, the applied tariff will be at the binding for all observations of political pressure. This implies that if a sector has a positive tariff overhang at any point in time, the associated tariff binding must be an interior solution. Based on this result, we divided our sample into "strong binding" sectors, where applied tariff has always been at the binding, and "weak binding" sectors, for which there is at least one positive overhang observation since 1995. As predicted by the theory, we confirm that market power has no significant effects on the level of the negotiated bindings for the strong binding subsample (Row 9 of Table 3), while it has a strong negative effect on the negotiated tariff bindings in the weak binding subsample (Row 8).

[23] Due to data availability issues, the number of observations declines by about 11% when IVs are included. This raises the concern that the increase in the size of the estimated coefficients in regressions # 2–4 may be caused by a selection bias. To address this concern, we ran the OLS regression #1 on the subsample that is used in IV regressions, and obtained results similar to regression #1.

[24] We define a sector as unbound if the tariff binding is missing but there is at least one reported applied tariff since 1995 for that sector. Alternatively, we defined a sector as unbound if the tariff binding was missing but trade volume was positive in at least one year since 1995. We only report the results based on the former definition.

[25] Results were qualitatively similar when we assigned a tariff of 600% for unbound sectors.

We can summarize the results introduced in Table 3 by calculating the economic magnitude of the effect of market power on the tariff binding. Using the result with world market power in the Tobit equation (Row 3), a doubling of the import share for a country at the median market share of 0.0005 will reduce the expected value of the tariff binding by 1.6 percentage points. For a country at the 75th percentile of market share, a doubling of import share reduces the expected binding by 1.4 percentage points. Increasing a country's market share from the median value to the 75th percentile has the effect of reducing the binding by approximately 4.4 percentage points, which is 15% of the median binding.

5.2.1. Robustness checks

We conduct two sets of robustness checks. First, we examine the determinants of tariff bindings for various subsets of sectors and countries (Table 4).[26] Our second set of robustness checks, summarized in Table 5, are related to other potential explanations for the pattern of tariff commitments, namely, concerns for balance of concessions and the free riding problem as discussed above.

Regressions 10 and 11 in Table 4 divide the sectors into differentiated and homogeneous products. The coefficients of the market power measure are negative and highly significant for both subsets of goods. Moreover, the coefficients on political instability are positive and highly significant in both equations.

When products are divided into agricultural products and non-agricultural products, the coefficients in the equation for agricultural products are consistent with the predictions of the model and highly significant as reported in Row 12. For non-agricultural products, the coefficients are smaller but still statistically significant at 1 and 5% level (Rows 13–15). If the sample is limited to sectors for which there is overhang at some point during the sample period (Row 14), the size and statistical significance of the market power coefficient increase. As we argued above, our theoretical prediction of a negative relationship between tariff bindings and market power applies only to the cases where there is an interior solution (i.e., weak binding). Ignoring this corner-solution problem is expected to reduce the significance and the magnitude of our estimation.

Regressions Rows 16–19 report the results for the developed and developing country subsamples. The results for developed countries are consistent with the prediction of the model and statistically significant.

[26] Table 4 reports the results for IV Tobit regressions using the log of world import share as the measure of market power. Results using log inverse export elasticity were similar.

Table 4
Tariff binding vs. import market power, robustness checks.

#	Sample	Model	# countries	World import share (logged)	Polit. instability index	# observations
10	Differentiated products	IV-4-Tobit	97	−2.661** (1.038)	3.579*** (1.098)	175,576
11	Homogeneous products	IV-4-Tobit	97	−3.565*** (0.982)	6.587*** (1.462)	95,686
12	Agricultural sectors	IV-1-Tobit	97	−8.632*** (2.687)	5.865** (2.388)	41,702
13	Non-agricultural sectors	IV-1-Tobit	97	−2.187** (0.912)	3.842*** (1.043)	229,560
14	Non-agricultural weak binding	IV-1-Tobit	95	−2.891*** (0.972)	1.930* (1.071)	177,303
15	Non-agricultural incl. unbounded	IV-1-Tobit	97	−9.495*** (2.842)	10.78*** (3.575)	300,169
16	Developed countries	IV-1-Tobit	23	−4.882*** (1.809)	8.356** (3.716)	81,365
17	Developing countries	IV-1-Tobit	74	−2.376** (0.988)	0.988 (1.476)	189,897
18	Developing weak binding	IV-1-Tobit	74	−2.819*** (1.013)	1.049 (1.476)	156,663
19	Developing incl. unbounded	IV-1-Tobit	74	−8.798*** (3.037)	7.446 (5.038)	255,887
20	Original members	IV-1-Tobit	80	−3.866*** (1.125)	4.788*** (1.299)	211,233
21	New members	IV-1-Tobit	17	−0.783 (0.623)	1.470 (1.343)	60,029
22	New members robust SE	IV-1-Tobit	17	−0.783*** (0.0374)	1.470*** (0.0397)	60,029

Note: *, **, and *** indicate statistical significance at 10, 5, and 1%, respectively. New WTO member country dummy included. IV-4 is IVSC-high for import share. See Table 3 for descriptions of other IVs.

The coefficient of market power in the developing country regression (Row 17) is smaller but still significant. The magnitude and statistical significance of this coefficient increases if the developing-country subsample is limited to weak binding sectors (Row 18). Including the unbounded sectors further improves the statistical significance of the market power effect (Row 19), which may reflect the relative abundance of unbound sectors in developing countries.

We also split the sample between original member countries and those that entered after 1996 (Rows 20–22). The coefficients for the original members are consistent with the theory and statistically significant at the 1% level for original members. Clustered standard errors for the new-member regressions do not show statistical significance. However, since there are only 17 new members, using clustered standard errors for statistical inferences runs the risk of over-rejection as discussed by Cameron and Miller (2015). For this reason we also present robust standard errors, which imply significance at the 1% level.

Rows 23 and 24 of Table 5 include the level of HHI and an interaction term with HHI and market power to capture the potential for free rider problems as considered by Ludema and Mayda (2013). The results yield a negative coefficient on market power that is statistically significant for both measures of market power. These equations also include the share of imports coming from FTA partners, to test whether countries are less likely to reduce tariffs on goods where a large share comes from FTA partners. We do not find a consistent role for this variable, as it is negative and significant at the 10% in Row 23 but insignificant in both Row 24 and Row 27.

The results reported in Rows 23 and 24 of Table 5 contrast with those obtained by Ludema and Mayda (2013) and are likely due to the differences in the measures of negotiated tariffs and market power. In particular, while we use tariff bindings that were explicitly negotiated by the WTO members, Ludema and Mayda use the average applied tariffs as a proxy for the negotiated tariffs. Moreover, as alternative proxies for import market power, Ludema and Mayda use the Rauch index of product differentiation, which does not vary across countries, and a categorical variable for high and low market power based on the estimates of export elasticity at the HS 4-digit level. Instead, we use share of world imports and the inverse of foreign export elasticities that vary across countries and sectors. The last three rows of Table 5 include MP_B, which is Ludema and Mayda's exporter-weighted average deficit ratio interacted with the market power measure. Controlling for MP_B does not alter the sign or statistical significance of the market power measure or the political instability index.

Table 5
Further robustness checks: exporter concentration and reciprocity.

#	Model	# countries	World import share (logged)	Inverse export elasticity (logged)	Polit. instability index	MP_B	Share of import from FTA partners	HHI	HHI* (import market power)	# observations
23	IV-1-Tobit	97	−4.961** (2.052)		4.275*** (1.252)		−11.28* (6.775)	22.98 (14.54)	4.357** (2.184)	271,262
24	IV-3-Tobit	91		−6.828** (3.060)	4.746*** (1.048)		0.733 (3.913)	31.97** (15.11)	10.71** (5.183)	158,458
25	OLS	95	−2.247*** (0.537)		4.168*** (0.940)	0.0333 (0.0412)				141,255
26	IV-1-Tobit	95	−6.736*** (1.736)		3.644*** (1.232)	−0.158* (0.0828)				124,751
27	IV-1-Tobit	95	−11.89*** (3.546)		3.440*** (1.236)	−0.186* (0.107)	−7.153 (8.453)	78.23*** (26.98)	14.01*** (4.737)	124,751

Note: *, **, and *** indicate statistical significance at 10, 5, and 1%, respectively. Clustered standard errors in parenthesis (country and sector clusters for OLS regressions and country clusters for IV Tobit). Two-digit HS sector dummies included in all regressions. See Tables 3 and 4 for descriptions of IVs.

Table 6
Overhang vs. import market power.

#	Sample	Model	# countries	World import share (logged)	Inverse export elasticity (logged)	Polit. instability index	# observations
1	Full sample	OLS	96	−1.180***		2.569***	302,268
				(0.348)		(0.830)	
2		IV-1-OLS	96	−2.384***		1.887**	269,054
				(0.808)		(0.904)	
3		IV-1-Tobit	96	−2.844***		3.320***	269,054
				(1.016)		(1.182)	
4		OLS	92		−0.644***	2.580***	181,090
					(0.134)	(0.694)	
5		IV-3-OLS	92		−3.579***	1.791**	180,795
					(1.197)	(0.757)	
6		IV-3-Tobit	92		−5.362***	2.856***	180,795
					(1.616)	(1.010)	
7	Differentiated products	IV-4-Tobit	96	−2.219*		2.475**	174,658
				(1.149)		(1.192)	
8	Homogeneous products	IV-4-Tobit	96	−3.278***		5.366***	94,396
				(1.020)		(1.371)	
9	Agricultural sectors	IV-1-Tobit	96	−7.869***		4.668**	40,558
				(2.316)		(2.365)	
10	Non-agricultural sectors	IV-1-Tobit	96	−2.068**		2.783**	228,496
				(0.991)		(1.115)	
11	Developed countries	IV-1-Tobit	23	−6.589***		5.732	81,204
				(2.391)		(3.835)	
12	Developing countries	IV-1-Tobit	73	−1.987*		2.305	187,850
				(1.147)		(2.107)	
13	Original WTO members	IV-1-Tobit	79	−3.736***		3.478***	209,250
				(1.073)		(1.198)	
14	New WTO members	IV-1-Tobit	17	−1.143*		1.146	59,804
				(0.671)		(1.188)	
15	New WTO members robust SE	IV-1-Tobit	17	−1.143***		1.146***	59,804
				(0.0376)		(0.0395)	

Note: *, **, and *** indicate statistical significance at 10, 5, and 1%, respectively. See Tables 3 and 4 for descriptions.

5.3. Tariff overhang

Proposition 2 predicts a negative relationship between market power and the magnitude of tariff overhang, $g = t^B - t^A$. Tariff overhang is also a truncated variable, since it will equal zero for sectors where the tariff is at the binding. We measure overhang as the difference between the tariff binding and the average level of the applied tariff over the sample period. We proceed as in the case of the tariff binding by estimating OLS, IV OLS, and IV Tobit equations for overhang using both the import share and inverse export elasticity as measures of market power.

The pattern in these estimations, which are reported in Table 6, is similar to that obtained in the tariff binding equations. The effect of market power is negative and statistically significant in the OLS equations in Rows 1 and 4. The use of an instrumental variable for market power (Rows 2 and 5) approximately doubles the absolute value of the coefficient for both measures of market power. The coefficients in both specifications are statistically significant at the 1% level. Tobit regressions using an IV for market power (Rows 3 and 7) yield coefficients on market power that are negative and significant at the 1% level and coefficients on political instability that are positive and significant at the 1% level.

We also evaluated the robustness of the overhang results, and the patterns are broadly similar to those obtained in the tariff binding equations. The split of the sample between differentiated and homogeneous products (Rows 7 and 8) yields coefficients on the market power variable that are significant at 10% and 1% levels, respectively. The result for the agricultural sectors (Row 9) is statistically significant at the 1% level, while that for the non-agricultural products (Row 10) is significant at the 5% level. The coefficient on political instability is positive and significant at the 5% level in each case.

The division between developed and developing countries (Rows 11 and 12) yields coefficients for market power that are negative and significant at the 1% and 10% levels, respectively. Finally the equation that includes only original members yields coefficients that are significant at the 1% level. The coefficients for new members reflect the same issues as discussed in the case of bindings.

Overall, these robustness checks find the strongest effects of the role of market power on flexibility in the case of homogeneous and agricultural products, and in country groupings of developed countries and original members.

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-neighbor motivations and flexibility in the design of trade agreements, and argue that recognizing this trade-off is an important factor in explaining 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 import market power. We find substantial evidence that the level of tariff binding and the size of tariff binding overhang are both inversely related to measures of import market power, which is consistent with the predictions of the theory. Our results thus complement previous work that has found support for the terms of trade theory in tariff policy and trade agreements.

We should note that 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. These mechanisms are an additional channel through which countries can obtain flexibility. 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 (2012), Beshkar (2010a,b), and Maggi and Staiger (2011, 2015), 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 (2015), assumes the availability of a costly state-verification process, in which parties may set tariffs above the binding if they 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.[27]

Appendix 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*

$$\frac{\mathrm{d}p^*}{\mathrm{d}\tau} = -\frac{m'(p)p^*}{m'(p)\tau + m^{*\prime}(p^*)} = -\frac{p^*}{\tau}\frac{\varepsilon}{\varepsilon+\varepsilon^*},$$

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

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

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

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

Thus, importing country's optimality condition, $\frac{\mathrm{d}V}{\mathrm{d}t} \equiv 0$, 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:

$$t^N(\theta) = \frac{1}{\eta-\theta}(\eta\omega+\theta), \quad (12)$$

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

$$\frac{\mathrm{d}W}{\mathrm{d}t} \equiv \frac{\partial W}{\partial p}\frac{\partial p}{\partial t} + \frac{\partial W}{\partial p^*}\frac{\partial p^*}{\partial t} = 0. \quad (13)$$

As shown by Bagwell and Staiger (1999), this condition reduces to $\frac{\partial V}{\partial p} = 0$,[28] which implies

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

or,

$$-\frac{t}{1+t}\varepsilon + \theta\frac{y}{m} = 0. \quad (14)$$

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

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

■

Appendix B. Supplementary data

Supplementary data to this article can be found online at http://dx.doi.org/10.1016/j.jinteco.2015.04.004.

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[27] 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 (2015) 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.

[28] 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, $\frac{\mathrm{d}W}{\mathrm{d}t} = \frac{\partial V}{\partial p}\frac{\partial p}{\partial t} = 0$ if and only if $\frac{\partial V}{\partial p} = 0$.

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