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Abstract

The Grossman and Helpman (1994) model explains tariffs as the outcome of a lobbying game between special interests and the government. Most empirical implementations of this framework use instead non-tariff barriers to measure the extent of protection. Importantly, while the former set of instruments allow the government to fully capture the rents from protection, the latter does not. As a result, structurally estimating the 'protection for sale' model using data on non-tariff barriers is likely to lead to biased parameter estimates. To address this problem, we augment Grossman and Helpman's (1994) model by explicitly considering trade policy instruments allowing only partial capturing. Taking our specification to the data, we find that, on average, 72–75 percent of the rent is actually captured. Furthermore, we obtain more realistic, lower estimates of the implied share of the population involved in lobbying activities than in the previous literature, while the estimated weight of aggregate welfare in the objective function of the government is as high as in previous studies.

Keywords: Protection for Sale, Non-tariff Barriers, Partial Rent Capturing.
JEL classification: F13.

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1 Introduction

Successive rounds of international trade negotiations have successfully reduced the use of tariffs. With a few exceptions, developed countries now face strict limitations, imposed by the GATT–WTO, on the magnitude of taxes that they can levy on imports. This does not imply that protectionist interests are no longer able to influence policy–makers, but rather that protectionist policies now often take the form of non-tariff barriers (NTBs) which, as shown by Bradford (2003b), are quantitatively very important. In light of this development, it is not surprising that the leading framework for the analysis of endogenous trade policy formation — Grossman and Helpman (1994)'s protection for sale model — has been tested using NTB coverage ratios as the dependent variable.[1] While their use seems justified by the institutional setting and the increased importance of non-tariff barriers, Grossman and Helpman (1994)'s original theory was meant to analyze the *tariff* formation process. Importantly, while tariffs allow the government to fully capture the rents from protection, NTB's do not. Thus, using NTB coverage ratios as the dependent variable to test this model is likely to lead to biased parameter estimates.[2]

To overcome the discrepancy between the theory and the data, we modify the protection for sale model to allow for non-tariff barriers that do not necessarily generate revenue for the government. In our model, lobbies representing politically active industries try to influence an incumbent government's choice of trade policies which will be a combination of tariffs and quantitative restrictions. As in Grossman and Helpman (1994) the interaction is modelled as a menu auction, i.e. as a two stage game. In the first stage, organized lobbies offer political contributions that are conditional on the entire vector of trade policies available to the government, i.e. they also depend on the protection awarded to other industries. In the second stage, the government chooses a policy vector that maximizes the weighted sum of political contributions and aggregate welfare, and collects the contributions. Importantly, if an import tariff is implemented for a particular product, the government fully captures the associated revenue. If a quantitative restriction is chosen, the degree of rent capturing—where the rent results from the difference between the domestic and the international price of the product—depends on the particular NTB: With a voluntary export restraint, the

[1]See, for instance, Goldberg and Maggi (1999) and Eicher and Osang (2002) among others.

[2]Goldberg and Maggi (1999) already pointed out some of the difficulties involved in using NTB coverage ratios. Mitra, Thomakos, and Ulubasoglu (2002) and McCalman (2004) have also highlighted this discrepancy, and have used tariff data to measure protection in the case of Turkey and Australia respectively.

foreign exporter captures the associated rent and the domestic government receives nothing. If import licenses are allocated through a competitive auction, the government fully captures the associated rent. If the auction is less than competitive, rent capturing will only be partial. In order to capture all these possibilities, our model allows for any degree of rent capturing.

Solving the game, we obtain an augmented trade policy equation that allows us to identify the degree of rent capturing. Using a three-digit cross-section of US manufacturing industries for 1983, which has been exploited also by Goldberg and Maggi (1999), Eicher and Osang (2002), and Gawande and Bandyopadhyay (2000), we estimate our augmented specification employing both a maximum likelihood and a minimum distance estimator. We find that only part of the rents associated with trade barriers are captured. Irrespective of the econometric methodology, our results show that the U.S. government appropriates only between 72 and 75 percent of the rents associated with trade policy. In addition, we can reject the assumption of perfect rent capturing that is implicit in the existing literature.

Allowing for partial rent capturing also affects the other structural parameters of the model. In particular, our estimates of the implied share of the population involved in lobbying activities are lower and more realistic than in Goldberg and Maggi (1999),[3] even though the government's weight on social welfare continues to be large.[4] Interestingly, while in Goldberg and Maggi (1999) the low level of average protection granted by the US government could be rationalized by either the high weight attached to aggregate welfare or by the extremely large share of the population that is organized, our analysis allows to dismiss the latter as a possible explanation. Thus, while our results emphasize the importance of taking the structural approach seriously, i.e. of having a theoretical model consistent with the data, they offer additional support for the protection for sale framework.

[3]This alleviates the problem pointed out by Mitra, Thomakos, and Ulubasoglu (2002), that a high estimate of the proportion of the population politically organized and a high estimate of the government's weight on aggregate welfare are not mutually consistent.

[4]In a recent contribution to this journal, Mitra, Thomakos, and Ulubasoglu (2005) make substantial headway in this regard. Taking all sectors to be lobbying, they use the resulting single estimated coefficient to identify the welfare weight based on assumed values for the share of population involved in lobbying. Their estimation produces a much more realistic welfare weight implying a government that does care considerably about contributions. We do not follow their innovative approach here because we want to relate our innovation, namely partial rent capturing, to the standard empirical protection for sale literature.

2 Non-tariff Barriers

International trade negotiations have been quite successful in reducing tariffs. Yet protectionism is far from dead as is illustrated by the pervasive use of non-tariff barriers (NTBs) even by countries that profess a free–trade orientation. NTBs comprise a long list of measures that alter, however indirectly, the prices and quantities of trade flows. Examples include import quotas, health and safety standards, biased government procurement, lax antitrust enforcement, burdensome customs procedures, and the list could go on.[5] While the importance of NTBs has been widely recognized, measuring their quantitative effects presents considerable conceptual and practical difficulties (see Deardorff and Stern (1997)).

At a theoretical level, the most satisfactory approach involves the computation of price gaps. The basic idea behind this methodology is that barriers to arbitrage across national borders should be considered barriers to trade. In other words, once the unavoidable costs involved in shipping goods between countries are taken into account, if a price gap still exists between equivalent commodities in both economies, we can conclude that the higher-priced market is protected. This price gap can then be used as a direct measure of the extent of protection, resulting in a tariff equivalent that represents the total effect of all trade barriers. Clearly, this approach poses demanding requirements on the availability of detailed price data for the goods considered. The data needs to be comparable across countries, that is, the goods must share similar qualitative characteristics etc. This approach has been pursued by Bradford (2003b) who uses the 1999 survey of highly disaggregate price data compiled by the OECD to compute purchasing power parity adjusted exchange rates. These data are likely to represent the best available measures for international comparisons, as OECD researchers made every effort to compare equivalent products from every country. The results obtained are striking and we report the numbers for the U.S. aggregated up to 26 GTAP sectors, in Table 1.[6]

⇒ [Table 1 approximately here] ⇐

The first column lists the nominal tariff rate and the second the NTB's tariff equivalent

[5]UNCTAD uses 18 different categories: quantity, price, quality,threat, advance payment, anti-dumping duty, anti-dumping investigation, countervailing duty, countervailing duty investigation, authorization, health and safety, license, inspection, labelling/marketing/packaging, product characteristics/standards, single channel, testing, embargoes/prohibitions. See also the discussion in Deardorff and Stern (1997).

[6]Information on the Global Trade Analysis Project (GTAP) can be obtained from the following website: http://www.gtap.agecon.purdue.edu/default.asp. For further details on the methodology see Bradford (2003a) and Bradford (2003b).

as estimated by Bradford (2003a). Note that the world price has been normalized to one, so that a value of, for example, 1.064 for the tariff rate on "Vegetables, fruit, nuts" indicates a 6.4 percent tariff. In the third column, we have calculated the share of NTBs in total protection.[7] As we can see, the extent of protection granted through NTBs is on average substantially higher than the tariff. On average, 60 percent of the tariff equivalent of total protection takes the form of NTBs. Among the highly protected sectors, crops as well as vegetable oils appear to be subject to extensive NTBs, with tariff equivalents in the order of 52 and 45 percent respectively, representing 96 and 87 percent respectively of the total protection. In sectors such as live animals and petroleum, on the other hand, protection mostly takes the form of import tariffs. The main message that emerges from Table 1 is that NTBs are quantitatively very important and any analysis that wants to explain the endogenous formation of trade policies should take this into account.

It is important to remember though that NTBs often do not allow the government to completely capture the rents associated with the distortion. For this reasons, using NTB coverage ratios[8] as the dependent variable in estimating the protection for sale model is likely to lead to a bias in the parameter estimates. To remedy this problem, we now turn to extending the basic model to accommodate partial rent capturing.

3 The Model

The specific factors model of trade forms the economic foundation of Grossman and Helpman (1994)'s 'protection for sale' approach. A small, open economy consists of $1 + n$ sectors, indexed by $i = 0, ..., n$, that produce under constant returns to scale. Sectors $\{1, ..., n\}$ each use a sector specific factor plus a common mobile factor. The exogenously given world market price for the output of each of these sectors is denoted by p_i^*, while the corresponding domestic price is $p_i^* + t_i$, where t_i is the import tariff imposed on this commodity.[9] Alternatively, since our framework allows for other trade policy instruments, t_i can equally represent the shadow

[7] Total protection is calculated as the sum of the tariff and NTB tariff equivalent rates.

[8] This measure is constructed by determining first, at the tariff line level of disaggregation, whether a product is subject or not to one of 18 different types of NTBs identified by UNCTAD. The "coverage ratio" is then calculated at the 3-digit level, and measures the percent of imports covered by one or more NTB.

[9] The original model also allows for import subsidies as well as export taxes and subsidies. The subsequent literature has largely disregarded these policies in line with the empirical facts or even explicitly excluded them, as in Levy (1999) and Maggi and Rodriguez-Clare (2000). In our context, subsidies would paradoxically be only partially funded by the government, and for this reason we follow the more recent literature and do not consider them.

value of a quantity restriction.

Good zero is manufactured using only the mobile factor, which can be thought of as unskilled labor, with an input output coefficient of one, and will be used as the numéraire, i.e. $p_0 = 1$. Strictly positive production in this sector implies that the wage of the mobile factor will also equal one, and the same holds for the world market price p_0^*, if we allow for free trade in this commodity. The production possibilities of the other n sectors are summarized by profit functions $\pi_i(p_i)$ that can be interpreted as rewards to the specific factors.

The economy is populated by N agents who might differ in their factor endowment. All of them supply one unit of labor, and *at most* one sector specific factor. Let α_i be the fraction of the population that owns the specific factor i. All agents share the same preferences represented by a quasi-linear, additively separable utility function $u = x_0 + \sum_{i=1}^{n} u_i(x_i)$, where x_i is the individual's consumption of good i and the subutility functions $u_i(.)$ are differentiable and strictly concave. Optimizing subject to a given income level E, individual demands are given by $x_i = d_i(p_i) \equiv (u_i')^{-1}(p_i)$ of goods $i = 1, ..., n$ and $x_0 = E - \sum_{i=1}^{n} p_i d_i(p_i)$ for the numéraire. Domestic demand for good i can be satisfied through domestic production and/or imports. The latter are defined as follows:

$$m_i = \phi_i(t_i) \equiv N d_i(p_i^* + t_i) - y_i(p_i^* + t_i),$$

where y_i is the domestic supply of commodity i derived from $\pi_i(p_i)$ via Hotelling's lemma. Note that since $m_i(t_i)$ is strictly decreasing, it can be inverted. This is convenient for our purposes, since it allows us to express the tariff equivalent of a quota q_i as:

$$t_i = \phi_i^{-1}(q_i).$$

Since our generalization of the model allows trade policy to take the form of tariffs as well as quotas, let Q denote the subset of sectors that face quantity restrictions and T the remaining sectors that are subject to tariffs. Note that Q or T could well be empty. If the former is empty, we are back in the traditional protection for sale model that only allows for tariffs. If the latter is empty, all sectors are subject to a quantity restriction. In what follows, we consider the general mixed case in which some sectors are protected by a tariff, while others are protected by a quantity restriction and instead of endogenizing the choice of policy instruments, as in Maggi and Rodriguez-Clare (2000), we will rely on the data to inform us about the actual degree of rent capturing and the implied policy mix.[10] In line

[10]Maggi and Rodriguez-Clare (2000) propose a model where this choice is endogenous. In their model, quantitative restrictions emerge only if domestic importers (or foreign exporters) carry substantial political clout.

with this objective, we assume that in each sector $i \in Q$ a percentage $\gamma_i \in [0, 1]$ of the rent associated with trade policy is captured by the domestic government.

We can now introduce the trade policy game. As in Grossman and Helpman (1994), we assume that only the specific factor owners in an exogenously given subset L of the non-numéraire sectors[11] have become organized and submit contribution schedules $C_i(t, q)$ to the government, which depend on the entire policy vector chosen. t is a vector of tariffs applied to all sectors $i \in T$ and, similarly, q is a vector of quantity restrictions introduced on all sectors $i \in Q$. In other words, the lobbies specify their monetary payment contingent on the policy vector chosen, where the policy vector is a mix of tariffs for one subset of sectors and quantity restrictions for the other. Depending on the institutional setting, such payments might involve illicit bribes or take the form of legal campaign support. The government subsequently grants or denies protection by choosing the domestic policy vector (t, q), and collects the contributions from the lobbying sectors.

Having described the strategy choice of the actors, let us turn to their respective payoffs. Each sector, lobbying or not, receives a gross payment $W_i(t, q)$ given by

$$W_i(t, q) = l_i + \pi_i(p_i^* + t_i) + \alpha_i N(r + s) \qquad \forall i \in T \tag{1}$$

$$W_i(t, q) = l_i + \pi_i(p_i^* + \phi_i^{-1}(q_i)) + \alpha_i N(r + s) \quad \forall i \in Q \tag{2}$$

where equations (1) and (2) respectively describe the gross welfare of a sector protected by a tariff and a quota.[12] More specifically, l_i is the total unskilled labor supply of the owners of specific factor i and thus the first term on the right hand side represents labor income. The second term is the reward to the specific factor. Remembering that α_i is the fraction of the population that owns specific factor i, we follow Grossman and Helpman (1994) and assume that the fiscal revenues associated with trade policy are rebated uniformly as lump-sum payments.[13] The last term is then the share of sector i in total fiscal revenue $(Nr(t, q; \gamma))$

[11]Remember that not all individuals need to own sector-specific factors. In particular, some might own only unskilled labor and, as in Grossman and Helpman (1994), we assume that unskilled workers are not able to organize. As a result, even if all non-numéraire sectors in the economy were organized, the share of the population that is organized might well be strictly less than one.

[12]Again note that this is a generalization of the standard model where Q is empty and T contains all non-numéraire sectors.

[13]Note that allowing for a non-uniform distribution of these payments would affect the policy vector as it changes the weights assigned to different parts of the rent. The effects of partial rent capturing are in a sense similar yet more extreme, as part of the rent is not given any consideration at all. We are grateful to an anonymous referee for pointing out this analogy.

and total consumer surplus ($Ns(t,q)$). Per capita fiscal revenues are defined as

$$
\begin{aligned}
r(t,q;\gamma) = & \sum_{i\in T} t_i(d_i(p_i^* + t_i) - y_i(p_i^* + t_i)/N) + \\
& \sum_{i\in Q} \gamma_i \phi_i^{-1}(q_i)(d_i(p_i^* + \phi_i^{-1}(q_i)) - y_i(p_i^* + \phi_i^{-1}(q_i))/N)
\end{aligned}
$$

The first term on the right hand side describes the revenues accruing to the government from those sectors in which a tariff is implemented, while the second represents the revenues raised by the government from those sectors where quantitative restrictions are used instead. Remembering that $\phi_i^{-1}(q_i)$ is the tariff equivalent of a quota q_i, the second term then represents the sum of the fractions $\gamma_i < 1$ of the (tariff equivalent) fiscal revenues actually captured by the government from sectors covered by quantity restrictions. Per capita consumer surplus is defined as

$$
\begin{aligned}
s(t,q) = & \sum_{i\in T} [u_i(d_i(p_i^* + t_i)) - (p_i^* + t_i)d_i(p_i^* + t_i)] + \\
& \sum_{i\in Q} \left[u_i(d_i(p_i^* + \phi_i^{-1}(q_i))) - (p_i^* + \phi_i^{-1}(q_i))d_i(p_i^* + \phi_i^{-1}(q_i))\right]
\end{aligned}
$$

where again we distinguish between those sectors that receive protection in the form of a tariff and those that are protected by means of a quantitative restriction.[14]

In determining the policy vector (t,q) to be granted to each sector—in the form of tariffs for one subset of sectors and quantity restrictions for the others—the government weighs the sum of aggregate welfare against the monetary contributions paid by the lobbies, i.e. it maximizes the following objective function:

$$
G = \beta \sum_{i=1}^{n} W_i(t,q) + (1-\beta) \sum_{i\in L} C_i(t,q).
$$

As is well known, this objective function implies that the incumbent politician values one dollar of campaign contributions in her coffers more than one dollar going to the public.

4 Equilibrium Protection Structure

In solving the game between organized sectors and lobbies we look for the subgame perfect Nash equilibrium, which is defined as follows

[14]This result follows immediately from the assumption of quasi-linearity and separability of the preferences. See Grossman and Helpman (1994) for further details.

Definition 1 *The collection* $(\{C_i^0(t,q)\}_{i\in L},(t^0,q^0))$ *is a subgame perfect Nash equilibrium of the tariff and quota game if* C_i^0 *is feasible for all* $i \in L$, $\beta \sum_{i=1}^n W_i(t,q)$, *and, given* $\{C_j^0(t,q)\}_{j\in L\setminus i}$, *no lobby* i *has an alternative feasible strategy* $C_i(t,q)$ *that would yield a higher (net) payoff.*

Bernheim and Whinston (1986) derive a useful characterization of subgame perfect Nash equilibria in menu auctions. We restate their proposition here using our notation:

Proposition 1 $(\{C_i^0(t,q)\}_{i\in L},(t^0,q^0))$ *is a subgame perfect Nash equilibrium for the tariff and quota game if and only if:*

i) $C_i^0(t,q)$ *is feasible* $\forall i \in L$,

ii) $(t^0,q^0) \in \arg\max\ (1-\beta)\sum_{i\in L} C_i(t,q) + \beta \sum_{i=1}^n W_i(t,q)$,

iii) $(t^0,q^0) \in \arg\max\ (1-\beta)\sum_{i\in L} C_i(t,q) + \beta \sum_{i=1}^n W_i(t,q) + W_i(t,q) - C_i(t,q)\ \ \forall i \in L$,

iv) $\forall i \in L, \exists (t^i,q^i) \in \mathbb{R}^n$ *that maximizes* $(1-\beta)\sum_{i\in L} C_i(t,q) + \beta \sum_{i=1}^n W_i(t,q)$ *such that* $C_i^0(t^i,q^i) = 0$.

Assuming differentiability of the contribution schedules and combining conditions *ii*) and *iii*) the optimal policy vector satisfies:

$$(1-\beta)\sum_{i\in L} \nabla W_i(\mathbf{t},\mathbf{q}) + \beta \sum_{i=1}^n \nabla W_i(\mathbf{t},\mathbf{q}) = 0 \tag{3}$$

Calculating the gradient of the sectors' gross pay-off function, we obtain:

$$\begin{aligned}
\frac{\partial W_i}{\partial t_j} &= (\delta_{i,j}-\alpha_i)\, y_j(p_j^*+t_j)\ +\ \alpha_i t_j \phi_j'(p_j^*+t_j) && \forall j \in T\\
\frac{\partial W_i}{\partial q_j} &= (\delta_{i,j}-\alpha_i\gamma_j)\,\frac{y_j(p_j^*+\phi_j^{-1}(q_j))}{\phi_j'(p_j^*+\phi_j^{-1}(q_j))}\ +\ \alpha_i\gamma_j\phi_j^{-1}(q_j) - \\
&\quad \alpha_i(1-\gamma_j)\,\frac{Nd_j(p_j^*+\phi_j^{-1}(q_j))}{\phi_j'(p_j^*+\phi_j^{-1}(q_j))} && \forall j \in Q
\end{aligned}$$

where $\delta_{i,j} = 1$ if $i = j$ and zero otherwise.[15] Substituting these partial derivatives back into equation (3) and rearranging we obtain the following result:

[15] Note that we do not need to distinguish sectors that face a tariff from sectors subject to a quota (that is, whether $i \in T$ or $i \in Q$) because only the direct profit term would differ; however, the indicator in front of this term does not switch on since i cannot equal j for cross derivatives.

Proposition 2 *The government chooses a policy vector that satisfies*

$$\frac{t_i}{1+t_i} = \frac{I_i - \alpha_L}{\frac{\beta}{1-\beta} + \alpha_L} \times \frac{z_i}{e_i} \qquad \forall i \in T \tag{4}$$

$$\frac{\phi_i^{-1}(q_i)}{1+\phi_i^{-1}(q_i)} = \frac{1}{\gamma_i} \times \frac{I_i - \alpha_L}{\frac{\beta}{1-\beta} + \alpha_L} \times \frac{z_i}{e_i} + \frac{1-\gamma_i}{\gamma_i} \times \frac{z_i}{e_i} \qquad \forall i \in Q \tag{5}$$

where I_i is an indicator that takes a value of one if the sector is organized and zero otherwise, $\alpha_L = \sum_{i \in L} \alpha_i$ describes the fraction of the population that is organized, $z_i = \frac{y_i}{m_i}$ is the inverse of the import penetration ratio, and $e_i = -\frac{m_i' p_i}{m_i}$ is the absolute value of the elasticity of import demand.

The equilibrium tariffs correspond exactly to the modified Ramsey rule derived by Grossman and Helpman (1994). Organized sectors obtain positive protection (since $I_i - \alpha_L > 0$) whereas unorganized sectors face negative protection, be it in the form of import subsidies or export taxes. To understand this result, consider the case where lobby membership comprises almost the entire population ($\alpha_L \to 1$). In this case organized sectors, that are given special consideration by the government, internalize the negative effect of protection on consumer surplus (net of tariff revenue) and the government policy chosen for those sectors converges towards free trade. At the same time, unorganized sectors, owned by a small part of the population which is accorded less weight in the government's objective function, suffer negative protection because this suits the (consumer) interests of the organized majority. If lobbies represent a smaller share of the population, both effects become less pronounced and organized sectors ask for, and obtain, positive protection while unorganized sectors suffer less negative protection. In addition, we have the familiar Ramsey pricing effect that protection (in either direction) is smaller (in absolute value) the higher is the import demand elasticity, because a higher elasticity renders the policy intervention more distortive. Similarly, protection decreases in import penetration (increases in its inverse) because import penetration also increases the inefficiency when holding the elasticity constant. Finally, protection decreases with the weight attached by the government to aggregate welfare (β), because this implies that the government cares more about efficiency.

Whereas the outcome for tariffs is standard, the result for quotas and in particular the additional term in equation (5) requires further explanation. Consider the case where the quota rent is fully captured ($\gamma_i = 1$). The tariff equivalent of the quota then equals the solution for the tariff. The above proposition thus implies:

Corollary 1 *Enacting a quantity restriction in a particular market is equivalent to setting the corresponding tariff as long as the quota rent is fully captured ($\gamma_i = 1$).*

That is, choosing a (binding) quota or a tariffs allows the government to determine the outcome in the market for a traded good, i.e. the combination of quantity demanded and domestic price. The lobbies' contributions then depend only on the market outcome, and not on the policy instrument used to achieve it.

Consider now the more general case in which rent is only partially captured. How does partial capturing affect the level of protection resulting from the policy game? Consider the derivative

$$\frac{\partial \phi_i}{\partial \gamma_i} = -\frac{1}{e_i \gamma_i^2} \left[\left(\frac{I_i - \alpha_L}{\frac{\beta}{1-\beta} + \alpha_L} \right) \frac{y_i}{m_i} - 1 \right]. \tag{6}$$

The sign of this derivative, and thus the effect of partial capturing on the protection level, depends on the term in square brackets. Assuming that sector i is organized, lower rent capturing will tend to increase the equilibrium protection level the lower the import penetration ratio, the smaller the government's weight on aggregate welfare, and the more concentrated the ownership of the organized sectors.

Next we will empirically test the predictions of our model. The data used is the same as in Gawande and Bandyopadhyay (2000), Eicher and Osang (2002) and Mitra, Thomakos, and Ulubasoglu (2005). It covers the U.S. manufacturing sector in 1983 at the 3-digit level, and contains 107 observations. Appendix A contains details on the construction of the variables and the different sources from which the data were obtained.

5 Empirical Test

A number of studies have estimated the original Grossman and Helpman (1994) model for a cross section of U.S. manufacturing industries using coverage ratios as the measure of protection. Even though the theory was originally developed for tariffs, Goldberg and Maggi (1999) in their well known paper find that "*the theoretical model is not inconsistent with our data.*" Similar conclusions have been reached by Gawande and Bandyopadhyay (2000) and Eicher and Osang (2002).

To evaluate the augmented model that allows for quotas or other instruments that imperfectly capture rents, we need to transform the equilibrium tariff and quota equations (4) and (5) to obtain an empirically testable specification. Following Goldberg and Maggi (1999) and Eicher and Osang (2002) we bring the elasticity on the left hand side of the regression to counter measurements errors, and we add an additive error term.[16] The estimating equations for our model thus take the form

$$\begin{aligned} \frac{t_i}{1+t_i}e_i &= \theta\, I_i\frac{y_i}{m_i}+\psi\frac{y_i}{m_i}+\epsilon_{1i} && \forall i \in T && (7)\\ \frac{\phi_i^{-1}(q_i)}{1+\phi_i^{-1}(q_i)}e_i &= \theta' I_i\frac{y_i}{m_i}+\psi'\frac{y_i}{m_i}+\lambda+\epsilon_{2i}, && \forall i \in Q && (8) \end{aligned}$$

where $\theta = \frac{1-\beta}{\beta+\alpha_L(1-\beta)}$ and $\psi = -\frac{\alpha_L(1-\beta)}{\beta+\alpha_L(1-\beta)}$ and correspondingly $\theta' = \frac{1}{\gamma}\theta$, $\psi' = \frac{1}{\gamma}\psi$ and $\lambda = -\frac{1-\gamma}{\gamma}$. Notice the non additive structure of the relationship predicted by the model: the inverse of the import penetration ratio ($\frac{y_i}{m_i}$) enters interactively with the political organization dummy. The model predicts that the direction of the relationship between trade protection and import penetration depends crucially on whether a sector is organized or not. At the same time, the extent of protection that an organized sector receives (likewise the extent of negative protection for unorganized sectors), will depend on its import penetration.

If product i is protected by a policy instrument which allows for complete rent capturing, protection will be set according to equation (7). This is the implicit assumption underlying previous empirical work. On the other hand, if only a share $\gamma_i < 1$ of the rents is captured domestically, the optimal level of protection is determined by equation (8). In the empirical implementation, the lack of time series data forces us to impose a uniform degree of rent capturing across industries. The sign restrictions implied by the model are that $\theta > 0$, $\psi < 0$, $\lambda \leq 0$ and $(\theta + \psi) > 0$.

Comparing the two equations, the presence of a negative constant term in equation (8) indicates that by making protection more expensive from the point of view of the domestic government, imperfect rent capturing uniformly lowers its level compared to the situation when a tariff is deployed. In addition, the slopes of the inverse of the import penetration ratio and of the interaction term are larger than under the tariff (i.e. $\theta' > \theta$ and $\psi' > \psi$). Empirically, if the observed rate of protection for organized sectors is very responsive to low rates of import penetration[17] and the sectors are protected by tariffs, i.eẇe are in the case described by equation (7), this will mean that the weight attached by the government to aggregate welfare (β) is low and/or that a small fraction of the population (α_L) is lobbying.

[16]We follow this particular specification choice for comparison purposes. As pointed out by Goldberg and Maggi (1999), page 1140, several other possible empirical strategies could be pursued.

[17]In other words, the coefficient on the interaction term is large.

In contrast, if sectors are protected by NTB's, equation (8), a similar empirical relationship could be rationalized by a low degree of rent capturing.

Two econometric issues have to be addressed when estimating the model. First, because coverage ratios lie between zero and one, the dependent variable is potentially censored on both sides.[18] The maximum likelihood estimator in Goldberg and Maggi (1999) jointly estimates the equation of interest—(7) or (8)—together with two reduced form equations (see below). The censoring of the dependent variable leads to a Tobit model, if we are willing to assume that the error terms ϵ_{1i} and ϵ_{2i} are normally distributed. The dependent variable in equation (8) becomes

$$ntb_i^* = \frac{NTB_i^*}{1 + NTB_i^*} e_i \tag{9}$$

with

$$NTB_i = \begin{cases} \frac{1}{\mu} NTB_i^* & \text{if} \quad 0 < NTB_i^* < \mu \\ 0 & \text{if} \quad NTB_i^* \leq 0 \\ 1 & \text{if} \quad NTB_i^* \geq \mu. \end{cases}$$

The variable NTB_i^* is a latent variable that can be thought of as the 'true' level of protection, proportional to the coverage ratio by a factor μ.[19]

Second, there are good reasons to believe that the two explanatory variables in the model, import penetration and the binary political organization variable, might be endogenous. This is certainly the case for import penetration, because sectors that receive low protection rates will, ceteris paribus, have larger import penetration (lower y/m) in the data. We need to instrument to control for this reverse causality. In our theoretical model, the organization dummy is exogenous. However, since we follow the existing literature and use contribution data to assign the political organization dummies and contributions are endogenous in our model, in the empirical implementation it might be desirable to treat I_i as econometrically endogenous.[20] As it turns out, in their implementation of Grossman and Helpman's model, Goldberg and Maggi (1999) report that their results are virtually identical if I_i is instead treated as exogenous. For this reason, we carry out our estimation using both approaches,

[18] In the data, only left-censoring actually occurs.

[19] Rather than estimating μ, we follow Goldberg and Maggi (1999) and fix it to a value of one. We tried alternative values (2 and 3) and the structural coefficient estimates are not sensitive to this change.

[20] Unfortunately, all the standard tests for endogeneity are invalid in the current model, because the dependent variable is censored and the potentially endogenous variable I_i enters the model interacted with a (certainly) endogenous variable (y/m).

obtaining comparable results[21] In Goldberg and Maggi (1999) estimation, both endogenous explanatory variables are modelled as linear functions of a set of instruments, and the tendency to organize is treated as a latent variable, which is observed only when it crosses a threshold, defined as in Goldberg and Maggi (1999) as a political action committee contribution for a three digit industry equal to 100 million dollars.[22]. Formally, to take into account the endogeneity of the explanatory variables, we will use the following equations:

$$\frac{y_i}{m_i} = \zeta_1' Z_i + u_{1i} \tag{10}$$

$$I_i^* = \zeta_2' Z_i + u_{2i} \tag{11}$$

$$\text{with } I_i = \begin{cases} 1 & \text{if } I_i^* > 0 \\ 0 & \text{if } I_i^* \leq 0. \end{cases}$$

The variables in Z are the instruments introduced by Trefler (1993).[23] Input shares for 12 production factors are used to proxy for comparative advantage, and hence we expect them to be good predictors for the level of import penetration. Given that factor endowments determine these variables, they are plausibly uncorrelated with the error term of the protection equation. To these instruments, we add the variables commonly used in the literature to explain political organization. These include proxies for the concentration in the upstream and downstream industries, for the geographic and ownership concentration in each industry, and for the organization of the workforce. While these factors are likely to predict the ability of an industry to become politically organized and generate contributions to influence trade policy, they have wider importance in the industries, and as a result they can plausibly be considered uncorrelated with the error term. For the vast majority of sectors, trade openness is sufficiently low as to enable to treat the organization of the industry as exogenous to the shock in the protection equation. A more complete justification of the approach is given in Goldberg and Maggi (1999).

In implementing the maximum likelihood estimation, we will assume the error terms in equations 9, 10 and 11 to be jointly normally distributed and potentially correlated. The maximum likelihood estimates are reported in Table 2, where for comparison we have included the baseline estimates of Goldberg and Maggi (1999) in the first column. The second column presents our results for the special case in which rent capturing is complete. Our estimates are similar, except for small differences in the reduced form coefficients, which lead

[21]See Appendix B for more details.

[22]Robustness checks using different thresholds are discussed in Section 6.2.

[23]See Appendix A for details.

to a lower implied share of the population involved in lobbying. These are due to residual differences in the data set.[24] Appendix B provide details on the exact implementation of our methodology and the derivation of our likelihood function.

$\Rightarrow$ [Table 2 approximately here] $\Leftarrow$

In the more general case where not all the rents from protection are captured domestically, equation (8) applies. The results for this case are reported in column (3). Most importantly, the negative constant term indicates that the U.S. government, realizing that the use of NTBs leads to an additional welfare loss, chooses—ceteris paribus—a uniformly lower level of protection. This interpretation is confirmed by the implied value for γ, the degree of rent capturing, which is estimated significantly less than one. In particular, our estimates imply that only 72 percent of the potential rents are actually appropriated by the U.S. government.

Note that the estimated degree of rent capturing γ can be given a more general interpretation. In practice, protection is set at a much more disaggregate level than the three digit SIC industries in our data set. Tariffs as well as other trade policy tools will be employed for different products in every industry, so both equations are relevant. Equation (8) can be understood as a weighted average of both original formulations. Suppose that a fraction δ of the products in industry i are protected by a tariff (rents are fully captured) and the remainder by a quota (a fraction γ' of the rents are captured, depending on how it is allocated). The linear combination of the two equations with the appropriate weights leads to a new relationship, where the right hand side takes the same form as in equation (8) only that now

$$\gamma = \frac{\gamma'}{\delta\gamma' + (1-\delta)}.$$

γ is a function of the structural coefficients δ and γ' that cannot be identified separately. An estimated γ of 0.72 is consistent with an industry protected by a quota of which 72 percent is captured, as well as with an industry where half of the products are protected by tariffs and the other half by a quota, of which 56 percent is captured, etc.

Compared to the baseline case in columns (1) and (2), the difference between organized and unorganized sectors remains, as can be readily seen from the highly significant coefficient on the interaction term. Organized sectors receive significantly higher protection than their

[24] Like Eicher and Osang (2002) – see footnote 7, page 1707 – we were not able to obtain the same dataset used by Goldberg and Maggi (1999). Furthermore, following Eicher and Osang (2002), we have used political contributions for the 1983-1984 cycle to construct the organization dummy while Goldberg and Maggi (1999) use data for the 1981–1982 campaign.

unorganized counterparts. It might seem surprising at first that import penetration alone does not play a significant role. Notice, however, that we are essentially estimating two different coefficients for each subset of the sample, organized and unorganized sectors. The coefficient for the organized subsample is the sum of the two coefficients reported above. It is only information from the unorganized sectors that would allow us to separately identify the role of import penetration. The theoretical model, of course, predicts that unorganized sectors should receive negative protection. Since the coverage ratios are censored at zero, this implies that if the model were deterministic, we should not have any information on this effect coming from the unorganized subsample. In the stochastic context at hand, obtaining the predicted negative coefficient must be due to large errors, which in turn explain the insignificance of this coefficient.

The third sign prediction of the model, namely that the sum of the two reduced form coefficients is larger than zero finds strong support in the data.[25] This is reflected in the lower implied share of the population that is organized (α_L). While Goldberg and Maggi (1999) estimate that over 80 percent of the population is involved in trade-related lobbying, we find a more reasonable estimate of 34 percent, which is closer to the share of the workforce employed in organized sectors (slightly below 50 percent).

Similarly to the previous literature, the weight on aggregate welfare in the government's objective function (β) is estimated to be very high. Combined with the low estimated share of the population involved in lobbying, it invalidates lobbying being ineffective as an explanation for the low average amount of protection granted by the U.S. government. The government values aggregate welfare and implements little or no protection for the majority of industries, while selectively granting some protection to a few industries which are organized. Average protection will be low, but sectors that lobby will still benefit.[26]

Partial rent capturing could provide yet another way to rationalize the low observed rates of protection. The fraction of rents that are not captured domestically, i.e. the inefficiency inherent in the trade policy, is taken into account as an additional cost in the trade-off between welfare and contributions. If γ were estimated close to zero, a small weight on

[25] The t-statistic for this test is 4.646.

[26] The parameter estimates in Goldberg and Maggi (1999) and Gawande and Bandyopadhyay (2000) are consistent with both alternative explanations for the low rates of observed protection. The weight of aggregate welfare in the government's objective function (β) and the share of the population involved in lobbying (α_L) are both estimated very high. The sizeable cross-sectoral variation in rates of protection in the data points towards β over α_L as an explanation for low average protection rates. In contrast with previous results, though, we estimate the share of the population involved in lobbying much lower: between 12 and 34 percent.

aggregate welfare would be sufficient to deter protection. While we do estimate the fraction of rents that are captured to be significantly below one, rent leakage of 25 to 28 percent is unlikely to be a significant deterrent to protectionism.

We also perform a specification test of the augmented model (column 3) versus the standard specification (column 2). This corresponds to testing whether γ is equal to one, versus the alternative that γ is less than one. The p-value associated with the test statistic is 0.019, that is, the one-sided test rejects that γ is equal to one at a significance level of 2 percent.[27] Given the small number of observations, only 107 sectors, this is relatively strong evidence against perfect rent capturing. The same test using results from the minimum distance estimator (see below) also rejects equality of γ to one, albeit only at a 10 percent significance level. This confirms the importance of explicitly accounting for partial rent capturing when estimating the Grossman and Helpman (1994) model.

6 Robustness checks

Finally, we consider a number of robustness checks. First, we re-estimate the model with the organization dummy included uninteracted, in addition to the interaction term with inverse import penetration. Second, we vary the threshold on Political Action Committee contributions that is used in the definition of the organization dummy. Third, we estimate the model using a variety of alternative econometric strategies: (i) the minimum distance estimator from Eicher and Osang (2002), (ii) without instrumenting for any of the explanatory variables, (iii) with a limited set of instruments for import penetration, and (iv) with a two-step maximum likelihood estimator, as in Gawande and Bandyopadhyay (2000). Finally, we run a set of separate regressions for sectors protected mainly by tariffs and sectors that are protected mainly by non–tariff barriers.

6.1 Including organization dummy uninteracted

Adding the direct effect for the organization status dummy to the estimating equation represents a uniform level of protection applied to all organized industries. According to the model developed by Grossman and Helpman (1994), this variable should not enter in the estimating

[27] A likelihood ratio test leads to the same conclusion. Note that the standard error on γ is calculated using the Δ-method. While the constant term in the estimating equation is only marginally significant, the structural parameter γ is a nonlinear function of this parameter.

equation, as the government can always improve welfare, at the margin, by discriminating between sectors, i.e. protection should always be a function of import penetration. Including the dummy uninteracted changes the results considerably. Estimates are reported in column (4) of Table 2.

The constant term is still estimated to be negative, although its significance drops. As expected, the coefficient on the organization dummy is estimated to be positive, but not significantly different from zero. While the coefficients on the inverse import penetration and on the interaction term between organization status and the inverse import penetration change signs, on average organized industries continue to receive positive protection. Evaluated at the mean import penetration, the predicted depended variable, $NTB/(1 + NTB) \times e$, is 0.094 for organized sectors. Because of the negative constant term, average protection remains negative for unorganized sectors. The negative coefficient on the interaction term would suggest that the government chooses to distort most where the import penetration is the largest, which cannot be optimal.

While it is somewhat arbitrary to calculate the structural coefficients without a model that explains why the organization dummy should enter uninteracted, the rent capturing coefficient only depends on the constant term in the reduced form. The point estimate corresponds to a rent capturing of 82 percent, slightly higher than in the benchmark case. It is reassuring that the sign of the constant term and the magnitude of the rent capturing are similar to the benchmark results.

6.2 Different thresholds for organization dummy

As a second robustness check, we re-estimate the protection equation using different threshold levels for PAC contributions to classify industries as organized or not. The benchmark cutoff, taken from Goldberg and Maggi (1999), was $100 million. Alternative thresholds of $200 million or $75 million result in very similar coefficient estimates, see columns (5) and (6) in Table 2. With the different threshold levels, the fraction of industries classified as organized drops to 44% or increases to 72%, respectively. As expected, the estimate for α_L varies in the same direction as these changes. The estimate for β, the weight of welfare in the government's objective function, is virtually unaffected and the same is true for the rent capturing parameter γ. With the high (low) threshold the latter drops (rises) to 70 (74) percent and continues to be significantly below one at the 3 percent level.

6.3 Other estimation methods

The model is also estimated using a variety of alternative econometric strategies. First, we implement the minimum distance estimator previously used by Eicher and Osang (2002), where the organization dummy is treated as endogenous. In a first stage, the reduced form equations for each of the three endogenous variables are estimated separately as a function of the same set of instruments as before. The (inverse) import penetration equation is estimated by ordinary least squares and the interaction between the organization status and the import penetration is estimated using a Tobit regression.[28] After substituting the two reduced form equations into the estimation equation of interest, the latter is also estimated using a Tobit regression. In a second stage, the structural coefficients of the model are obtained from the reduced form coefficients by GMM. The method is described in more detail in Appendix B and the exact formula for the weighting matrix and standard errors are in Lee (1995).

Results are reported in Table 3 using the same format as in Table 2, where the first column now reproduces the original results of Eicher and Osang.[29] As can be seen from the table, the results are very similar to those obtained by maximum likelihood. We take this to be a sign of robustness. Importantly, the degree of rent capturing (γ), which is estimated to be 75 percent, is hardly different from the 72 percent we found using maximum likelihood.

$\Rightarrow$ [Table 3 approximately here] $\Leftarrow$

Next, in column (4) of Table 3, we present results where we did not instrument for any of the explanatory variables. We would expect the uninstrumented results to underestimate the coefficient on inverse import penetration for organized sectors (the interaction term) and vice versa for unorganized sectors (coefficient on y/m). Sectors that receive high rates of protection will see their import penetration reduced (y/m increased) and move to the right in the y/m–protection space. The regression line will become flatter. Moreover, the organization status is assumed to be exogenous in the theoretical model, but in practice firms choose endogenously to become organized. Sectors that receive *a priori* low protection, for example

[28] Ideally, the reduced form equation explaining the organization status as a function of the instruments should be estimated with a Probit regression. However, the interaction of the reduced forms for organization status and inverse import penetration ($I \times y/m$) would generate more reduced form coefficients than we have observations available. Therefore, we follow the same pragmatic solution as Eicher and Osang (2002).

[29] Our results differ somewhat from those obtained by Eicher and Osang (2002), as can be seen comparing the first two columns in Table 2. We verified with them that we used the exact same estimation approach. We also use the same data set, provided by Kishore Gawande. One difference is that they dropped one industry, likely because of missing values for one of the variables required in the other model they estimate.

because they are not considered to be strategically important, have a greater incentive to become organized, leading again to a reverse causality. Overlooking the endogeneity of organization will underestimate the effect on protection that organization brings, exacerbating the underestimate of the interaction coefficient.

The results in column (4) of Table 3 confirm that ignoring the endogeneity of I and y/m will lead to underestimate the effect of import penetration (the sum of the two coefficients) and of the organization status (the coefficient on the interaction term). The sum of the two coefficients, which measures the responsiveness of protection to import penetration, is estimated at 0.0013, down from 0.0104 (column (3) in Table 2) or 0.0168 (column (3) in Table 3). The effect comes largely from the coefficient on the interaction term, which measures the difference in protection between organized and unorganized sectors. This coefficient is now estimated at -0.0016, down from 0.0157 (Table 2) or 0.0190 (Table 3). As a result, controlling for import penetration the organized sectors now seem to receive less protection than the average sector in the economy , a result that seems highly counterintuitive. The structural coefficients indicate that governments place 100% of their weight on welfare and none on contributions. The parameter measuring the share of the population involved in lobbying (α_L) exceeds one, a result that is again inconsistent with the model. Finally, rent capturing is nearly perfect, and for all this reasons taking the endogeneity of the explanatory variables into account is very important.

Next, we limit the number of instruments used to estimate the model. In fact, while as a group the original instruments used by Goldberg and Maggi (1999) and Eicher and Osang (2002) are significant at predicting import penetration,[30] many individual coefficients in the first stage regressions are insignificantly different from zero. To check the robustness of our results, for the results in column (5) of Table 3 we only include the capital stock and the four categories of workers (engineers, white collar, skilled, and semiskilled) as instruments for the inverse import penetration. These were among the most precisely estimated coefficients in the first stage and, as measures of factor abundance, they should be good predictors of import penetration. The F-statistic for the reduced set of instruments is slightly smaller at 3.042 but still exceeds the threshold for joint-significance, which is now 2.31. The structural coefficient estimates are virtually unchanged from the results with the full set of instruments.

Finally, we also report the results if we use the two-step MLE estimator discussed in Appendix B. The estimator is consistent, but not efficient, which is borne out by the results

[30] The F-statistic is 4.108.

in column (6) of Table 3. None of the reduced form coefficients is estimated significantly different from zero, even though the signs and magnitudes are relatively similar to the benchmark results. The point estimate for rent capturing (γ) is slightly higher, estimated at 85 percent, but still significantly below one. Estimates for β and α_L are also higher than before, but all the qualitative conclusions go through unchanged.

6.4 Protection by tariffs

As mentioned earlier, previous studies have used NTB coverage ratios to measure protection even though the original protection for sale model was designed to explain tariff levels. The commonly offered rationale is that successive GATT/WTO rounds have limited countries' ability to set tariffs. If we use tariff rates to construct the dependent variable, $t/(1+t) \times e$, we obtain similar results, as can be seen in columns (1) and (2) of Table 4. The first column reports the benchmark results, assuming perfect rent capturing, and the second column contains the results if rent capturing can be imperfect. While the magnitude of the coefficient estimates are much smaller (tariff rates are much lower than coverage ratios), the implied structural coefficients are similar. The estimated degree of rent capturing is 1.088 and is not significantly different from one, as we would expect in the case of tariffs.

$\Rightarrow$ [Table 4 approximately here] $\Leftarrow$

Our model presupposes that sectors are either protected by tariffs or NTBs. Estimating equations (7) and (8) jointly on the full sample of industries is impossible because the dependent variables differ. Protection by NTB is proxied by coverage ratios which are not comparable to percentage tariff rates.[31] Even splitting the sample is nontrivial. Consider an industry with no NTB or tariff protection. Without additional information it is impossible to know which of equation (7) or (8) applies.

To overcome these difficulties we pursue an alternative approach. In column (3) we use tariffs as the dependent variable and exclude those sectors for which NTB protection is very high. All sectors with coverage ratios exceeding 0.50 are dropped, which amounts to approximately 20% of the sample, as tariffs do not seem to be the primary instrument to protect these industries. In column (4) we use NTB protection as the dependent variable and

[31] Ideally one should use the tariff equivalent of NTBs, as in the second column of Table 1, but those are not available at the SIC industry level.

drop sectors with tariff rates exceeding 5 per cent[32]—as these are arguably well-protected by tariffs. For example, SIC industry 333 'primary metals' only receives very low tariff protection—the ad valorem rate is on average 0.4%—but it is one of the industries most heavily protected by NTBs, with a coverage ratio of 75 percent. We now drop this industry from the sample when trying to explain tariff rates. For the results in columns (1) and (2), this industry would misleadingly be assigned a very low rate of protection (based on the tariff), even though it is organized and has a high coverage ratio. The estimated degree of rent capturing (γ) is now even closer to one in column (3), as expected for tariffs, and it is reduced to 0.674 in column (4) for NTB protection.

7 Conclusion

In this paper we have addressed the existing discrepancy between the Grossman and Helpman (1994) theoretical model explaining tariff protection, and its empirical implementations that have for the most part used NTB coverage ratios as the measure of protection. Extending the model by allowing for partial rent capturing, a salient feature of NTBs, we have derived an augmented specification which we have empirically implemented employing both a maximum likelihood as well as a minimum distance estimator. Our augmented specification finds support in the data, and the average degree of rent capturing for our preferred estimators turns out to be 72-75 percent.

Furthermore, we obtain lower and more reasonable estimates than the previous literature for the share of the population involved in lobbying activity, while the weight on aggregate welfare in the government's objective function continues to be very high, as in previous implementations. When we allow for partial rent capturing, the low average amount of protection granted by the U.S. government should be interpreted as the result of the high weight associated to aggregate welfare, rather than to the strategic interaction between competing lobbies. Imperfect rent capturing reduces equilibrium rates of protection, but it is not the primary reason for the low observed rates of protection. While our results show the importance of taking the structural approach seriously, i.e. of having a theoretical model that is consistent with the data, they offer additional support for the protection for sale framework.

[32]This represents about 25% of the sample, and we have chosen this cut-off point because the distribution of tariff rates exhibits a natural break at this point.

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Table 1: Tariffs and NTBs

GTAP sector	Tariff	NTB	NTB share
Vegetables, fruit, nuts	1.064	1.203	0.760
Crops: Garden products	1.020	1.524	0.963
Live Animals: Pets	1.043	1.000	0
Other Ag. Products: Eggs	1.092	1.000	0
Fishing	1.005	1.301	0.984
Bovine cattle, sheep and goat, horse meat products	1.108	1.001	0.001
Meat product n.e.c.: Poultry, pork	1.060	1.004	0.063
Vegetable oils and fats	1.065	1.447	0.873
Dairy products	1.082	1.145	0.639
Processed rice	1.054	1.119	0.688
Sugar	1.278	1.000	0
Food products n.e.c.	1.040	1.071	0.640
Beverages and tobacco products	1.126	1.063	0.333
Textiles	1.072	1.271	0.790
Wearing apparel	1.142	1.000	0
Leather products: Footwear	1.143	1.000	0
Wood products	1.045	1.000	0
Paper products, publishing	1.008	1.066	0.892
Petroleum, coal products	1.008	1.000	0
Chemical, rubber, plastic products	1.049	1.287	0.854
Mineral products n.e.c.: Glassware and Tableware	1.087	1.096	0.525
Metal products	1.047	1.192	0.803
Motor vehicles and parts	1.034	1.157	0.822
Electronic equipment	1.042	1.061	0.592
Machinery and equipment n.e.c.	1.040	1.085	0.680
Manufactures n.e.c.	1.065	1.016	0.198
Weighted geometric means	1.058	1.087	0.602

Source: Bradford (2003a, 2003b) and own calculations

Notes: The international price is normalized to one for all goods. A tariff inclusive price of 1.064 thus implies a 6.4 % import tariff. A similar argument applies for non-tariff barriers. Following Bradford (2003a), total protection is defined as the sum of tariff protection and the tariff equivalent of the existing NTB.

Table 2: Estimation of the augmented Grossman-Helpman model by MLE

	Dependent variable: $\frac{NTB}{1+NTB} \times e$, sample of 107 sectors					
Threshold for I	\$100m	\$100m	\$100m	\$100m	\$200m	\$75m
	(1)	(2)	(3)	(4)	(5)	(6)
(y/m)	-0.0093**	-0.0081**	-0.0053	0.0083**	-0.0039	-0.0059
	(0.0040)	(0.0043)	(0.0055)	(0.0036)	(0.0066)	(0.0052)
$(y/m) \times I$	0.0106**	0.0166***	0.0157***	-0.0098*	0.0151***	0.0160***
	(0.0053)	(0.0045)	(0.0054)	(0.0061)	(0.0065)	(0.0051)
I				0.3381		
				(0.3896)		
constant			-0.3937*	-0.2187	-0.4336*	-0.3523
			(0.2626)	(0.2398)	(0.2978)	(0.2563)
β	0.986	0.983	0.988	1.008	0.989	0.988
	(0.005)	(0.004)	(0.004)	(0.005)	(0.005)	(0.004)
α_L	0.883	0.489	0.338	0.847	0.261	0.370
	(0.223)	(0.134)	(0.244)	(0.541)	(0.233)	(0.284)
γ	1.000	1.000	0.718	0.820	0.697	0.739
			(0.135)	(0.161)	(0.145)	(0.140)
Log-likelihood		-308.2	-305.4	-305.4	-315.8	-295.5

Notes: Variables definitions: (y/m) is the inverse import penetration ratio and I is the organization dummy, equal to one if the sector is organized. β is the weight on welfare in the government's objective function, α_L is fraction of the population that lobbies, γ is the fraction of rents captured by the government. For the \$100m threshold, 63% of sectors have I=1, 44% for \$200m and 72% for \$75m. (1) Goldberg and Maggi (1999), Table 1; (2)-(6) are estimated with maximum likelihood, details and likelihood function are in Section 5 and Appendix B. We instrument for the inverse import penetration ratio using the full set of instruments listed in Table A.1. These include measures of competition in upstream and downstream industries, indicators of production technology and characteristics of the workforce, and factor inputs. Standard errors in parentheses. Standard errors on the structural parameters are obtained using the Δ-method. * indicates significant at the 10% level, ** at the 5% level, and *** at the 1% level. In Columns (2)-(6), the test statistic for joint significance of the explanatory variables in the y/m–equation is 4.1083 (for Column (1) it is 4.131). The statistic is distributed according to the F(20,86) distribution, with a threshold of 1.70 for significance at the 5% level.

Table 3: Other estimation methods

	Dependent variable: $\frac{NTB}{1+NTB} \times e$, sample of 107 sectors					
	MDE	MDE	MDE	Tobit	MLE	MLE
	(1)	(2)	(3)	(4)	(5)	(6)
(y/m)	-0.0098***	-0.0026**	-0.0022	0.0029	-0.0054	-0.0030
	(0.0023)	(0.0013)	(0.0027)	(0.0027)	(0.0077)	(0.0033)
$(y/m) \times I$	0.0374***	0.0173***	0.0190***	-0.0016	0.0140*	0.0055
	(0.0051)	(0.0018)	(0.0017)	(0.0029)	(0.0075)	(0.0038
constant			-0.3255*	-0.0051	-0.3046	-0.1684
			(0.2330)	(0.0967)	(0.215)	(0.1131)
F-test for y/m equation		4.108	4.108		3.042	4.108
χ^2-test for $y/m \times I$ equation		45.252	45.252			44.970
β	0.96	0.982	0.985	1.001	0.989	0.995
		(0.002)	(0.003)	(0.003)	(0.006)	(0.003)
α_L	0.26	0.149	0.117	1.808	0.384	0.545
		(0.086)	(0.152)	(2.171)	(0.298)	(1.394)
γ	1.000	1.000	0.754	0.995	0.766	0.855
			(0.189)	(0.096)	(0.126)	(0.082)

Notes: Variables definitions: (y/m) is the inverse import penetration ratio and I is the organization dummy, equal to one if the sector is organized. β is the weight on welfare in the government's objective function, α_L is fraction of the population that lobbies, γ is the fraction of rents captured by the government. (1) Eicher and Osang (2002), Table 1 (standard errors for the structural coefficients and test statistics are not reported). (2)-(3) Estimated with the same minimum distance estimator, details are in Section 6.3 and Appendix B. The full set of instruments is used in the first stage for each variable. These include measures of competition in upstream and downstream industries, indicators of production technology and characteristics of the workforce, and factor inputs. Standard errors (in parentheses) are calculated as in Lee (1995), controlling for the two-step nature of the estimator. (4) Tobit estimates, treating both (y/m) and I as exogenous. Structural coefficients are calculated ignoring the uninteracted organization dummy. (5) Maximum likelihood estimation using a reduced set of instruments (only the type of workers and capital stock are included). (6) Two-step maximum likelihood estimation as in Nelson and Olson (1978) using all instruments, first stage for (y/m) estimated by OLS and for $y/m \times I$ by Tobit. Standard errors on the structural parameters are obtained using the Δ-method. * significant at the 10% level, ** at the 5% level, and *** at the 1% level. The F-test statistic is distributed according to the F(20,86) distribution in (2), (3), and (6), and F(5,101) in (5). The thresholds for significance at the 5% level are 1.70 and 2.31, respectively. The χ^2-statistics follows the $\chi^2(20)$ distribution and the corresponding threshold is 31.41.

Table 4: Results with tariff rates and reduced samples

	Dependent variable: $\frac{NTB/t}{1+NTB/t} \times e$			
Protection by	Tariff	Tariff	Tariff	NTB
Sectors excluded	none	none	NTB>0.50	Tariff>0.10
	(1)	(2)	(3)	(4)
inverse import penetration (y/m)	-0.0007***	-0.0012***	-0.0019***	-0.0019
	(0.0002)	(0.0004)	(0.0003)	(0.0040)
(y/m) $\times$ organization dummy	0.0019***	0.0016***	0.0023***	0.0198***
	(0.0002)	(0.0003)	(0.0005)	(0.0016)
constant term		0.0810	0.0290	-0.4824
		(0.0572)	(0.0594)	(0.3242)
Number of sectors	107	107	79	86
F-test for y/m equation	4.108	4.108	3.429	3.661
χ^2-test for $y/m \times I$ equation	45.252	45.252	35.290	41.477
β	0.998	0.998	0.997	0.987
	(0.0003)	(0.0003)	(0.0004)	(0.003)
α_L	0.370	0.761	0.809	0.084
	(0.139)	(0.385)	(0.300)	(0.020)
γ	1.000	1.088	1.030	0.674
		(0.068)	(0.063)	(0.193)

Notes: β is the weight on welfare in the government's objective function, α_L is fraction of the population that lobbies, γ is the fraction of rents captured by the government. Estimation with the minimum distance estimator as in Eicher and Osang (2002), using the full set of instruments: measures of competition in upstream and downstream industries, indicators of production technology and characteristics of the workforce, and factor inputs. Standard errors (in parentheses) are calculated as in Lee (1995), controlling for the two-step nature of the estimator. Columns (1)–(3) use tariffs in the construction of the dependent variable, while in column (4) NTBs are used, as before. In column (3) sectors with high NTB protection are excluded; column (4) excludes sectors with high tariff rates. Standard errors on the structural parameters are obtained using the Δ-method. * significant at the 10% level, ** at the 5% level, and *** at the 1% level. The F-statistic is distributed according to the F(20,86) distribution in (1)-(2), according to F(20,58) in (3), and F(20,65) in (4). The thresholds for significance at the 5% level are 1.70, 1.76, and 1.74, respectively. The χ^2 test statistics follow the $\chi^2(20)$ distribution throughout and the corresponding threshold is 31.41.

Appendix A Data

We use the same data set that was previously employed by Gawande and Bandyopadhyay (2000).[33] It covers the U.S. manufacturing sector in 1983 at the 3-digit level, giving a total of 107 observations. Below we describe the different pieces of information and indicate the original sources. Summary statistics on all variables are in Table A.1.

Import demand elasticities (e_i) are taken from Shiells, Stern, and Deardorff (1986). Following Goldberg and Maggi (1999), the small number of industries with positive import demand elasticities are set to zero.

Non-tariff barriers (NTB_i proxy for $\phi_i^{-1}(q_i)$), which enter the dependent variable in the model, are taken from Trefler (1993), and aggregated to the 3-digit level using as weights the value of shipment (from the 1996 NBER productivity database). The extent of protection is measured by the NTB coverage ratio (that is, the fraction of an industrys imports covered by one or more of such non-tariff measures). Non-tariff barriers includes price-oriented measures such as antidumping duties and countervailing duties, quantity-oriented measures such as quotas and voluntary export restraints, and threats of quality and quantity monitoring. For the full list see footnote 6. Following the transformation of variables in Goldberg and Maggi (1999), as described in Section 5, we multiply $NTB_i/(1+NTB_i)$ by the import elasticity for the sector (e_i) to obtain the actual dependent variable used in the analysis.

Tariff rates (t_i) (Gawande and Bandyopadhyay (2000)), U.S. post-Tokyo round ad valorem tariff rate.

Import penetration ratio (m_i/y_i) (Trefler (1993)), the ratio of imports (from the rest of the world) relative to domestic (U.S.) output; aggregated to the 3-digit level using the value of shipments as weights.

Organization dummy (I_i), (Gawande and Bandyopadhyay (2000)), if total contributions in a sector exceed a threshold, the dummy takes on the value of one and zero otherwise. The threshold we use ($100,000,000) is the same as in Goldberg and Maggi (1999). Information on Political Action Committee contributions is also taken from Gawande and Bandyopadhyay (2000); it sums total firm and union contributions by sector for the 1983-1984 congressional elections. In Table 2 we use alternative thresholds to define the organization

[33] Thanks are due to these authors for generously making their data available to us. Eicher and Osang (2002) use the same data set, but we have been unable to obtain the data used in Goldberg and Maggi (1999).

dummy as a robustness check.

Instrumental variables, (Trefler (1993)), aggregated to the 3-digit level using as weights the value of shipments. A first set of variables is commonly used to predict political organization. Four variables measure concentration in upstream and downstream industries. Two variables capture other aspects of concentration: geographic and a high minimum efficient scale concentrates capital in fewer plants. Finally, unionization and tenure are positively related to the organization of the workforce, making lobbying more likely. A second set of variables capture factor endowments and, hence, comparative advantage and are included mainly to predict import penetration. It measures labor, land, capital, and other inputs, broken down in several categories. For details on how they are calculated, see Trefler (1993).

Buyer concentration: Weighted average of four firm concentration ratios among buyers of an industry output (consumers and downstream industries).

Seller concentration: Weighted average of four firm concentration ratios in supplier (upstream) industries.

Buyer (seller) number of firms: Number of companies scaled by industry sales.

Geographic concentration: Measure of the difference between population and industry production patterns across the 50 states.

Minimum efficient scale: Caves (1976) minimum efficient plant size, defined as the percentage of industry sales supplied by the median plant.

Unionization: Percentage of workers unionized.

Tenure: Average year of tenure by workers in the industry.

Engineers, white collars, Skilled, Semi-skilled; Cropland, Pasture, Forest; Physical capital, Inventories; Coal, Mineral and petroleum services: All these are factor shares. For each industry and each factor, factor shares are the total (in an input-output sense) factor earnings generated by producing one dollar of final industry output.

Table A.1: Summary statistics

Variable	Mean	Standard error
Dependent variables:		
$\frac{NTB_i}{1+NTB_i} \times e_i$ (dependent variable)	0.1929	(0.5946)
$\frac{t_i}{1+t_i} \times e_i$ (alternative dep. var.)	0.0354	(0.0462)
Explanatory variables:		
y/m (inverse import penetration)	34.633	(65.070)
organization dummy	0.6147	(0.4889)
Instruments:		
Buyer concentration	0.3691	(0.0618)
Seller concentration	0.3618	(0.1538)
Buyer number of firms	0.4092	(0.5248)
Seller number of firms	0.2263	(0.2592)
geographic concentration	0.7097	(0.1431)
Minimum efficient scale	0.0228	(0.0340)
Unionization	0.3435	(0.1597)
Tenure	5.5211	(1.6439)
(Factor shares)		
Engineers	0.0314	(0.0214)
White collar	0.1536	(0.0440)
Skilled workers	0.1081	(0.0308)
Semi-skilled workers	0.0957	(0.0398)
Cropland	0.0197	(0.0521)
Pasture	0.0073	(0.0269)
Forest	0.0005	(0.0021)
Physical capital	0.3596	(0.2563)
Inventories	0.0302	(0.0123)
Coal	0.0020	(0.0022)
Mineral	0.0010	(0.0017)
Petroleum	0.0332	(0.0473)

Appendix B Structural estimation of the protection equation

Maximum likelihood estimation

Estimation of equations (7) or (8) by maximum likelihood poses specific challenges, because of the endogenous nature of the explanatory variables, the censoring from below of the dependent variable, and discrete nature of the organization dummy. As the original paper by Goldberg and Maggi (1999) is silent on the exact way in which estimation was carried out, we have experimented with several estimation strategies, yielding similar results. In the main table of results, Table 2, we choose the method that leads to parameter estimates values that are closest to the Goldberg and Maggi (1999) results for the original protection for sale model.

The most straightforward way to estimate the model is by a two-step procedure, initially proposed by Nelson and Olson (1978). The endogenous variables in the Tobit model are replaced with consistent first-stage estimates. This mirrors the estimation strategy in the related model of Gawande and Bandyopadhyay (2000). Import penetration and organization are replaced with fitted values from, respectively, a least squares and probit regression of either variable on the full set of instruments. Alternatively, in the first stage the interaction term ($I \times y/m$) can be predicted directly, with a Tobit regression, comparable to the approach in the minimum distance results. Results for this approach are reported in column (6) of Table 3. In the former case, where I is predicted separately, results are very similar ($\hat{\gamma} = 0.879$, $\hat{\beta} = 0.996$, $\hat{\alpha_L} = 0.880$).

The F-test for joint significance of the instruments in the import penetration equation and the χ^2-tests for the Probit regression of I and Tobit regression of $I \times y/m$ reject the null hypothesis of joint-insignificance, confirming that the instruments have predictive value in the MLE estimation.[34] If we limit the set of instruments, using only physical capital and composition of the workforce for y/m and geographic concentration and composition of the workforce for I (and the combination of these variables for $I \times y/m$, results are again very similar, but the estimates for γ become 0.812 and 0.807.

As Amemiya (1979) has shown, the two-step procedure is consistent, but not asymptot-

[34] We do not report the first stage estimates, but they are very similar to those obtained in Goldberg and Maggi (1999) which use the same explanatory variables, but their left-hand side variables refer to a different year.

ically efficient. Consequently, we have also tried to implement a one-step procedure. We did not find any example in the literature where the coefficient on the interaction of an endogenous limited dependent variable and another endogenous variable is estimated in a single step. If we ignore the endogeneity of the organization dummy, we can use the procedure proposed in Smith and Blundell (1986). The original estimation by Goldberg and Maggi (1999) mentions explicitly that: "[...] we also estimated a specification in which the political-organization dummies were treated as econometrically exogenous; this turned out to make no appreciable difference, either for the point estimates or the standard errors." (p.1143) With only a single endogenous variable on the right-hand side, the log-likelihood function, after concentrating over σ_2^2 (the variance of the error term in the import penetration equation) is given by:

$$
\begin{aligned}
\ln L &= \ln\Big(L(\epsilon_2)L(\epsilon_1|\epsilon_2)\Big) \\
&= -\frac{N}{2}\ln\Big(\frac{1}{N}\sum_i(\frac{y_i}{m_i} - X'\beta_2)^2\Big) \\
&\qquad + I_{[ntb_i>0]}\left[\frac{1}{2}\ln\delta + (\frac{\epsilon_{1i}}{\delta})^2\right] + I_{[ntb_i\leq 0]}\Phi\Big(\frac{\epsilon_{1i} - ntb_i}{\omega}\Big)
\end{aligned}
$$

$$
\begin{aligned}
\text{where}\quad \epsilon_{1i} &= ntb_i - \frac{\psi' + \theta' I_i}{\sigma_1}\frac{y_i}{m_i} - \delta(\frac{y_i}{m_i} - X'\beta_2) \\
\delta &= \frac{\sigma_{12}}{\sigma_2^2} \\
\omega &= [\sigma_1^2(1-\rho_{12}^2)]^{1/2} \\
ntb_i &= \frac{NTB_i}{1+NTB_i}e_i
\end{aligned}
$$

Because the results of the one-step estimator are closer to the results obtained by Goldberg and Maggi (1999), on a slightly different data set, and to the minimum distance results, we used this method for all results in Table 2. Table 3 contains robustness checks using other estimation methods.

Minimum distance estimator

The minimum distance estimation proceeds in two steps. In the first step, we estimate the reduced form equations for each of the three endogenous variables separately as a function of the same set of instruments (Z) used also for the maximum likelihood estimation. The (inverse) import penetration equation, equation (B.12), is estimated by ordinary least squares.

The interaction between the organization status and the import penetration, equation (B.13), is estimated using a Tobit regression. As mentioned in the text, we do not have enough observations to estimate the reduced form regression for the organization dummy separately and obtain the reduced form expression for the protection equation by multiplying out the interaction term. Therefore, we follow the same pragmatic solution as Eicher and Osang (2002). Substituting the two endogenous explanatory variables into the estimation equation of interest, equation (8), we obtain the third reduced form equation, equation (B.14), which is also estimated using a Tobit regression. The three first-stage regressions are given here:

$$\frac{y_i}{m_i} = \zeta_1' Z_i + u_{1i} \tag{B.12}$$

$$I_i^* \frac{y_i}{m_i} = \zeta_2' Z_i + u_{2i} \tag{B.13}$$

$$\begin{aligned} y_i^* &= \theta' I_i^* \frac{y_i}{m_i} + \psi' \frac{y_i}{m_i} + \lambda + \epsilon_{2i} \\ &= \theta'(\zeta_2' Z_i + u_{2i}) + \psi'(\zeta_1' Z_i + u_{1i}) + \lambda + \epsilon_{2i} \\ &= \underbrace{\lambda + (\theta'\zeta_2' + \psi'\zeta_1')}_{\zeta_3'} Z_i + \underbrace{(\theta' u_{2i} + \psi' u_{1i} + \epsilon_{2i})}_{u_{3i}} \qquad \text{(B.14)} \end{aligned}$$

In the second stage, we estimate the structural coefficients of the model (θ' and ψ') from the reduced form coefficients with a two-step GMM procedure. The estimated coefficients $\hat{\zeta_3}'$ are regressed on $\hat{\zeta_2}'$ and $\hat{\zeta_1}'$ using an appropriate weighting matrix constructed from the scores of the first stage regressions. The method is described in detail in Lee (1995), which also contains all the formulas and a sample algorithm.