Costly distribution and the non-equivalence of tariffs and quotas

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Abstract

When governments impose a quota or tariff on imports, it is well known that the resulting rents and revenues trigger costly rent-seeking and revenue-seeking activities, which are welfare-reducing and may be economically more significant than the efficiency losses resulting from the protectionist-induced resource misallocation. Repeated interaction among firms can eliminate wasteful rent- and revenue-seeking expenditures through cooperation. We show that while aggregate outcomes are equivalent under tariffs and quotas if cooperation arises, the conditions under which cooperation arises differ by policy. This difference arises because a firm must incur additional cost to physically import and distribute the goods associated with additional quota licenses, whereas there is no such cost when it comes to consuming additional tariff revenue. Thus, quotas and tariffs are non-equivalent. We provide a simple sufficient condition under which cooperative elimination of rent-seeking under quotas is easier than cooperative elimination of revenue-seeking under tariffs and therefore a quota is the preferred policy whenever the policy admits cooperation.

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1 Introduction

First discussed extensively in the 1960s, the equivalence of tariffs and quotas has been debated ever since. The standard interpretation of this equivalence states that if the level of imports implied by the tariff is set as a quota, then this "tariff-equivalent quota" generates an implicit tariff equal to the explicit tariff originally under consideration. The implicit tariff is the quota-induced wedge between foreign and domestic prices. Krueger's seminal 1974 paper, however, showed that tariffs and quotas are not necessarily equivalent because quotas create rent-seeking incentives as firms vie for quota licenses and their associated rents. Indeed, the welfare costs of a quota could far exceed those of a tariff as the economy finds itself inside the production possibilities frontier due to welfare costs that go beyond the inefficiency associated with quota- or tariff-induced resource reallocation. Subsequently, Bhagwati (1980) and Bhagwati and Srinivasan (1980) pointed out that tariffs may induce revenue-seeking behavior that is just as wasteful as the rent-seeking induced by quotas. In this paper, we examine whether tariffs and quotas are equivalent in a repeated game setting when allowing cooperation that eliminates rent-seeking under a quota and revenue-seeking under a tariff.

Despite significant trade liberalization over the past 50 years, many countries still impose both tariffs and quotas. Examples of quotas include marble in India, completely knocked-down motor vehicle parts in Ecuador, and toys in Mexico (Trade Policy Review Body 2011; Committee on Foreign Trade 2012; Trade Policy Review Body 2013), not to mention the wide use of tariff rate quotas on agricultural products.[1] Moreover, firms exert significant rent-seeking efforts to obtain quota licenses and tariff revenues. Marshall (2002) and Marowits (2015) document import license lobbying for white corn in Mexico and cheese in Canada.[2] In the United States, thousands of special interest groups lobby over federal budgetary appropriations (5219 groups in 2009, Center for Responsive Politics 2015) and tax expenditures in particular (Drutman 2012; Rowland 2013).[3] Of course, only a portion of government revenues derive from tariff revenue. But tariff revenue is

[1] A tariff rate quota (TRQ) is a two-part tariff wherein one tariff is applied until imports exceed a fixed amount after which additional imports face a higher "out-of-quota" tariff. Often the out-of-quota tariff is prohibitive and results in zero out-of-quota imports. In this case, a TRQ is similar to an outright quota.

[2] Interestingly, as discussed in Hranaiova et al. (2006), auctioning import licenses is rare despite the attention received in the literature (see, for example, Krishna 1990, 1993a,b). Instead, government allocation in response to import license requests by firms constitutes the most common method of quota administration (Hranaiova et al. 2003).

[3] Practically, firms could lobby to shift government disbursements toward infrastructure projects relevant to their industry or for corporate tax breaks.

nonetheless government revenue and so lobbying over government revenue is, *de facto*, lobbying over tariff revenue.[4] Indeed, according to Bhagwati and Srinivasan (1980, pp. 1070-71), "That lobbies exist, and utilize real resources for pursuit of a share in the revenues disbursed by the state, is so obvious from the most casual observation as to require no extended justification." Ultimately, a policy environment featuring tariffs and quotas and their induced rent- and revenue-seeking behavior reflects the reality of current trade policy.

We re-consider the equivalence between tariffs and quotas by allowing the possibility that repeated interaction may support cooperation among firms that agree, implicitly or explicitly, to eliminate wasteful rent- and revenue-seeking under, respectively, a quota or tariff policy regime. We allow firms to engage in rent-seeking to influence the government's allocation of import licenses under a quota regime or in revenue-seeking over the tariff revenue collected by the government. We assume that the imported good requires a (non-traded) distribution service to import and deliver the good from the port of entry to the market. Practically, this represents the services provided by importers or customs brokers who identify and build relationships with exporters in foreign countries, arrange transport of the good, clear the good through customs, and deliver it into the domestic distribution network. These real-world features of importing make import distribution costly, which plays an important role in our analysis.

Our main result is a non-equivalence between tariffs and quotas. When firms sustain cooperation, outcomes (including labor and production allocations, prices, and income) are equivalent under the tariff and tariff-equivalent quota. However, while cooperative outcomes are identical, the conditions determining whether cooperation occurs differ. In particular, we provide a simple sufficient condition under which cooperation is easier to sustain under quotas and so, for a given range of the discount factor, cooperative elimination of rent-seeking occurs under the quota policy regime but not under the tariff policy regime. Thus, tariffs and quotas non non-equivalent.

A "costly distribution" effect in the presence of diminishing marginal returns drives our non-equivalence result. The benefit of deviating from cooperation under a quota is reduced by the continually increasing labor requirement needed to make use of each additional import license gained by deviating. Conversely, no labor is required to enjoy the additional tariff revenue gained through

[4] According to the World Bank World Development Indicators, the share of government revenue accounted for by tariff revenue was, on average, 13.3% in 2010 (23% for low-income countries).

revenue-seeking, so that each additional unit of tariff revenue is as profitable as the initial unit. Hence, it is not costly distribution *per se* that drives our results, but rather the rising marginal cost of distribution. General equilibrium effects on prices and wages exacerbate the reduction in distribution profits under quotas. Thus, costly import distribution makes deviation under a quota less attractive relative to deviation under a tariff, making cooperation easier to sustain under the quota regime relative to the tariff regime.

Given our specific factors model of trade, diminishing marginal returns to distribution activities emerge naturally. Specifically, firms own equal shares of the fixed capital stock used for distribution, and the fixed nature of a firm's distribution capital stock generates diminishing marginal productivity of labor. However, our result generalizes beyond this particular environment. Our "distribution service" entails more than physically moving goods from port to market. The importer also provides services that rely on identifying and building relationships with exporters in foreign countries. Thus, in practice, a firm's distribution capital stock consists of physical capital (e.g., trucks and warehouses) and firm-specific intangible capital (e.g., relationships with exporters). While the former may be transferable between firms (perhaps in rental markets), the latter is not readily traded between firms. Thus, difficulties associated with transferring the firm-specific intangible capital that underlie an importer's ability to produce distribution services generate diminishing returns in more general settings than our specific factors model.

We also consider the impact of our non-equivalence result on the government's policy choice. Our second main result is that, in situations where cooperation prevails, a quota always maximizes the government's payoff and, for a substantial range of discount factors, it uniquely maximizes the government's payoff. Underlying this result is that cooperation may be sustainable only under the quota. Moreover, this may help reconcile the discrepancy between the perceived theoretical superiority of tariffs over quotas with the non-trivial practical usage of quotas.

The theoretical literature generally views tariffs as superior to quotas.[5,6] In particular, tariffs confer less market power and thus lower prices than quotas (see, for example, Harris 1985; Krishna 1989). [7] Tariffs are also preferred over quotas in practice. As a general rule, Article XI of the General

[5]Bhagwati et al. (1998, p.225) certainly hold this view by stating that "[Pelcovits (1976)] shows that ... the tariff is not always preferable to a quota [in terms of welfare], contrary to general intuition."

[6]Nevertheless, Chen et al. (2011b), Chen et al. (2011a), and Hwang et al. (2011) find that quotas may be preferable to tariffs in the sense that they deliver lower consumer prices.

[7]According to Blonigen et al. (2013, p.1), the market power effect is "[o]ne of the most well-known examples of

Agreement on Tariffs and Trade (GATT) bans quantitative restrictions and the recent elimination of quotas under the Multi Fibre Agreement put this principle into practice. Nevertheless, while some countries do not use quotas, quotas remain an important trade policy instrument in practice. For example, in 2014, Brazil and the European Union each imposed quantitative restrictions on 2800 and 2500 products, respectively, nearly 600 of which were outright quotas in the European Union and 40 in Brazil.[8] Thus, our result on policy choice helps rationalize the persistent usage of quotas rather than tariffs despite apparent theoretical evidence to the contrary and the influence of GATT Article XI.

Our paper merges two literatures: the equivalence of tariffs and quotas, and the effect of repeated interaction on rent-seeking expenditures. A long literature has established that equivalence breaks down in a variety of partial equilibrium environments. Early contributions emphasized imperfect competition (e.g., Bhagwati 1965; Shibata 1968; Rodriguez 1974; Fishelson and Flatters 1975; Itoh and Ono 1982). Recent contributions emphasize dynamic profit-maximization (Dockner and Haug 1990), asymmetric information (Matschke 2003), demand uncertainty (Chen et al. 2011b), tariff-rate quotas (Chen et al. 2011a), or the presence of an upstream producer (Hwang et al. 2011).[9] However, none of these papers considers the impact of rent- or revenue-seeking on equivalence or the issue of cooperation in a repeated game. Moreover, given their partial equilibrium nature, they do not address general equilibrium welfare consequences of tariffs versus quotas.

Nor does the rent-seeking literature address these questions. The traditional rent-seeking literature has focused on rent dissipation in rent-seeking contests (Krueger 1974; Posner 1975) and, under free entry into rent-seeking, the full dissipation of rents (Corcoran 1984; Corcoran and Karels 1985; Higgins et al. 1985).[10] We are not, of course, the first authors to show that repeated interaction may mitigate the costs of rent-seeking through cooperation. Recent work on repeated rent-seeking games considers how repetition affects the possibility of cooperation in regulatory contests (Shaffer and Shogren 2008), the appropriation of government foreign aid revenue (Svensson 2000), and the

this nonequivalence" of tariffs and quotas.

[8]Data are disaggregated at the 8-digit level and are from the non-tariff measures (NTM) records available in the UNCTAD Trade Analysis and Information System (TRAINS) database, accessed via WITS (World Integrated Trade Solution) at `http://wits.worldbank.org/`.

[9]Blonigen et al. (2013) also find empirical support for quotas conferring more market power than tariffs on market participants.

[10]See Congleton et al. (2008) for a survey.

level of rent-seeking (Shaffer and Shogren 2009).[11]

In contrast to these literatures, our focus is on comparing the possibilities for cooperation (and thereby elimination of rent-seeking) in a general equilibrium environment under two different policies, tariffs and quotas, that are equivalent in a world without rent-seeking. Even if the aggregate economic effects of two policies are identical, we show that policy details can create differences in the possibility of eliminating rent-seeking through cooperation and, therefore, a preference for one policy over the other.

2 Model of a rent-seeking economy

We model a small open economy consisting of three sectors: the agricultural sector (A), which is the exportable sector and the numeraire good, the manufacturing sector (F), which is the importable sector and, following Krueger (1974), the distribution sector (D) that produces a non-traded service required to import the manufactured good.[12] Units of account are chosen such that international prices of traded goods are 1 and one unit of D is needed to import one unit of F. Thus, the domestic price of F is

$$p_F = 1 + p_D + t, \tag{1}$$

where p_D is the endogenous price of D and $t \geq 0$ is the tariff.

2.1 Production and consumption

Each sector $j = A, F, D$ has a fixed supply of a specific factor $\bar{K}_j$ and n_j specific factor owners who own equal shares, $\frac{\bar{K}_j}{n_j}$, of the factor specific to their sector. We assume that $n \equiv n_D = n_A + n_F$ so that each specific factor owner in a tradeable sector also owns the specific factor required for distribution.[13] Letting L_j denote the labor hired by a representative specific factor owner in sector

[11]See also Leininger and Yang (1994), who analyze a dynamic version of the classic Tullock (1980) model, Pecorino (1998), and Polborn (2006). Cheikbossian (2012) actually shows that cooperation can increase rent-seeking expenditure by resolving a collective action problem.

[12]Distribution costs for domestically produced goods are embedded in their production functions.

[13]We relax this assumption in Section 5.1.

j, specific factor owners face the constant returns to scale production functions

$$
\begin{aligned}
Q_A &= a\left(L_A, \frac{\bar{K}_A}{n_A}\right) \\
Q_F &= f\left(L_F, \frac{\bar{K}_F}{n_F}\right) \\
Q_D &= d\left(L_D, \frac{\bar{K}_D}{n_D}\right)
\end{aligned}
$$

that display positive but diminishing marginal product of labor ($f_L \equiv \frac{\partial f(\cdot)}{\partial L_F} > 0$ and $f_{LL} \equiv \frac{\partial^2 f(\cdot)}{\partial L_F^2} < 0$, and similarly for $a(\cdot)$ and $d(\cdot)$). While Q_j denotes output of a representative firm in sector j, A, F and D denote the aggregate output of all firms in a given sector. Further, we let η_j denote the elasticity of labor demand in sector j (in absolute value) and $\phi_{j,k}$ denote the share of output in sector(s) k paid to sector j labor (for example $\phi_{F,F} = \frac{f_L(L_F) \times L_F}{F}$ denotes manufacturing labor's share of manufacturing output and $\phi_{F,FD} = \frac{f_L(L_F) \times L_F}{F+D}$ denotes manufacturing labor's share of *total* $F + D$ output).[14]

Thus, a specific factor owner in sector j faces the following maximization problem:

$$\max_{L_j, L_D} p_j \times Q_j(L_j) + p_D \times Q_D(L_D) - w \times (L_j + L_D).$$

Taking the wage w as given (see Section 2.3 for equilibrium determination of w), profit-maximizing factor owners hire labor up to the point where

$$a_L(L_A) = w, \tag{2}$$

$$f_L(L_F) \times p_F = w, \text{ and} \tag{3}$$

$$d_L(L_D) \times p_D \geq w. \tag{4}$$

Given that one unit of the distribution good is required to bring a unit of imports from port to market, aggregate output of the distribution good, D, must equal imports, M, in equilibrium. The inequality in (4) is one implication of this. By constraining imports and hence distribution output, a quota implies that (4) holds with a generally strict inequality.

When analyzing the differing prospects for cooperation under the tariff and quota regimes in

[14] In equilibrium, $\phi_{j,k}$ and η_j are invariant across specific factor owners within sector j.

later sections, we distinguish between "normal" rents, Π, and "excess" rents, π, of specific factor owners (equivalently, firms) in their distribution sector activities (or, analogously, the agriculture or manufacturing sectors). Letting W denote the total wage bill, the left-hand side of Figure 1 depicts these concepts for an individual firm with respect to labor hired in the distribution sector under quotas. A firm maximizes profits under free trade or a tariff regime by hiring labor until the wage equals the marginal revenue product, $w = p_D \times d_L(L_D)$. However, a firm is constrained under a binding quota and hires only the labor required to distribute its quota allocation (denoted $\bar{L}_D$ in Figure 1), which yields $w < p_D \times d_L(\bar{L}_D)$. The difference $p_D \times d_L(\bar{L}_D) - w$ represents the excess rent on each unit of labor hired. Under tariffs or free trade, this difference vanishes and leaves a firm's share of any tariff revenue as its excess rent associated with the distribution of imports.

[Figure 1 about here.]

The right-hand side of Figure 1 illustrates these concepts with respect to firm-level output decisions. The upward sloping curve depicts the labor cost incurred to produce each marginal unit of output. The price of distribution services is decomposed into two parts. One part, ρ, compensates the firm for labor costs incurred in producing the marginal unit of output. A second part

$$\tau_D \equiv p_D - \frac{w}{d_L(L_D(Q_D))} = p_D - \rho_D \tag{5}$$

represents the excess rent on the *marginal* unit of output. Again, if the firm is unconstrained in its labor hiring decisions, as under tariffs or free trade, it hires until $\rho_D = p_D$ (labor cost of the marginal unit equals price of the marginal unit) and the excess rent on the marginal unit of output, τ_D, vanishes. But, when the amount of labor required in distribution is constrained by a quota, $\rho_D < p_D$ and $\tau_D > 0$. It is useful to note here that, by construction, the quota-equivalent tariff equals the value of τ_D under the quota in the absence of rent-seeking.[15] In this case, a firm's excess distribution rent is $\pi_D = t \times Q_D = \tau_D \times Q_D$ under the tariff and quota regimes, respectively.

For the consumption side of the economy, we assume a representative consumer with demand for the manufactured good given by

$$C_F = C(p_F, Y), \tag{6}$$

[15]A firm would choose to produce its quota level of distribution output under the tariff regime if the price it receives under the tariff regime is $p_D - t$ where $t = \tau_D$. As such, the labor demands of all firms in all sectors would be unchanged across the tariff and quota regimes, as would all endogenous variables in the model.

where Y is aggregate income. Letting C_A denote consumption of A, we also assume homothetic preferences, which imply that the consumption ratio $\frac{C_F}{C_A}$ is decreasing in the relative price p_F, $\frac{\partial(C_F/C_A)}{\partial p_F} < 0$, but independent of income.[16] Finally, aggregate income is

$$Y = A + p_F \times F + p_D \times D + t \times M. \tag{7}$$

Each worker earns income w and each specific factor owner earns firm profits (revenues net of wages paid to workers) plus any share of tariff revenue under the tariff.

2.2 Quotas, tariffs, rent- and revenue-seeking

Absent rent- and revenue-seeking, import licenses and tariff revenue are distributed equally among specific factor owners. Thus, for a tariff t and import level M, tariff revenue is $t \times M$ and each specific factor owner receives $\frac{t \times M}{n}$. Analogously, the restricted level of imports under the (binding) quota is $\bar{M}$ with each specific factor owner allocated $\frac{\bar{M}}{n}$ licenses, which endows the right to import and sell this amount of F.[17] Our interest revolves around the case where, in the absence of rent- and revenue-seeking, the quota and tariff are equivalent so that the quantity of imports under the tariff is the same as under the quota.[18]

When rent- or revenue-seeking takes place, L_R denotes the level of rent-seeking labor hired by a representative firm (rent-seeking expenditures are thus $L_R \times w$) and R denotes the aggregate level of rent- or revenue-seeking by all firms. All specific factor owners can engage in both revenue-seeking under the tariff and, given the allocation of the specific factor in the distribution sector, rent-seeking under the quota.[19] In this case, a contest success function determines a firm's allocation of tariff revenue, $\frac{L_R}{R} \times t \times M$, and quota licenses, $\frac{L_R}{R} \times \bar{M}$ given its level of rent-seeking L_R.

Under tariffs, a representative rent-seeking firm in sector j faces the following optimization

[16] Recall that $p_A = 1$.

[17] We assume that the quota remains binding throughout the paper. Moreover, we assume that a given trade policy is time-invariant; Brainard and Verdier (1997) and Fernandez and Rodrik (1991) model this persistence.

[18] We abstract from other sources of revenue and assume that tariffs are the only source of government revenues over which firms lobby. We do this in order to directly compare rent-/revenue-seeking and the potential for cooperation under the tariff and quota regimes.

[19] As in Findlay and Wellisz (1982) and Grossman and Helpman (1994), we assume that workers do not engage in rent-seeking.

problem:

$$\max_{L_R, L_j, L_D} p_j \times Q_j(L_j) + p_D \times Q_D(L_D) + \frac{L_R}{R} \times t \times M - w \times (L_j + L_D + L_R).$$

The first-order conditions with respect to L_j and L_D produce equations (2)-(4). Assuming a symmetric Nash equilibrium, the first order condition with respect to rent-seeking L_R yields

$$L_R = \frac{n-1}{n^2} \times \frac{1}{w} \times V, \tag{8}$$

where $n = n_A + n_F$ and $V = t \times M$ represents the tariff revenue or, more generally, the "rents" being sought under the tariff.[20]

Under quotas, a representative rent-seeking firm faces the following optimization problem:

$$\begin{aligned} \max_{L_R, L_j, L_D} \quad & p_j \times Q_j(L_j) + p_D \times Q_D^* - w \times (L_j + L_D + L_R) \\ \text{s.t.} \quad & Q_D^* = \min\left\{ \frac{L_R}{R}\bar{M}, d\left(L_D, \frac{\bar{K}_D}{n}\right)\right\}. \end{aligned}$$

The constraint conveys that a firm can only import and distribute goods for which it has a license and must produce the distribution service to do so. Clearly, to avoid hiring unused labor or gaining unused quota licenses, a firm's distribution output equals its quota allocation: $Q_D^* = Q_D = \frac{L_R}{R}\bar{M}$. Denoting the amount of labor required to produce this level of distribution output by $L_D\left(\frac{L_R}{R}\bar{M}\right)$, the specific factor owner's optimization problem can be rewritten as:

$$\max_{L_j, L_R} p_j \times Q_j(L_j) + p_D \times \frac{L_R}{R}\bar{M} - w \times \left(L_j + L_D\left(\frac{L_R}{R}\bar{M}\right) + L_R\right).$$

The first-order condition for L_j produces (2)-(3). The first-order condition for L_R, again imposing a symmetric Nash equilibrium, yields the Nash equilibrium level of rent-seeking

$$L_R = \frac{n-1}{n^2} \times \frac{1}{w} \times V, \tag{9}$$

[20] Section 5.2 discusses the situation wherein less than the full amount of tariff revenue is available for allocation and thus subject to revenue-seeking.

where $V \equiv \tau_D \times \bar{M}$ represents the total excess rents under the quota regime.[21]

Thus, equations (8) and (9) give the same general expression for firm-level "rent-seeking", L_R, regardless of whether "rents" are tariff revenues or quota rents. Naturally, L_R is proportional to available rents and decreasing in the cost of hiring labor, w, to undertake such activities. Further, a larger group competing for rents increases aggregate rent-seeking ($n \times L_R$) but reduces rent-seeking by an individual specific factor owner (L_R).

2.3 Equilibrium conditions

Equilibrium in the economy is defined by equilibrium in the markets for the consumption goods and the distribution service, equilibrium in the labor market, and balanced trade. In all three sectors, consumption must equal production net of trade:

$$\begin{aligned} C_A &= A - X & (10) \\ C_F &= F + M & (11) \\ M &= D. & (12) \end{aligned}$$

Letting $\mathcal{L}_j$ denote aggregate labor use by all firms in sector $j \in \{A, D, F\}$, labor market equilibrium is characterized by full employment and wage equality resulting from labor mobility:

$$\begin{aligned} \bar{L} &= \mathcal{L}_A + \mathcal{L}_F + \mathcal{L}_D + R & (13) \\ w &= a_L(L_A) = f_L(L_F) \times p_F \leq d_L(L_D) \times p_D, & (14) \end{aligned}$$

with the last inequality taking the form of a strict equality under tariffs and a (generally) strict inequality under quotas. Finally,

$$M = X \qquad (15)$$

is the balanced trade condition.

Under free trade (i.e., no binding quota and $t = 0$), the full employment condition (13) and the inverted versions of the first-order conditions (14) yield an optimal labor demand for each sector,

[21] See Appendix for a derivation of (9).

$L_j^*(p_j)$, that depends only on p_j. Using (1) and (6) together with (11)-(12) yields

$$c(1+p_D, Y) = F + D, \tag{16}$$

representing goods market equilibrium. Substituting (7) and the optimal labor demands into (16) yields

$$\begin{aligned} & c(1+p_D, n_A \times Q_A(L_A^*(p_D)) + (1+p_D) \times n_F \times Q_F(L_F^*(p_D)) + p_D \times n \times Q_D(L_D^*(p_D))) \\ = \; & n_F \times Q_F(L_F^*(p_D)) + n \times Q_D(L_D^*(p_D)), \end{aligned} \tag{17}$$

which depends only on the single endogenous variable p_D. The equilibrium value of p_D then allows solving for all other endogenous variables. Departing from the assumption of free trade introduces only minor modifications to the solution procedure.

2.4 Economy's output reallocation response when $\bar{L}$ falls

For later sections, it is useful to relate the technological parameters $\phi_{j,k}$ and η_j to the economy's output reallocation response in situations when the labor supply effectively falls. We consider two scenarios.

First, suppose that rent-seeking does not occur but employment in the distribution sector rises exogenously so that the effective labor supply available for producing A and F falls. A standard result of the specific factors model is that the output reallocation response is given by $\frac{dF/F}{dA/A} = \frac{\phi_{F,F}\eta_F}{\phi_{A,A}\eta_A}$. That is, relative output $\frac{F}{A}$ rises if and only if $\frac{dF/F}{dA/A} < 1$, which holds if and only if $\phi_{A,A}\eta_A > \phi_{F,F}\eta_F$. We assume $\phi_{A,A}\eta_A > \phi_{F,F}\eta_F$ throughout.[22] Intuitively, when the labor share of output is higher in agriculture than manufacturing then, all else equal, the "labor-intensive" agricultural sector contracts proportionately more than the manufacturing sector when available labor falls. This intuition remains valid unless the elasticity of labor demand is sufficiently biased toward the manufacturing sector.[23]

[22] If the economy happens to import A and export F, then the condition $\phi_{A,A}\eta_A > \phi_{F,F}\eta_F$ becomes $\phi_{F,F}\eta_F > \phi_{A,A}\eta_A$. See section 3.2.2, footnote 26.

[23] Note that the elasticity of labor demand is the inverse elasticity of the marginal product of labor, so η_F sufficiently larger than η_A says that the marginal revenue product curve for the F sector is sufficiently flatter than for the A sector. Moreover, Cobb-Douglas technology implies $\eta_A = \eta_F = 1$ and so $\phi_{A,A}\eta_A > \phi_{F,F}\eta_F$ holds if and only if $\phi_{A,A} > \phi_{F,F}$, where the labor share of output is the exponent on labor in the production function.

Second, suppose that aggregate rent- or revenue-seeking labor exogenously rises. The effective labor supply available for producing A, F, and D therefore shrinks. The output reallocation response can be represented as $\frac{d(F+D)/(F+D)}{dA/A}$ with *total* relative supply of the manufactured good, $\frac{F+D}{A}$, rising if and only if $\frac{d(F+D)/(F+D)}{dA/A} < 1$. Similarly to the expression in the previous paragraph, $\frac{d(F+D)/(F+D)}{dA/A} < 1$ reduces to $\phi_{A,A}\eta_A > \phi_{F,FD}\eta_F$ under the quota or $\phi_{A,A}\eta_A > \phi_{F,FD}\eta_F + \phi_{D,FD}\eta_D$ under the tariff. (These expressions differ because, unlike under the binding quota, distribution output can vary under the tariff.) We assume $\phi_{A,A}\eta_A > \phi_{F,FD}\eta_F + \phi_{D,FD}\eta_D$ throughout.[24] The intuition is similar to that above: when the labor share of agricultural output is higher than that of total output associated with the imported good (i.e., inclusive of manufacturing and distribution) then, all else equal, the "labor-intensive" agricultural export sector contracts proportionately more than the importable sector.

3 Cooperation in the infinitely repeated rent-seeking game

We now investigate the equivalence of tariffs and quotas using an infinitely repeated rent-seeking game; hereafter, we use "rent-seeking" generically to cover both rent-seeking under the quota and revenue-seeking under the tariff.

The game proceeds as follows:

- Period 0: government chooses policy instrument (tariff or quota), level of instrument, and informs firms of tariff revenue or quota allocation rules.
- Stage 1 of periods $1, 2, \ldots$: each specific factor owner in sector $j = A, F$ chooses labor hired for rent-seeking $L_R \geq 0$, distribution $L_D \geq 0$, and production $L_j \geq 0$.
- Stage 2 of periods $1, 2, \ldots$: quotas are allocated, goods are produced, imported, distributed, and consumed, and any tariff revenue is disbursed.

Throughout Section 3, we take the policy instrument (i.e., tariff or quota) and its level chosen by the government in period 0 as exogenous (we investigate the government's policy choice in Section 4). Given the associated equilibrium of the economy in stage 2 of each period, we solve for the subgame perfect equilibrium of the infinitely repeated game that begins in period 1. Our interest

[24] The assumption $\phi_{A,A}\eta_A > \phi_{F,F}\eta_F$ made above implies $\phi_{A,A}\eta_A > \phi_{F,FD}\eta_F$ because $\phi_{F,F} > \phi_{F,FD}$.

lies in analyzing how the sustainability of cooperation, where cooperation means zero aggregate rent-seeking ($R = 0$), depends on the government's choice of policy instrument in period 0. Given our interest in whether tariffs and quotas are equivalent, we assume the tariff and quota chosen by the government in period 0 generate identical import levels in the absence of rent-seeking.

3.1 Constraints on cooperation under tariffs versus quotas

Given policy regime r, i.e., a tariff or quota regime, let $v_j^{r,\theta}$ denote the payoff for a representative firm in sector j when the outcome of the stage game is $\theta \in \{d, c, N\}$, where d, c, and N denote respectively that the representative firm deviates from the cooperative outcome, all firms cooperate, or all firms choose the Nash equilibrium level of rent-seeking. We use similar notation hereafter but omit irrelevant superscripts where possible without confusion. Letting δ denote the (common) discount factor for firms, cooperation can be sustained under policy regime r via grim trigger strategies when $\delta \geq \max\left\{\bar{\delta}_F^r, \bar{\delta}_A^r\right\} \equiv \bar{\delta}^r$, where

$$\bar{\delta}_j^r \equiv \frac{v_j^{r,d} - v_j^{r,c}}{\left(v_j^{r,d} - v_j^{r,c}\right) + \left(v_j^{r,c} - v_j^{r,N}\right)}. \tag{18}$$

That is, eliminating rent-seeking through cooperation is possible when δ exceeds each firm's threshold value $\bar{\delta}_j^r$. The constraint on cooperation, $\bar{\delta}_j^r$, is slacker (tighter) when the punishment threat for cheating, $v_j^{r,c} - v_j^{r,N}$, is larger (smaller) relative to the one-shot deviation incentive, $v_j^{r,d} - v_j^{r,c}$.

Ultimately, we are interested in ranking the critical discount factors necessary to sustain cooperation under the different policy regimes. Since the binding constraint for each sector is $\max\left\{\bar{\delta}_j^q, \bar{\delta}_j^t\right\}$, we compare the sector-specific constraints across policy regimes by analyzing how the one-shot deviation incentive (Section 3.2) and the punishment threat (Section 3.3) for each sector vary between the tariff and quota regimes.

3.2 One-shot deviation incentive

As noted above, the one-shot deviation incentive under policy regime r for a representative firm in sector j is $v_j^{r,d} - v_j^{r,c}$. To compare the one-shot deviation incentive across tariffs and quotas, we first establish the equivalence of tariffs and quotas under cooperation. This is useful because it means that the difference in one-shot deviation incentives across policy regimes only depends on differences in deviation payoffs across policy regimes.

3.2.1 Cooperation payoff

The equivalence of tariff and quota outcomes under cooperation follows easily given that the quota is the tariff-equivalent quota. That is, under cooperation, the level of imports is identical under the quota and tariff.

The difference between the cooperative payoffs across the two policies for a representative firm in sector j is

$$\begin{aligned} v_j^t - v_j^q &= \left[p_j^t Q_j^t + p_D^t Q_D^t - w^t \left(L_j^t + L_D^t\right) + \frac{t\bar{M}}{n}\right] \\ &\quad - \left[p_j^q Q_j^q + p_D^q Q_D^q - w^q \left(L_j^q + L_D^q\right)\right]. \end{aligned} \tag{19}$$

Absent rent-seeking, firm-level demand for distribution and production labor is identical across policies because imports are identical across policies. In turn, wages, final-good prices, labor allocations, and production are also identical across policies. Recalling that $\rho_D^{q,c} + \tau_D^{q,c} = p_D^{q,c} = p_D^{t,c} + t$ and $p_D^{t,c} = \frac{w}{d_L(L_D)} \equiv \rho_D^{q,c}$, we have $t = \tau_D^{q,c}$ and hence

$$v_j^{t,c} - v_j^{q,c} = \frac{t\bar{M}}{n} - \tau_D^{q,c}\frac{\bar{M}}{n} = 0. \tag{20}$$

Thus, firm-level cooperative payoffs do not depend on the policy regime, and differences in one-shot deviation incentives are driven entirely by differences in the deviation payoff across policy regimes.

3.2.2 Deviation payoff

The deviation payoff for a representative firm in sector j under the tariff regime relative to the quota regime is

$$\begin{aligned} v_j^t - v_j^q &= \underbrace{\left[p_j^t Q_j^t + p_D^t Q_D^t - w^t \left(L_j^t + L_D^t\right)\right]}_{\Pi_j^t + \Pi_D^t} + \underbrace{t\bar{M}}_{\pi_D^t} \\ &\quad - \underbrace{\left[p_j^q Q_j^q + p_D^q Q_D^q - w^q \left(L_j^q + L_D^q\right)\right]}_{\Pi_j^q + \Pi_D^q + \pi_D^q}. \end{aligned} \tag{21}$$

We will show that the deviation payoff is higher under the tariff regime, $v_j^t - v_j^q > 0$, because, unlike additional tariff revenue, additional import licenses under the quota entail the costly use of resources to distribute the additional imports.

Under the tariff regime, cooperating firms refrain from rent-seeking and tariff revenues are split evenly among firms. Given that other firms abstain from rent-seeking, a deviating firm captures the entire tariff revenue by hiring an arbitrarily small amount of rent-seeking labor. As the amount of rent-seeking labor is arbitrarily small, all other outcomes are (essentially) identical under deviation and cooperation with tariffs. That is, under the tariff regime, sector output levels as well as prices and wages are identical whether all firms cooperate or a single firm deviates.

A firm deviating from cooperation under the quota regime similarly gains all import licenses by hiring an arbitrarily small amount of rent-seeking labor. However, unlike under the tariff regime, the deviating firm must also hire additional labor to distribute the additional licenses. Moreover, because the deviating firm has a fixed amount of firm-specific distribution capital and the distribution production function exhibits diminishing marginal productivity of labor, the total amount of labor used for distribution increases when one firm deviates and distributes the entire quota: $L_D^{q,d} > n \times L_D^{q,c}$. Moreover, the increase in aggregate labor used in the distribution sector triggers general equilibrium effects that exacerbate the additional labor cost. Thus, deviation under the quota has two effects on the deviating firm's payoff: the direct impact of hiring extra labor for distribution, and the indirect impact via general equilibrium effects.

To show this formally using equation (21), we first abstract from the general equilibrium effects of deviation under the quota (i.e., we set $p_F^{q,d} = p_F^{q,c}$ and $w^{q,d} = w^{q,c}$). As explained below, incorporating general equilibrium effects merely implies that expression (22) is a lower bound. Given $p_F^{q,d} = p_F^{q,c}$ and $w^{q,d} = w^{q,c}$, the difference in deviation profits across regimes in (21) due to agriculture and manufacturing profits is $\Pi_j^{t,d} - \Pi_j^{q,d} = 0$. Hence, the right hand side of (21) reduces to the difference between total distribution rents under the two regimes $\left(\Pi_D^{t,d} + \pi_D^{t,d}\right) - \left(\Pi_D^{q,d} + \pi_D^{q,d}\right)$. This difference is (see Appendix for step-by-step derivation)

$$\left(\Pi_D^{t,d} + \pi_D^{t,d}\right) - \left(\Pi_D^{q,d} + \pi_D^{q,d}\right) = \int_{\frac{\bar{M}}{n}}^{\bar{M}} \frac{w^{q,c}}{d_L\left(L_D\left(Q_D\right)\right)} dQ_D - \rho_D^{q,c}\left[\bar{M} - \frac{\bar{M}}{n}\right] > 0. \tag{22}$$

Figure 2 illustrates (22), showing normal rents, Π, excess rents, π, and the wage bill, W, in the distribution sector under the tariff and quota regimes for the deviating firm. Mathematically, the right hand side of (22) corresponds to area W_3 in Figure 2(b).[25] This can be understood geometrically. Recalling the discussion of Figure 1 in Section 2.1, Figure 2(a) shows that a deviating firm under the tariff produces distribution output $\frac{\bar{M}}{n}$, yielding normal distribution profits Π_1. Additionally, the firm receives the entire tariff revenue $t\bar{M}$, areas $\pi_1+\pi_2$. Figure 2(b) shows that a deviating firm under the quota produces distribution output $\bar{M}$, yielding normal profits $\Pi_1+\Pi_2$ and excess rents π_1. Thus, the additional distribution rents earned by a deviating firm under the tariff relative to the quota are given by area π_2 in Figure 2(a) which is equal to area W_3 in Figure 2(b).

Area W_3 has a simple economic intuition: it is a manifestation of costly distribution. When expanding distribution output from $\frac{\bar{M}}{n}$ to $\bar{M}$ by deviating under the quota, additional labor is required to distribute the imports associated with the additional quota licenses. In contrast, deviating under the tariff does not require additional labor for consuming the additional tariff revenue. W_3 represents the additional labor cost required to distribute the additional licenses relative to the labor cost incurred if either (i) the firm could expand output at a constant marginal product of labor or, equivalently, (ii) aggregate distribution output $\bar{M}$ was shared equally by all n firms. In other words, area W_3 would vanish if the marginal product of labor were constant and the $\frac{w^{q,c}}{d_L(L_D)}$ curve were horizontal. Thus, it is not costly distribution *per se* that creates W_3 but rather the rising marginal cost of distribution stemming from diminishing marginal product of labor.

[Figure 2 about here.]

General equilibrium effects on $w^{q,d}$ and $p_D^{q,d}$ reinforce the result that deviating from cooperation under the quota erodes distribution rents. First, the effect on $p_D^{q,d}$ depends on the economy's output allocation response across A and F once distribution absorbs more of the economy's labor supply. If *relative* output $\frac{F+D}{A}$ increases, the relative supply curve (i.e., total supply of the manufactured good relative to the agricultural good) shifts and reduces $p_D^{q,d}$. This happens under our assumption that $\phi_{A,A}\eta_A > \phi_{F,F}\eta_F$ (see Section 2.4). Since labor's share of output is higher in A than F then, as long as the elasticity of labor demand is not too biased towards F, the "labor-intensive" A sector contracts proportionately more than the F sector when more labor is allocated to the D sector.[26]

[25]Specifically, the integral term in (22) is equal to areas W_2+W_3 while the second term on the right hand side of (22) is area W_2.

[26]More generally, the sufficient condition is $\phi_{X,X}\eta_X > \phi_{M,M}\eta_M$, where M denotes the importable good and X denotes the exportable.

Second, $w^{q,d}$ must rise to facilitate the associated labor reallocation from the A to the F sector.[27]

Figure 2(b) shows geometrically that the general equilibrium effects $p_D^{q,d} < p_D^{q,c}$ and $w^{q,d} > w^{q,c}$ further decrease the benefit of deviation under quotas. A lower p_D^q reduces excess distribution rents π_1, and a higher w^q reduces both excess distribution rents π_1 and normal distribution rents $\Pi_1 + \Pi_2$. Thus, general equilibrium effects exacerbate the costly distribution effect.[28]

Of course, the result that the deviation payoff is greater under the tariff rests on the sufficient condition that $\phi_{A,A}\eta_A > \phi_{F,F}\eta_F$ which ensures that the price of distribution services falls upon deviation under the quota regime. The necessary condition is naturally weaker and requires only that any increase in the distribution price cannot offset the higher wage bill stemming from the costly distribution effect. Lemma 1 summarizes the comparison of one-shot deviation incentives.

Lemma 1. *If the marginal product of labor is diminishing and $\phi_{A,A}\eta_A > \phi_{F,F}\eta_F$, then the one-shot deviation incentive, $v_j^{r,d} - v_j^{r,c}$, is greater under the tariff regime than the quota regime.*

Ultimately, deviation is less attractive under the quota because enjoying the fruits of deviation under the quota regime, i.e., quota licenses, entails costly distribution whereas enjoying the fruits of deviation under the tariff regime, i.e., tariff revenue, does not.

3.3 Punishment threat

Having addressed one-shot deviation incentives, we now provide a sufficient condition ensuring that the rent-seeking payoff is greater, and thus the punishment threat weaker, under tariffs than quotas. The difference in rent-seeking payoffs for a firm in sector j is

$$\begin{aligned} v_j^t - v_j^q &= \underbrace{\left[p_j^t Q_j^t + p_D^t Q_D^t - w^t\left(L_j^t + L_D^t\right)\right]}_{\Pi_j^t + \Pi_D^t} + \underbrace{tM}_{\pi_D^t} - w^t L_R^t \\ &\quad - \underbrace{\left[p_j^q Q_j^q + p_D^q Q_D^q - w^q\left(L_j^q + L_D^q\right)\right]}_{\Pi_j^q + \Pi_D^q + \pi_D^q} - w^q L_R^q . \end{aligned} \tag{23}$$

[27] A fall in the wage results in a contradiction. A falling wage implies that L_A rises. With the increased labor in distribution (since the entire binding quota is now supplied by a single firm subject to diminishing marginal returns), L_F must fall. But, given the binding quota, this implies a decrease in the consumption ratio $\frac{C_F}{C_A}$, which can only happen if p_D^q rises. The rising p_D^q contradicts the initial starting point that p_D^q falls. Thus, $\phi_{A,A}\eta_A > \phi_{F,F}\eta_{LF}$ is not only a sufficient condition for the distribution price to fall upon deviation but also for the wage to rise upon deviation.

[28] Moreover, the envelope theorem implies that (i) the higher wage reduces normal agricultural rents and (ii) the higher wage and lower p_F reduce normal manufacturing rents.

Equation (23) comprises four elements: normal rents from producing good j, normal distribution rents, excess distribution rents, and rent-seeking expenditures.

While rent-seeking outcomes and therefore punishment threats generally differ across regimes, we focus on the case where the punishment threat is positive under either regime: $v_j^{r,c} > v_j^{r,N}$.[29] By reducing the labor supply available for productive purposes, our assumptions on the technological parameters η_j and $\phi_{j,k}$ imply that rent-seeking should reduce the price of the manufactured output, $p_F^N < p_F^c$, and therefore distribution services, $p_D^N < p_D^c$. Furthermore, part of the rent-seeking labor comes from the agricultural sector which raises wages: $w^N > w^c$.[30] The higher wage and lower prices have three implications. First, normal rents fall in all sectors. Second, excess distribution rents fall under the quota (see (5)). Third, distribution services fall under the tariff (see equation (4)), which lowers imports and hence tariff revenue.[31] These three implications on top of the rent-seeking expenditures themselves imply that the rent-seeking payoff under either policy is lower than the cooperative payoff. That is, the punishment threat $v_j^c - v_j^N$ is positive.

It is more difficult to make general statements about the relation between the rent-seeking payoffs under the tariff and quota regimes. Given the generality of our trade model, this stems from the inherent difficulty in comparing the level of rent-seeking under the two regimes. Thus, we provide a sufficient condition ensuring that the punishment threat is weaker under tariffs than quotas and, by way of example, use broad economic intuition to argue that the sufficient condition is reasonable.

As a starting point, we address the specific case when the rent-seeking level of imports under tariffs equals that under the quota.[32]

Lemma 2. *If $M^{t,N} = \bar{M}$, then the rent-seeking payoffs under the tariff policy equal those under the quota policy, i.e., $v_j^{t,N} = v_j^{q,N}$.*

As argued above, rent-seeking causes imports under the tariff to fall below $\bar{M}$. That is, $M^{t,N} < \bar{M}$ in equilibrium. Nevertheless, as long as payoffs are continuous in $M^{t,N}$, Lemma 2 implies that

[29] Given that our technological assumptions only imply $(\frac{F+D}{A})^N > (\frac{F+D}{A})^c$, it is possible under tariffs that $\left(\frac{C_F}{C_A}\right)^N = (\frac{F+D}{A-X})^N < \left(\frac{C_F}{C_A}\right)^c = (\frac{F+D}{A-X})^c$ and, via homothetic preferences, $p_F^N > p_F^c$. However, this cannot happen under quotas because $D = \bar{M} = X$. Thus, a negative punishment threat can arise under tariffs but not quotas. Neverthless, in this case, we immediately have that the punishment threat is weaker under tariffs than quotas as desired.

[30] See Appendix for a proof.

[31] Note that $w^{t,N} > w^{t,c}$ and $p_D^{t,N} < p_D^{t,c}$ together with (4) imply $L_D^{t,N} < L_D^{t,c}$ and hence $M^{t,N} < \bar{M}$. In contrast, imports under the quota with rent-seeking remain $\bar{M}$.

[32] See Appendix for proof.

rent-seeking payoffs, and hence punishment threats, are similar under the tariff and quota regimes when $M^{t,N}$ is not too far below $\bar{M}$.

Lemma 3 formalizes this idea in the form a sufficient condition.

Lemma 3. *There exists a non-empty interval $[\underline{M}, \bar{M}]$ such that $M^{t,N} \in [\underline{M}, \bar{M}]$ implies $v_j^{t,N} \geq v_j^{q,N}$.*

That is, the punishment threat is weaker under tariffs than quotas when the Nash level of imports under the tariff lie in a well specified interval around $\bar{M}$, with non-emptiness of the interval following directly from Lemma 2.[33]

Not only is the interval $[\underline{M}, \bar{M}]$ non-empty, but it reasonably consists of more than the singleton point $\bar{M}$. The broad economic intuition has three parts, each revolving around $M^{t,N} < \bar{M}$. First, when rent-seeking shrinks the size of the productive economy, the bigger distribution sector under the quota means that, all else equal, more labor is withdrawn from the agricultural sector, which keeps the wage higher under the quota. Second, the quantitative nature of the quota should keep relative output of the manufacturing sector, $\frac{F+D}{A}$, higher under the quota and thus, through homothetic preferences, push the importable price lower under the quota.[34] However, $\bar{M} > M^{t,N}$ also implies that excess rents are collected on a larger quantity under the quota. This tension between the price and wage effects on the one hand and the quantity effect on the other aligns with the idea behind Lemma 3: when $M^{t,N}$ is close enough to $\bar{M}$, any extra rents earned on a greater quantity of distribution services under the quota cannot outweigh the higher wage and lower importable price under the quota.

To illustrate this intuition geometrically, suppose the levels of rent-seeking labor are identical under tariffs and quotas. We can now directly compare the four elements of rent-seeking payoffs: rent-seeking expenditures, normal production rents, normal distribution rents, and excess distribution rents. Identical levels of rent-seeking labor and the higher quota wage imply that rent-seeking *expenditures* are higher under the quota. The higher wage and lower importable price under quotas also imply that agricultural and manufacturing normal rents are lower under quotas. This leaves a comparison of total distribution rents under each policy: $\left(\Pi_D^{t,N} + \pi_D^{t,N}\right) - \left(\Pi_D^{q,N} + \pi_D^{q,N}\right)$.

Figure 3 illustrates the comparison and the tension between the lower price and higher wage under the quota, on the one hand, and the higher quantity of distribution output on the other.

[33] Lemma 2 says that $M^{t,N} = \bar{M}$ implies $v_j^{t,N} = v_j^{q,N}$.

[34] Again, the possibility of rent-seeking raising p_F under tariffs only strengthens this effect.

Areas B represent efficiency savings under the tariff resulting from a lower wage. Area E represents the additional excess distribution rents enjoyed under the tariff due to the higher price. Areas C are the rents earned on additional units under the quota because $\bar{M} > M^{t,N}$.[35] Figure 3 makes clear that the rent-seeking payoff is higher under the tariff than the quota whenever areas B and E outweigh areas C. This happens as long as imports under the tariff do not fall too far below $\bar{M}$ (i.e., areas C are relatively small). That is, there is some interval $\left[\underline{M}, \bar{M}\right]$ where rent-seeking distribution rents, and hence the rent-seeking payoff, are higher under tariffs than quotas as long as $M^{t,N}$ lies in this interval.

[Figure 3 about here.]

It is important to emphasize that the condition $M^{t,N} \in \left[\underline{M}, \bar{M}\right]$ in Lemma 3 is a *sufficient* condition for rent-seeking to be no less attractive under the tariff relative to the quota. Thus, even if the rent-seeking equilibrium level of imports $M^{t,N}$ lies outside the interval (perhaps because the interval collapses to the singleton point $\bar{M}$), the rent-seeking payoff may still be higher under tariffs than quotas and, hence, the punishment threat may still be weaker under tariffs. Moreover, even if the punishment threat is stronger under tariffs, our main result (Proposition 1 in the following section) still holds as long as the difference in punishment threats across policy regimes is sufficiently small. Nevertheless, the analysis above reasonably argues that the interval $\left[\underline{M}, \bar{M}\right]$ is non-singleton and thus the punishment threat can easily be weaker under tariffs than quotas.

3.4 Non-equivalence

We now formally state our main result. This is based on Lemmas 1 and 3 which, respectively, establish conditions where the one-shot deviation incentive is stronger and the punishment threat weaker under tariffs than quotas.

Proposition 1. *If the following three conditions hold (see Lemmas 1 and 3), then cooperation is easier to sustain under the quota regime than the tariff regime, i.e.,* $\bar{\delta}^q < \bar{\delta}^t$*: (i) technology in the distribution sector is subject to diminishing marginal product of labor, (ii)* $\phi_{A,A}\eta_A > \phi_{F,F}\eta_F$*, and (iii)* $M^{t,N} \in [\underline{M}, \bar{M}]$.

[35] Areas A represent rents under either policy regime.

By construction, the quota is a tariff-equivalent quota absent any rent-seeking. Thus, *conditional* on cooperation, aggregate and individual outcomes are identical across policies and, in this sense, the policies are equivalent. However, non-equivalence emerges because, while equilibrium outcomes are equivalent conditional on cooperation, the conditions under which cooperation is sustainable differ. Specifically, when the sufficient conditions in Proposition 1 hold and $\delta \in \left(\bar{\delta}^q, \bar{\delta}^t\right)$, cooperation is sustained only under the quota.[36] Even though outcomes under each policy would be equivalent if cooperation were sustained, outcomes actually differ because cooperation is sustainable only under the quota regime.

4 Government's choice of policy regime

In Section 3, we investigated the equivalence of tariffs and quotas in an environment where firms could cooperate to eliminate wasteful rent-seeking. To highlight the possibility of cooperation under tariffs versus quotas, it was important that the two policies were equivalent in the absence of rent-seeking. Thus, we treated the tariff and quota levels chosen by the government in period 0 as exogenous but, more importantly, we fixed the tariff level equal to the quota-equivalent tariff corresponding to the exogenous quota level. We now investigate the government's policy choice in period 0 regarding both the policy instrument itself and its level.

We first adopt the Grossman and Helpman (1994, hereafter GH) menu-auction framework and then describe how our results generalize beyond this context. In period 0, the government chooses the policy instrument, a tariff or quota, and its level. To this end, μ denotes the policy so that $\mu \equiv \bar{M} \in \left[0, M^{FT}\right]$ under the quota and $\mu \equiv t \in [0, t^{pro}]$ under the tariff where t^{pro} is the prohibitive tariff that results in zero imports. Firms can influence the government's policy choice via lobbying. Lobbying takes the form of a "contribution schedule." A sector's contributions to the government depend on the policy μ implemented by the government, with $R_j(\mu)$ denoting contributions by sector $j = A, F$.[37,38] Notice that, unlike earlier sections where *rent-seeking* uses real resources (i.e.,

[36] Our definition of cooperation, i.e., $R = 0$, implies *full* cooperation. There could be many other subgame perfect Nash equilibria where firms sustain partial cooperation with positive levels of rent-seeking that fall below the Nash level. Nevertheless, the insight in Proposition 1 still holds when, for a given discount factor, full cooperation is sustainable under the quota but only partial cooperation is sustainable under the tariff.

[37] One interpretation is that these contributions provide funds for short-term electoral contests.

[38] GH assume contributions are undertaken at the sector level, which essentially assumes away any coordination problem among firms within a sector. Our subsequent analysis does not rely on sector level contributions. We could alternatively model firm level contributions and, in what follows, replace $R_j(\mu)$ and $v_j(\mu)$ for $j = A, F$ with firm-level

labor) to influence rent allocation, *lobbying* (via contributions) is merely a transfer between firms and the government.[39] The policy chosen by the government in period 0 takes effect in period 1 and induces a stationary subgame perfect equilibrium as described in previous sections.

Following GH, we assume that some sectors are organized and give contributions.[40] Specifically, an organized sector j contributes according to $R_j(\mu) = V_j(\mu) - B_j$, where B_j is a sector-specific constant that GH refer to as the payoff anchor and $V_j(\mu)$ is the payoff in sector j given the policy μ. In our model, $V_j(\mu) = n_j \frac{\delta}{1-\delta} v_j^c(\mu)$ if $\delta \geq \bar{\delta}(\mu)$ but $V_j(\mu) = n_j \frac{\delta}{1-\delta} v_j^N(\mu)$ if $\delta < \bar{\delta}(\mu)$.[41]

Also following GH, we assume the government's payoff is $G(\mu) = \sum_{j \in O} R_j(\mu) + aW(\mu)$ where O is the set of organized sectors, $W(\mu)$ is national welfare resulting from the policy (i.e., the sum of individual consumer utilities) and $a \geq 0$ is the weight placed by the government on national welfare relative to contributions. In our model, $W(\mu) = \sum_{s=1}^{\infty} \mathit{\Gamma}_s \omega_s(\mu)$ where $\omega_s(\mu)$ is the one period national welfare from policy μ and $\mathit{\Gamma}_s$ represents how much the government discounts period s national welfare. This formulation allows us to depart from the standard treatment where $\Gamma_s \equiv \beta^s$ with β denoting the government's time-invariant one period discount factor. For example, $\mathit{\Gamma}_s \neq \beta^s$ may reflect that term limits restrict government concern over distant outcomes.[42]

GH show that a policy maximizing the government's payoff $G(\mu)$ is given by

$$\mu^* = \arg\max \sum_{j \in O} V_j(\mu) + aW(\mu). \tag{24}$$

In our model, the government chooses both the trade policy instrument and its level. A policy μ^*

variables $R_i(\mu)$ and $v_i(\mu)$ for $i = 1, ..., n$.

[39] This distinction may arise, for example, from a system where elected officials choose trade policy but career bureaucrats make tariff revenue and import license allocations. The presence of political contributions allows us to model policy choice using the popular GH framework. However, as described below, the result does not depend on this distinction.

[40] The organized sectors could be both A and F or just one of these sectors.

[41] We treat the actions of firms in subsequent periods $s \geq 1$, and hence their payoffs in such periods, as given by the subgame perfect equilibrium of the game analyzed in the previous section. More formally, period 0 firm strategies are merely represented by the sector contribution schedules $R_j(\mu)$.

[42] Specifically, perhaps $\mathit{\Gamma}_s = 1$ for $s = 1, 2, 3, 4$ but $\mathit{\Gamma}_s = 0$ for $s \geq 5$.

is then obtained from:

$$\begin{array}{cc} \max\limits_{\mu \in \{t^*, M^*\}} & \sum_{j \in O} V_j(\mu) + aW(\mu) \\ \text{s.t.} & \begin{array}{c} t^* = \underset{t \in [0, t^{pro}]}{\arg\max} \sum_{j \in O} V_j(t) + aW(t) \\ M^* = \underset{\bar{M} \in [0, M^{FT}]}{\arg\max} \sum_{j \in O} V_j(\bar{M}) + aW(\bar{M}) \,. \end{array} \end{array} \quad (25)$$

In understanding our main result on the government's policy choice, it is useful to define $\hat{t}$ and $\hat{M}$ as, respectively, the tariff and quota solutions to the constraints in (25) when rent-seeking is *exogenously* imposed as zero in periods $s \geq 1$. In turn, let $\hat{\mu} \in \left\{\hat{t}, \hat{M}\right\}$ be the policy that maximizes the government's payoff in this situation. Importantly, note that $\mu^* \neq \hat{\mu}$ is possible even if the policy μ^* sustains cooperation. That is, the policy that maximizes the government's payoff when no rent-seeking is exogenously imposed, i.e., $\hat{\mu}$, may induce rent-seeking when firms endogenously engage in rent-seeking. The government may thus find it attractive to implement some policy $\mu^* \neq \hat{\mu}$ where firms endogenously refrain from rent-seeking under μ^*. For example, a policy $\hat{\mu} \in \left\{\hat{t}, \hat{M}\right\}$ may create high enough rents that firms cannot resist deviating from cooperation, but moving the policy away from $\hat{\mu}$ may allow cooperation by mediating rents and, thus, deviation incentives.

Before presenting our result on the government's policy choice, we make the following assumption, where $\underline{\delta} = \min\left\{\bar{\delta}(\mu) \,|\, \mu \in \left[0, M^{FT}\right] \text{ or } \mu \in [0, t^{pro}]\right\}$ is defined as the minimum value of δ that could sustain cooperation under some policy.

Assumption 1. *(i) $\bar{\delta}(\mu)$ is continuous in μ for each policy regime.*

(ii) $G(\mu)$ is strictly concave in μ for each policy regime when, exogenously, $R_s = 0$ for all periods $s \geq 1$.

(iii) If $\mu^* = \bar{M}$ and $\delta > \bar{\delta}(\bar{M})$ then $G(\bar{M}) > G(\mu)$ for all μ such that $\delta \in (\underline{\delta}, \bar{\delta}(\mu))$.

Part (i) of Assumption 1 simply depends on the continuity of individual payoff functions underlying $\bar{\delta}(\mu)$ (see (18)). Part (ii) does two things.[43] First, it ensures that $\hat{t}$ and $\hat{M}$, described above, are unique. Second, and more importantly, it allows comparison of government payoffs across different policies in the absence of rent-seeking because the government prefers smaller deviations from $\hat{t}$ and $\hat{M}$. Finally, part (iii) allows us to make a particular comparison of government payoffs across

[43] Using a similar GH-type setup to that in the current section, Maggi and Rodrıguez-Clare (2000) also assume strict concavity of the government payoff function.

situations where cooperation is and is not sustained. Specifically, if the policy that solves (25) is a quota that sustains cooperation, then the government cannot obtain a higher payoff via a policy that does not sustain cooperation. Part (iii) is thus a fairly weak uniqueness requirement.

We now present our main result on government policy, recalling that μ^* is a policy that maximizes the government's payoff.

Proposition 2. *Suppose the conditions in Proposition 1 hold. Then, a quota maximizes the government's payoff whenever cooperation is possible under μ^*. While $\hat{t}$ and $\hat{M}$ both maximize the government's payoff when $\delta \geq \bar{\delta}\left(\hat{t}\right)$, a quota uniquely maximizes the government's payoff when (i) $\delta \in \left[\bar{\delta}\left(\hat{M}\right), \bar{\delta}\left(\hat{t}\right)\right)$, in which case $\mu^* = \hat{M}$, or (ii) $\delta < \bar{\delta}\left(\hat{M}\right)$ and cooperation prevails under μ^*, in which case $\mu^* = \bar{M}$ for some $\bar{M} \neq \hat{M}$.*

Proposition 2 essentially follows from the results that (i) tariffs and quotas are equivalent under cooperation and (ii) cooperation is easier to sustain under quotas than tariffs. First, suppose μ^* sustains cooperation *and* firms actually sustain cooperation when allowed to rent-seek under the policies $\hat{t}$ and $\hat{M}$. Then, $\hat{t}$ and $\hat{M}$ must both maximize the government's payoff: not only do firms endogenously refrain from rent-seeking under these policies but, by definition, they maximize the government's payoff in the absence of rent-seeking. Given that cooperation is easier to sustain under quotas than tariffs, this case corresponds to $\delta \geq \bar{\delta}\left(\hat{t}\right)$. Second, once $\delta \in \left[\bar{\delta}\left(\hat{M}\right), \bar{\delta}\left(\hat{t}\right)\right)$, the quota $\hat{M}$ still sustains cooperation but the tariff $\hat{t}$ no longer does. Thus, the quota $\hat{M}$ is now the unique policy that maximizes the government's payoff.

Finally, $\delta < \bar{\delta}\left(\hat{M}\right)$ implies that firms cannot sustain cooperation under either $\hat{t}$ or $\hat{M}$. Thus, such policies cannot maximize the government's payoff if firms endogenously refrain from rent-seeking under μ^*. Indeed, moving the policy away from $\hat{t}$ or $\hat{M}$ may generate cooperation (perhaps by lowering rents and reducing deviation incentives). Moreover, a quota $\bar{M} \neq \hat{M}$ is the unique policy that maximizes the government's payoff if μ^* generates cooperation because (i) sustaining cooperation is easier under quotas than tariffs and (ii) Assumption 1 implies the government can get closer to $\hat{M}$ with a quota that sustains cooperation than it can get to $\hat{t}$ with a tariff that sustains cooperation.

We use the GH framework to fix ideas given its widespread usage when modeling endogenous policy choice. However, Proposition 1 generalizes beyond this framework. Given the equivalence of tariffs and quotas under cooperation and the result that sustaining cooperation is easier under quotas than tariffs, Proposition 2 only depends on Assumption 1 and not the particular nature of lobbying interaction between firms and the government in period 0. Moreover, the crucial part of Assumption 2 is part (ii): part (iii) is a fairly weak uniqueness requirement and part (i) is independent of period 0 interaction between firms and the government. Thus, regardless of the exact nature of lobbying in period 0, Proposition 1 holds if lobbying preserves strict concavity of the government's payoff in the (exogenous) absence of rent-seeking during subsequent periods, a standard assumption in prior literature (e.g., Maggi and Rodrıguez-Clare 2000).[44]

Thus, the distinction made above between lobbying (as a transfer of resources) and rent-seeking (as a use of labor) is useful for adopting the familiar GH framework but not necessary for our result. Even if the period 0 interaction takes the form of rent-seeking, Proposition 1 continues to hold if the government's payoff function (in the exogenous absence of rent-seeking) is strictly concave with respect to trade policy. For example, instead of a direct transfer of resources, firms may hire labor in period 0 to provide the government with electoral services similar to those provided by Political Action Committees (PACs) in the United States. Such services include the coordination and pooling of donor funds by traditional PACs and the "independent expenditures" made by Super PACs that have become especially important following the 2010 ruling in Speechnow.org v. Federal Election Commission.[45] These electoral services are valuable to the government but are rewarded with restrictive trade policies that generate welfare losses. This creates a trade-off whereby the government's payoff can be concave with respect to trade policy so that Assumption 1 still holds.

[44]This concavity arises because the government faces a trade-off between the benefits (e.g., contributions) and the welfare costs of lobbying created by non-free trade policies. The government's payoff is concave because small deviations from free trade impose negligible welfare costs but these costs become overwhelming with large deviations from free trade.

[45]The Center for Responsive Politics describes independent expenditures as expenditures used to "buy ads, send mail or otherwise advocate for the election or defeat of specific candidates" (`https://www.opensecrets.org/resources/learn/glossary.php`). The Speechnow.org v. Federal Election Commission ruling allows organizations that only engage in independent expenditures to essentially raise unlimited funds for such purposes.

5 Extensions

5.1 Distinct owner of distribution capital

So far, we have assumed a uniform allocation of distribution sector capital across specific factor owners in the agricultural and manufacturing sectors. We now consider the case where distribution sector capital is owned by a third group. The case where distribution capital is owned by a subset of A and F specific factor owners is analogous.

While tariff revenues remain subject to rent-seeking by all specific factor owners, quota allocations are subject only to rent-seeking by specific factor owners of the distribution sector. Thus, the relevant $\bar{\delta}_j^r$ determining sustainability of cooperation under tariffs is $\max\{\bar{\delta}_D^t, \bar{\delta}_F^t, \bar{\delta}_A^t\}$ but under quotas it is $\bar{\delta}_D^q$. Nevertheless, the cooperation constraint is tighter under tariffs than quotas if $\bar{\delta}_D^q < \bar{\delta}_D^t$.

When a distinct group owns the distribution capital, the size of the group engaging in rent-seeking is higher under the tariff than the quota. A "group size effect" is the key implication in this case. The group size effect influences both the deviation incentive and the punishment threat. Underlying Proposition 1 is the idea that an increasing marginal cost of distribution makes deviation less attractive under the quota relative to the tariff regime. The "group size effect" reinforces this result: since quota rents are now shared among a smaller group under cooperation, there is a smaller gain from deviating and gaining all import licenses. This further strengthens the result of Proposition 1.

However, the effect of group size on the punishment threat must also be considered. A smaller group engaging in quota rent-seeking increases *firm-level* rent-seeking labor but lowers *aggregate* rent-seeking labor (see (9)). All else equal, the former lowers a firm's rent-seeking payoff by increasing rent-seeking expenditures. But the latter mitigates the upward pressure on w and the downward pressure on p_D caused by rent-seeking through general equilibrium effects, increasing a firm's excess rent (see (5)) and reducing rent-seeking expenditures. Thus, when general equilibrium wage and price effects are minimal, the group size effect strengthens Proposition 1. However, it is possible that Proposition 1 would be overturned if the general equilibrium effects are strong enough to weaken the punishment threat so far that it outweighs the smaller gain from deviation under quotas.

5.2 Non-discretionary tariff revenue

While quota rents accrue directly to distribution firms through market mechanisms, the government allocates tariff revenue across various uses. Moreover, some portion of this revenue will likely be non-discretionary, which reduces the amount of tariff revenue whose allocation can be influenced by rent-seeking.[46] Earlier sections abstracted from this consideration because, by construction, this destroys the equivalence of tariffs and quotas even under cooperation.

Naturally, a non-discretionary tariff revenue component reduces the incentive to deviate from cooperation under tariffs because the tariff revenue captured by rent-seeking falls. Thus, all else equal, the ability to sustain cooperation rises under tariffs. Indeed, despite costly import distribution, the deviation incentive could now be weaker under the tariff regime rather than the quota regime if the share of non-discretionary government revenue is sufficiently large.

However, non-discretionary tariff revenue also weakens the punishment threat, which in turn reduces the ability to sustain cooperation under tariffs. First, non-discretionary tariff revenue reduces firm-level tariff revenue receipts and directly weakens the punishment threat.[47] General equilibrium consequences reinforce this effect. Less labor is hired for rent-seeking because the reward for rent-seeking is lower. This in turn reduces upward wage pressure and increases agriculture and manufactured output. Thus, when some tariff revenue is non-discretionary, the net impact on the relative ability to sustain cooperation under tariffs and quotas depends on whether the weaker deviation incentive is outweighed by the weaker punishment threat under the tariff regime. Proposition 1 would be overturned if the tariff deviation incentive weakens sufficiently relative to the tariff punishment threat.

6 Conclusion

This paper contributes to the long-standing debate over the equivalence of tariffs and quotas in environments where agents can engage in both rent- and revenue-seeking. Our paper is novel in considering repeated interaction, which allows individual firms to sustain cooperation and thereby

[46] On the other hand, government revenue is derived from sources other than tariff revenue. Thus, the revenue whose allocation can be influenced by lobbying may exceed tariff revenue. This case is the opposite of the non-discretionary revenue case.

[47] While the revenue allocation is smaller under both cooperation and rent-seeking, the effect is proportionately greater under cooperation.

eliminate wasteful rent- and revenue-seeking expenditures through implicit punishments.

In the flavor of prior literature, tariffs and quotas are equivalent if cooperation obtains under both policies. However, non-equivalence emerges because the conditions under which cooperation is sustained differ across policies. In particular, when a simple sufficient condition is satisfied, cooperation is easier to sustain under quotas than tariffs. In this sense, quotas are welfare enhancing relative to tariffs because cooperation eliminates wasteful rent-seeking. This main result arises because of a costly distribution effect. Unlike consumption of additional tariff revenue, benefiting from additional import licenses requires that specific factor owners in the distribution sector hire additional labor, which makes deviation less attractive under the quota regime relative to the tariff regime.

We also consider the government's policy choice in light of this non-equivalence result. Because the constraint on cooperation has more slack under quotas, a quota is chosen if the policy that maximizes the government's payoff produces cooperation in equilibrium. This contrasts with the general preference for tariffs over quotas in the current institutional environment and, thus, may help explain the persistent use of quotas in practice.

Our analysis suggests some additional questions of interest. First, we assume that the specific factors are uniformly distributed across specific factor owners. Equilibrium outcomes and constraints on cooperation may differ when the specific factor distribution is non-uniform, and a skewed distribution of capital may change the possibility of cooperation and thus the incidence of rent-seeking. Second, we maintain assumptions about the relative labor intensity of the three industries. It would be interesting to consider how these assumptions relate to a country's factor endowments and its trade pattern.

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Appendix

A Proofs

Proof of Equation (9). The first-order condition with respect to L_R is

$$\frac{R-L_R}{(R)^2}p_D\bar{M}-w\left(1+\frac{\partial L_D\left(\frac{L_R}{R}\bar{M}\right)}{\partial L_R}\right)=0. \tag{26}$$

Moreover, letting $\kappa=\frac{L_R}{R}\bar{M}$ represent the rent-seeking firm's quota allocation,

$$\begin{aligned}
\frac{\partial L_D\left(\frac{L_R}{R}\bar{M}\right)}{\partial L_R} &= \frac{\partial L_D(\cdot)}{\partial \kappa}\times\frac{\partial \kappa}{\partial L_R}\\
&= \frac{\partial L_D(\cdot)}{\partial Q_D}\times\frac{\partial \kappa}{\partial L_R}\\
&= \frac{1}{d_L(L_D)}\times\frac{R-L_R}{(R)^2}\bar{M}.
\end{aligned}$$

Substituting into (26), imposing a symmetric solution for all firms, using the definition of τ_D in (5) and rearranging yields:

$$\begin{aligned}
\frac{R-L_R}{(R)^2}\bar{M}\left(p_D-\frac{w}{d_L(L_D)}\right)-w &= 0\\
\frac{n-1}{n^2}\frac{1}{L_R}\bar{M}\tau_D-w &= 0\\
L_R &= \frac{n-1}{n^2}\frac{1}{w}V. \qquad (27)
\end{aligned}$$

Proof of Equation (22). First, setting $p_F^{q,d}=p_F^{q,c}$ and $w^{q,d}=w^{q,c}$, note that:

$$\begin{aligned}
\left(\Pi_D^{t,d}+\pi_D^{t,d}\right)-\left(\Pi_D^{q,d}+\pi_D^{q,d}\right) &= \left[p_D^{t,d}Q_D^{t,d}-w^{t,d}L_D^{t,d}(Q_D^{t,d})+t\bar{M}\right]-\left[p_D^{q,d}Q_D^{q,d}-w^{q,d}L_D^{q,d}(Q_D^{q,d})\right]\\
&= \left[p_D^{t,d}\frac{\bar{M}}{n}-w^{t,d}L_D\left(\frac{\bar{M}}{n}\right)+t\bar{M}\right]-\left[p_D^{q,d}\bar{M}-w^{q,d}L_D\left(\bar{M}\right)\right]\\
&= \left[\rho_D^{q,c}\frac{\bar{M}}{n}-w^{q,c}L_D\left(\frac{\bar{M}}{n}\right)+t\bar{M}\right]-\left[p_D^{q,c}\bar{M}-w^{q,c}L_D\left(\bar{M}\right)\right]\\
&= \left[w^{q,c}L_D(\bar{M})-w^{q,c}L_D\left(\frac{\bar{M}}{n}\right)\right]-\left[p_D^{q,c}\bar{M}-\rho_D^{q,c}\frac{\bar{M}}{n}-t\bar{M}\right]. \qquad (28)
\end{aligned}$$

Second, note that:

$$\begin{aligned} p_D^{q,c}\bar{M} &= \left(\rho_D^{q,c}+\tau^{q,c}\right)\bar{M} \\ &= \left(\rho_D^{q,c}+t\right)\bar{M}. \end{aligned} \tag{29}$$

Thus, substituting (29) into (28) yields:

$$\begin{aligned} \left(\Pi_D^{t,d}+\pi_D^{t,d}\right)-\left(\Pi_D^{q,d}+\pi_D^{q,d}\right) &= \left[w^{q,c}L_D(\bar{M})-w^{q,c}L_D\left(\frac{\bar{M}}{n}\right)\right]-\rho_D^{q,c}\left[\bar{M}-\frac{\bar{M}}{n}\right] \\ &= \int_0^{\bar{M}}\frac{w^{q,c}}{d_L\left(L_D\left(Q_D\right)\right)}dQ_D-\int_0^{\frac{\bar{M}}{n}}\frac{w^{q,c}}{d_L\left(L_D\left(Q_D\right)\right)}dQ_D-\rho_D^{q,c}\left[\bar{M}-\frac{\bar{M}}{n}\right] \\ &= \int_{\frac{\bar{M}}{n}}^{\bar{M}}\frac{w^{q,c}}{d_L\left(L_D\left(Q_D\right)\right)}dQ_D-\rho_D^{q,c}\left[\bar{M}-\frac{\bar{M}}{n}\right]. \end{aligned}$$

Proof that wages rise with rent-seeking. The proof is by contradiction. First, consider a binding quota so that $Q_D^{q,N}=\frac{\bar{M}}{n}$ and $L_D^{q,N}=L_D^{q,c}$. Suppose $w^{q,c}>w^{q,N}$. Then, $L_A^{q,N}>L_A^{q,c}$ and, given $L_R^{q,N}>0$, full employment and a symmetric equilibrium implies $L_F^{q,N}<L_F^{q,c}$. In turn, $f_L(L_F^{q,N})>f_L(L_F^{q,c})$ which, via the first-order condition (3), implies $p_F^{q,N}<p_F^{q,c}$. However, since $X=M=\bar{M}=D$ and, given symmetry, F falls and A rises (due to changes in sectoral labor), then $\frac{F+D}{A-X}=\frac{C_F}{C_A}$ falls. Homothetic preferences then imply $p_F^{q,N}>p_F^{q,c}$ which is a contradiction.

Second, consider a tariff. Suppose $w^{t,c}>w^{t,N}$. Then $L_A^{t,N}>L_A^{t,c}$. Since $L_R^{t,N}>0$, full employment and symmetry imply either $L_F^{t,N}<L_F^{t,c}$, $L_D^{t,N}<L_D^{t,c}$, or both.

Let $L_F^{t,N}<L_F^{t,c}$ and $L_D^{t,N}<L_D^{t,c}$. Then, $\frac{F+D}{A-X}$ falls upon rent-seeking and, via homothetic preferences, $p_F^{t,N}>p_F^{t,c}$. But, given symmetry, the first-order condition (3) implies $p_F^{t,N}<p_F^{t,c}$ given $f_L\left(L_F^{t,N}\right)>f_L\left(L_F^{t,c}\right)$ and $w^{t,N}<w^{t,c}$. This is a contradiction.

Now, let $L_F^{t,N}<L_F^{t,c}$ and $L_D^{t,N}>L_D^{t,c}$. Hereafter, $\Delta x\equiv x^{t,N}-x^{t,c}$ for any variable x; e.g., $\Delta p_D\equiv p_D^{t,N}-p_D^{t,c}$ and $\Delta f_L\equiv f_L\left(L_F^{t,N}\right)-f_L\left(L_F^{t,c}\right)$. Then $\Delta f_L>0$ and $\Delta d_L<0$. In turn, given $w^{t,c}>w^{t,N}$, then first-order condition (3) requires $\Delta p_F<0$. Moreover, given $p_F=1+p_D+t$, the first-order conditions (3)-(4) require $f_L\left(L_F\right)<d_L\left(L_D\right)$ and $\Delta w=\Delta\left(p_F f_L\left(\cdot\right)\right)\equiv p_F^{t,N}f_L\left(L_F^{t,N}\right)-p_F^{t,c}f_L\left(L_F^{t,c}\right)=\Delta\left(p_D d_L\left(\cdot\right)\right)\equiv p_D^{t,N}d_L\left(L_D^{t,N}\right)-p_D^{t,c}d_L\left(L_D^{t,c}\right)$. But, $\Delta\left(p_F f_L\left(\cdot\right)\right)=f_L\left(L_{,F}^{t,c}\right)\Delta p_D+\left(1+p_D^{t,N}+t\right)\Delta f_L>d_L\left(L_D^{t,c}\right)\Delta p_D+p_D^{t,N}\Delta d_L=\Delta\left(p_D d_L\left(\cdot\right)\right)$ which is a contradiction.

Finally, let $L_D^{t,N}<L_D^{t,c}$ and $L_F^{t,N}>L_F^{t,c}$. Four observations establish the contradiction. First,

$\Delta L_D < 0$ and $\Delta L_F > 0$. Second, given $\Delta L_A > 0$ and $L_R^{t,N} > 0$, full employment requires $\Delta L_D < -\Delta L_F < 0$. Third, $w^{t,N} < w^{t,c}$ implies $\Delta L_A > 0$, $\Delta A > 0$ and, using the first-order condition (4), $\Delta p_D < 0$ and hence $\Delta p_F < 0$. Fourth, the first-order conditions (3)-(4) require $f_L\left(L_F^{t,c}\right) < d_L\left(L_D^{t,c}\right)$ which, in turn, implies $f_L\left(L_F\right) < d_L\left(L_D\right)$ for any $L_F > L_F^{t,c}$ and $L_D < L_D^{t,c}$. Letting $\mathrm{d}L_F = -\,\mathrm{d}L_D > 0$, the first and fourth observations imply $\mathrm{d}Q_F\left(L_F^{t,c}\right) = f_L(L_F^{t,c}) \times \mathrm{d}L_F < -\left(d_L(L_D^{t,c}) \times \mathrm{d}L_D\right) = -\,\mathrm{d}Q_D$. Since the fourth observation implies the previous expression holds for any marginal changes $\mathrm{d}L_F = -\,\mathrm{d}L_D > 0$ then the second observation ($\Delta L_D < -\Delta L_F < 0$) implies $\Delta Q_F < -\Delta Q_D < 0$. However, we now have a contradiction because, via symmetry and $\Delta X = \Delta M = \Delta D$, $\Delta\left(\frac{F+D}{A}\right) < 0$ which, via homothetic preferences, requires $\Delta p_F > 0$ and contradicts the third observation.

Proof of Lemma 2. The proof is by contradiction. We omit the N superscript for brevity since all variables refer to the Nash rent-seeking equilibrium. Note that $M^t = \bar{M}$ and symmetry imply $L_D^t = L_D^q$ and $Q_D^t = Q_D^q$. We first show $L_A^t = L_A^q$ by ruling out $L_A^t < L_A^q$ and $L_A^t > L_A^q$.

Suppose $L_A^t < L_A^q$ (and, hence, $Q_A^t < Q_A^q$). Two implications follow. First, using (2), $w^t > w^q$. Second, full employment and symmetry (see (13)) require either (i) $L_F^t > L_F^q$ or (ii) $L_F^t \leq L_F^q$ and $L_R^t > L_R^q$.

Case (i): $L_F^t > L_F^q$ implies $Q_F^t > Q_F^q$. Thus, given $Q_D^t = Q_D^q$ and $Q_A^t < Q_A^q$, we have $\left(\frac{F+D}{A-X}\right)^t > \left(\frac{F+D}{A-X}\right)^q$. Via homothetic preferences, this implies $p_F^t < p_F^q$. Further, $L_F^t > L_F^q$ implies $f_L(L_F^t) < f_L(L_F^q)$. But, (3) then implies $f_L(L_F^t) \times p_F^t = w^t < w^q = f_L(L_F^q) \times p_F^q$, a contradiction to $w^t > w^q$.

Case (ii): First, let $L_F^t = L_F^q$. Then, given $D = M = X$, $\left(\frac{F+D}{A-X}\right)^t > \left(\frac{F+D}{A-X}\right)^q$ and, via homothetic preferences, $p_F^t < p_F^q$. But, combined with $f_L(L_D^t) = f_L(L_D^q)$, we now have the contradiction that $w^t < w^q$. Second, let $L_F^t < L_F^q$ and, given symmetry, $F^t < F^q$. Given $L_R^t > L_R^q$ and $w^t > w^q$, (8) and (9) imply revenues exceed rents: $t \times M = t \times \bar{M} > \tau \times \bar{M}$. In turn, $t > \tau$. Further, given $w^t > w^q$ and $L_D^t = L_D^q$, we have $p_D^t = \frac{w^t}{d_L(L_D^t)} > \frac{w^q}{d_L(L_D^t)} = \frac{w^q}{d_L(L_D^q)} \equiv \rho$ and thus $p_F^t = 1+t+p_D^t > 1+\tau+\rho \equiv 1+p_D^q = p_F^q$. Homothetic preferences then imply $\left(\frac{F+D}{A-X}\right)^t < \left(\frac{F+D}{A-X}\right)^q$. However, our technological assumptions in Section 2.4 imply $\left(\frac{F+D}{A}\right)^t > \left(\frac{F+D}{A}\right)^q$ when $L_R^t > L_R^q$ and $M^t = \bar{M}$. Further, $F^t < F^q$ and $D^t = D^q$ imply $\left(\frac{F+D}{D}\right)^t < \left(\frac{F+D}{D}\right)^q$. Thus, given $X = D$, manipulating $\left(\frac{F+D}{A-X}\right)^t > \left(\frac{F+D}{A-X}\right)^q$ reveals the contradiction that $F^q < F^t$.

Now suppose $L_A^t > L_A^q$ (and, thus, $Q_A^t < Q_A^q$). Two implications follow. First, using (2),

$w^t < w^q$. Second, full employment (see (13)) requires either (i) $L_F^t < L_F^q$ or (ii) $L_F^t \geq L_F^q$ and $L_R^t < L_R^q$. Similar logic to cases (i) and (ii) above yields similar contradictions. Thus, we have established $L_A^t = L_A^q$ and, in turn, $w^t = w^q$ and $Q_A^t = Q_A^q$.

The second step of the proof is to show $L_F^t = L_F^q$ and $L_R^t = L_R^q$. Given $L_D^t = L_D^q$ and $L_A^t = L_A^q$ and the full employment condition, this only requires ruling out (i) $L_F^t < L_F^q$ and (ii) $L_F^t > L_F^q$. But, the same logic that ruled out these cases above applies again. Therefore, $M = \bar{M}$ implies $L_j^t = L_j^q$ for $j = D, A, F, R$.

Finally, we establish $v_j^t = v_j^q$. Since we have established $L_j^t = L_j^q$ for $j = D, A, F, R$ then $Q_j^t = Q_j^q$ for $j = D, A, F$ and $w^t = w^q$. Thus, $p_F^t = p_F^q$ given homothetic preferences and $X = M = D$. Moreover, we have $\rho \equiv \frac{w^q}{d_L(L_D^q)} = \frac{w^t}{d_L(L_D^t)} = p_D^t$ which, via (1) and (5) together with $p_F^t = p_F^q$, implies $\tau = t$. Thus, $\Pi_j^t = \Pi_j^q$ and $\pi_j^t = \pi_j^q$ for $j = A, D, F$ which implies $v_j^t = v_j^q$ for $j = A, F$.

Proof of Proposition 2. Let $\hat{\mu} \in \left\{\hat{M}, \hat{t}\right\}$ and $\mu^* \in \{M^*, t^*\}$ and suppose μ^* sustains cooperation, i.e., $\delta > \bar{\delta}(\mu^*)$. There are two cases to consider: $\hat{\mu} = \mu^*$ and $\hat{\mu} \neq \mu^*$.

First, let $\hat{\mu} = \mu^*$. Suppose $\hat{\mu} = \hat{t} \equiv \hat{t}\left(\bar{M}\right)$ where $\hat{t}\left(\bar{M}\right)$ is the quota equivalent tariff of $\bar{M}$. Then, $\delta > \bar{\delta}(\hat{t}\left(\bar{M}\right))$. Moreover, via Proposition 1, $\bar{M}$ also sustains cooperation because $\delta > \bar{\delta}(\hat{t}\left(\bar{M}\right)) > \bar{\delta}(\bar{M})$. By equivalence, $G\left(\hat{t}\left(\bar{M}\right)\right) = G\left(\bar{M}, \cdot\right) = G\left(\hat{M}, \cdot\right)$ and hence $\hat{t}\left(\bar{M}\right) = \hat{\mu} = \mu^*$ implies $\hat{M} = \hat{\mu} = \mu^*$.

Now suppose $\hat{\mu} = \hat{M}$. Then, $\delta > \bar{\delta}(\hat{M})$. By Proposition 1, $t\left(\hat{M}\right)$ sustains cooperation if and only if $\delta > \bar{\delta}\left(t\left(\hat{M}\right)\right)$ where $\bar{\delta}\left(t\left(\hat{M}\right)\right) > \bar{\delta}(\hat{M})$. If $\delta > \bar{\delta}\left(t\left(\hat{M}\right)\right)$ then, by similar logic to the previous case, $t\left(\hat{M}\right) = \hat{\mu} = \mu^*$. But, parts (ii) and (iii) of Assumption 1 imply $\hat{M} = \hat{\mu} = \mu^*$ is unique if $\delta < \bar{\delta}\left(t\left(\hat{M}\right)\right)$.

Second, let $\hat{\mu} \neq \mu^*$ but $\delta > \bar{\delta}\left(\mu^*\right)$ so that cooperation prevails under μ^* even though Proposition 1 implies $\delta < \bar{\delta}(\hat{M}) < \bar{\delta}(\hat{t})$. We want to show $\mu^* \neq t$ for any t. Take any tariff $\tilde{t}$ yielding cooperation (i.e., $\delta > \bar{\delta}\left(\tilde{t}\right)$). Then, Proposition 1 implies $\delta > \bar{\delta}\left(\tilde{t}\right) > \bar{\delta}(M(\tilde{t}))$ where $M\left(\tilde{t}\right)$ is the tariff equivalent quota of $\tilde{t}$. Assumption 1(i)-(ii) implies there exists $\bar{M}$ such that $\left|\hat{M} - \bar{M}\right| < \left|\hat{M} - M(\tilde{t})\right|$ and $\bar{\delta}\left(\bar{M}\right) < \delta < \bar{\delta}\left(t(\bar{M})\right)$. Letting $\hat{G}\left(\mu\right)$ denote the government's payoff under policy μ when $L_{R,s} = 0$ is exogenously imposed for all periods $s \geq 1$, $G\left(\bar{M}, \cdot\right) = \hat{G}\left(\bar{M}, \cdot\right) = \hat{G}\left(t\left(\bar{M}\right), \cdot\right) > \hat{G}\left(M\left(\tilde{t}\right), \cdot\right) = \hat{G}\left(\tilde{t}, \cdot\right) = G\left(\tilde{t}, \cdot\right)$. Thus, $G\left(\bar{M}, \cdot\right) > G\left(\tilde{t}, \cdot\right)$. Hence, $\mu^* \neq t$ for any t such that $\delta > \bar{\delta}(t)$ because there exists $\bar{M}$ such that $\delta > \bar{\delta}(\bar{M})$ and $G\left(\bar{M}, \cdot\right) > G\left(t, \cdot\right)$. Finally, Assumption 1(iii) implies $\mu^* \neq \mu$ for any μ such that $\delta < \bar{\delta}(\mu)$.

References

Bhagwati, J. (1965). On the equivalence of tariffs and quotas. In *Trade, growth and the balance of payments: essays in honor of Gottfried Haberler*, pages 53–67. Rand McNally.

Bhagwati, J. N. (1980). Lobbying and welfare. *Journal of Public Economics*, 14(3):355–363.

Bhagwati, J. N., Panagariya, A., and Srinivasan, T. N. (1998). *Lectures on international trade.* MIT press.

Bhagwati, J. N. and Srinivasan, T. (1980). Revenue seeking: A generalization of the theory of tariffs. *The Journal of Political Economy*, 88:1069–1087.

Blonigen, B. A., Liebman, B. H., Pierce, J. R., and Wilson, W. W. (2013). Are all trade protection policies created equal? Empirical evidence for nonequivalent market power effects of tariffs and quotas. *Journal of International Economics*, 89(2):369–378.

Brainard, S. L. and Verdier, T. (1997). The political economy of declining industries: Senescent industry collapse revisited. *Journal of International Economics*, 42(1):221–237.

Center for Responsive Politics (2015). Lobbying database.

Cheikbossian, G. (2012). The collective action problem: Within-group cooperation and between-group competition in a repeated rent-seeking game. *Games and Economic Behavior*, 74(1):68–82.

Chen, C.-C., Chang, C.-C., and McCarl, B. A. (2011a). The equivalence of tariffs and quotas under a tariff-rate quota system: A case study of rice. *Canadian Journal of Agricultural Economics/Revue canadienne d'agroeconomie*, 59(4):573–587.

Chen, H.-Y., Chang, Y.-M., and Chiou, J.-R. (2011b). A welfare analysis of tariffs and equivalent quotas under demand uncertainty: Implications for tariffication. *International Review of Economics & Finance*, 20(4):549–561.

Committee on Foreign Trade (2012). Committee on foreign trade resolution no. 65. Technical report, Coordinating Minister of Production, Employment, and Competitiveness, Ecuador. http://www.produccion.gob.ec/wp-content/uploads/downloads/2012/09/RESOLUCION-65.pdf.

Congleton, R. D., Hillman, A. L., and Konrad, K. A. (2008). *40 Years of Research on Rent Seeking*, volume 1 and 2. Springer Science & Business Media.

Corcoran, W. J. (1984). Long-run equilibrium and total expenditures in rent-seeking. *Public Choice*, 43(1):89–94.

Corcoran, W. J. and Karels, G. V. (1985). Rent-seeking behavior in the long-run (Efficient rents 1). *Public Choice*, 46(3):227–246.

Dockner, E. J. and Haug, A. A. (1990). Tariffs and quotas under dynamic duopolistic competition. *Journal of International Economics*, 29(1):147–159.

Drutman, L. (2012). Lobby more, pay less in taxes. http://sunlightfoundation.com/blog/2012/04/16/lobby-more-pay-less-in-taxes/.

Fernandez, R. and Rodrik, D. (1991). Resistance to reform: Status quo bias in the presence of individual-specific uncertainty. *The American Economic Review*, 81(5):1146–1155.

Findlay, R. and Wellisz, S. (1982). Endogenous tariffs, the political economy of trade restrictions, and welfare. In Bhagwati, J., editor, *Import Competition and Response*, pages 223–234. University of Chicago Press.

Fishelson, G. and Flatters, F. (1975). The (non) equivalence of optimal tariffs and quotas under uncertainty. *Journal of International Economics*, 5(4):385–393.

Grossman, G. M. and Helpman, E. (1994). Protection for sale. *The American Economic Review*, 84(4):833–850.

Harris, R. (1985). Why voluntary export restraints are "voluntary". *Canadian Journal of Economics*, 18(4):799–809.

Higgins, R. S., Shughart II, W. F., and Tollison, R. D. (1985). Free entry and efficient rent seeking (Efficient rents 2). *Public Choice*, 46(3):247–258.

Hranaiova, J., De Gorter, H., and Falk, J. (2006). The economics of administering import quotas with licenses-on-demand in agriculture. *American journal of agricultural economics*, 88(2):338–350.

Hranaiova, J., Falk, J., and de Gorter, H. (2003). The economics of administering import quotas with licenses-on-demand. Paper prepared for the World Bank's Agricultural Trade Group.

Hwang, H., Kao, K.-F., and Peng, C.-H. (2011). Tariff and quota equivalence in vertically related markets. *Review of Development Economics*, 15(1):19–32.

Itoh, M. and Ono, Y. (1982). Tariffs, quotas, and market structure. *The Quarterly Journal of Economics*, 97(2):295–305.

Krishna, K. (1989). Trade restrictions as facilitating practices. *Journal of International Economics*, 26(3):251–270.

Krishna, K. (1990). The case of the vanishing revenues: Auction quotas with monopoly. *American Economic Review*, 80(4):828–36.

Krishna, K. (1993a). Auctions with endogenous valuations: the persistence of monopoly revisited. *The American Economic Review*, 83(1):147–160.

Krishna, K. (1993b). Theoretical implications of imperfect competition on quota license prices and auctions. *The World Bank Economic Review*, 7(1):113–136.

Krueger, A. O. (1974). The political economy of the rent-seeking society. *The American Economic Review*, 64(3):291–303.

Leininger, W. and Yang, C.-L. (1994). Dynamic rent-seeking games. *Games and Economic Behavior*, 7(3):406–427.

Maggi, G. and Rodrıguez-Clare, A. (2000). Import penetration and the politics of trade protection. *Journal of International Economics*, 51(2):287–304.

Marowits, R. (2015). Saputo calls on Ottawa to reserve EU cheese import quotas for Canadian dairies. *The Canadian Press.*

Marshall, M. I. (2002). Political market impact on Mexican import permits for white corn.

Matschke, X. (2003). Tariff and quota equivalence in the presence of asymmetric information. *Journal of International Economics*, 61(1):209–223.

Pecorino, P. (1998). Is there a free-rider problem in lobbying? Endogenous tariffs, trigger strategies, and the number of firms. *American Economic Review*, 88(3):652–660.

Pelcovits, M. D. (1976). Quotas versus tariffs. *Journal of International Economics*, 6(4):363–370.

Polborn, M. (2006). Investment under uncertainty in dynamic conflicts. *The Review of Economic Studies*, 73(2):505–529.

Posner, R. A. (1975). The social cost of monopoly and regulation. *Journal of Political Economy*, 83(3):807–828.

Rodriguez, C. A. (1974). The non-equivalence of tariffs and quotas under retaliation. *Journal of International Economics*, 4(3):295–298.

Rowland, C. (2013). Tax lobbyists help businesses reap windfalls. *The Boston Globe.*

Shaffer, S. and Shogren, J. (2008). Infinitely repeated contests: How strategic interaction affects the efficiency of governance. *Regulation & Governance*, 2(2):234–252.

Shaffer, S. and Shogren, J. F. (2009). Repeated contests: A general parameterization. *Economics Letters*, 105(2):159–161.

Shibata, H. (1968). A note on the equivalence of tariffs and quotas. *The American Economic Review*, 58(1):137–142.

Svensson, J. (2000). Foreign aid and rent-seeking. *Journal of International Economics*, 51(2):437–461.

Trade Policy Review Body (2011). Trade policy review, report by the secretariat: India. Technical Report WT/TPR/S/249, World Trade Organization.

Trade Policy Review Body (2013). Trade policy review, report by the secretariat: Mexico. Technical Report WT/TPR/S/279, World Trade Organization.

Tullock, G. (1980). Efficient rent-seeking. In Buchanan, J. M., Tollison, R. D., and Tullock, G., editors, *Toward a theory of the rent-seeking society*, pages 97–112. Texas A.&M. University Press.

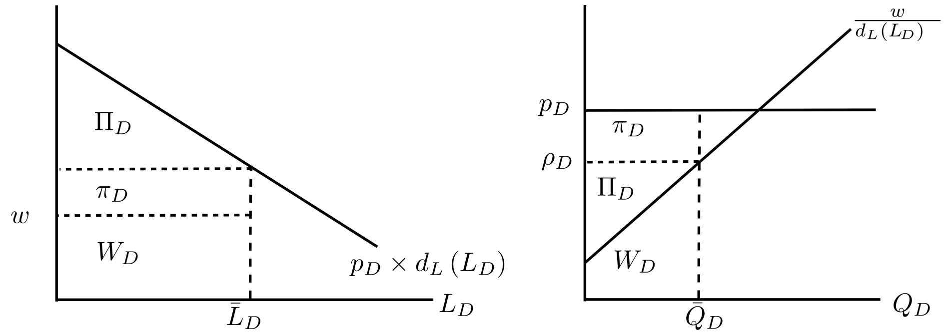
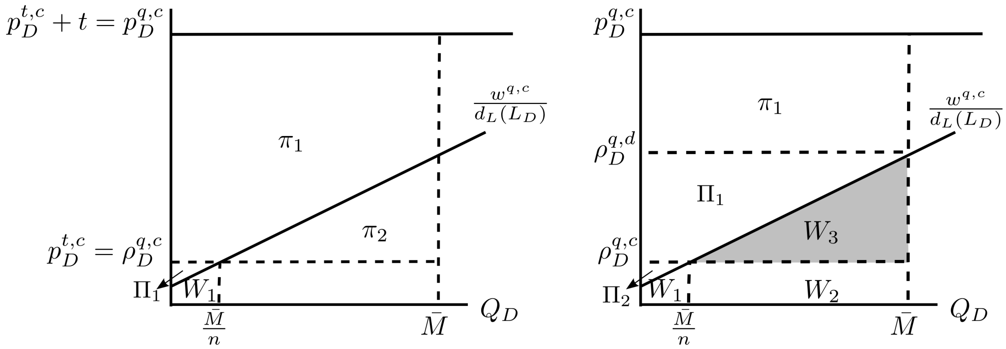


Figure 1: Normal and excess rents in the distribution sector



(a) Tariff (b) Quota

Figure 2: Deviation payoffs in distribution under tariff and quota regimes

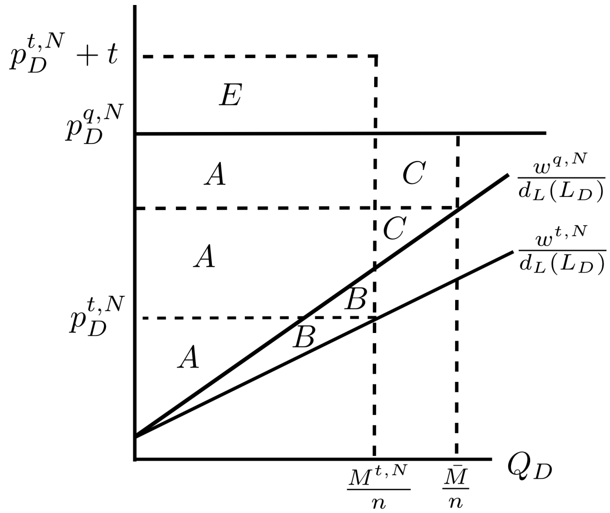


Figure 3: Comparison across policies of total distribution sector rents under rent-seeking