The Near-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 quota/tariff-induced resource reallocation. 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, we say that quotas and tariffs are only near-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 optimal policy whenever the optimal 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 that is 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. In a further development, 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. The central concern of this paper is to examine whether tariffs and quotas are indeed equivalent in a repeated game setting when allowing for 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 (WTO 2011, Committee on Foreign Trade 2012, WTO 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 licences and tariff revenues. Marshall (2002) and Marowits (2015) document import licence lobbying for white corn in Mexico and cheese in Canada.[2] In the U.S., thousands of special interest groups lobby over U.S. federal budget appropriations (5219 groups in 2009 according to the Center for Responsive Politics) and tax expenditures in particular (Drutman 2012, Rowland 2013).[3] Of course, only a portion of government revenues are derived

[1] A tariff rate quota (TRQ) is a two-part tariff where 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, the auctioning of import licenses is rare despite the attention received in the literature (see for example Krishna 1990, 1993a, 1993b). 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 towards infrastructure projects relevant to their industry or for corporate tax breaks.

from tariff revenue. But tariff revenue is nonetheless government revenue and so lobbying over government revenue is, *de facto*, lobbying over tariff revenue.[4] Indeed, according to Bhagwati and Srinivasan (1980), "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 causal 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 who implicitly agree to eliminate wasteful rent- and revenue-seeking under, respectively, a quota or tariff policy regime. We use a specific factors model of international trade where firms can engage in rent-seeking to influence the government's allocation of import licenses under a quota regime or engage in revenue-seeking over the tariff revenue collected by the government. We assume 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 exporters in foreign countries, arrange for the import of the good, clear the good through customs, and deliver it into the domestic distribution network. The presence of costly import processing and distribution plays an important role in our analysis.

Our main result is that quotas and tariffs are neither equivalent nor non-equivalent but, in our own terminology, they are *near-equivalent*. When firms sustain cooperation, outcomes (including labor and production allocations, prices, and income) are equivalent under the tariff and tariff-equivalent quota. However, we say that tariffs and quotas are *near-equivalent* because even though cooperative outcomes are identical, the conditions that determine 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.

A "costly distribution" effect drives our near-equivalence result. Specifically, the benefit of deviating from cooperation under a quota is reduced by the need to hire additional labor in order to make use of the additional import licences gained via deviation. General equilibrium effects

[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).

on prices and wages then exacerbate this reduction. Conversely, benefitting from additional tariff revenue does not require more labor. Thus, costly distribution of imports 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.

We also consider the impact of this near-equivalence result on the government's optimal policy choice. Our second main result is that, in situations where cooperation prevails, a quota is always an optimal policy and, for a substantial range of discount factors, it is the unique optimal policy. This is due to the fact that cooperation may only be sustainable under the quota.

Our paper brings together two separate areas of inquiry: 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. The first generation of literature emphasized the importance of imperfect competition for this result (for examples, see Bhagwati 1965, Shibata 1968, Rodriguez 1974, Fishelson and Flatters 1975, and Itoh and Ono 1982). More recent contributions have shown that equivalence also breaks down under dynamic profit-maximization (Dockner and Haug 1990), asymmetric information (Matschke 2003), demand uncertainty (Chen, Chang, and Chiou 2011), tariff-rate quotas (Chen, Change, and McCarl 2011), or the presence of an upstream producer (Hwang, Kao, and Peng 2011).[5] 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, these papers do not address the general equilibrium welfare consequences of tariffs versus quotas.[6]

Nor does the rent-seeking literature address these questions. The traditional rent-seeking literature has focused on the dissipation of rents via rent-seeking (Krueger 1974, Posner 1975) and, under free entry into rent-seeking, the full dissipation of rents (Corcoran 1984, Corcoran and Karels 1985, Higgins, Shughart, and Tollison 1985).[7] 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

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

[6]Chen, Chang, and Chiou 2011, Chen, Chang, and McCarl 2011 and Hwang, Kao, and Peng 2011 do find that quotas can be preferable to tariffs in the sense that they deliver lower consumer prices.

[7]See Congleton, Hillman and Konrad 2008 for a survey.

(Svensson 2000), and the level of rent-seeking (Shaffer and Shogren 2009).[8]

In contrast to these literatures, our focus is on comparing the possibilities for cooperation (and thereby the 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 the same, we show that policy details can lead to differences in the possibility of eliminating rent-seeking through cooperation and therefore to a preference for one policy over the other.

2 Model of a Rent-Seeking Economy

We model an 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 bring the imported good from port to market.[9] The economy is small, and the units of account are chosen such that international prices of traded goods are 1 and one unit of D is needed to bring one unit of imports from port to market. 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 of the factor specific to their sector. We assume $n \equiv n_D = n_A + n_F$ so that each specific factor owner in a tradeable sector also owns the specific factor required for distribution.[10] Thus, $\bar{K}_{i,j} = \frac{\bar{K}_j}{n_j}$ for any specific factor owner i in sector j. Letting $L_{i,j}$ denote the labor hired by specific factor owner i in sector j, specific factor owners face the constant returns to scale production

[8]See also Leininger (1994), who analyzes 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.

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

[10]We relax this assumption in section 5.1.

functions

$$\begin{aligned} Q_{i,A} &= a(L_{i,A}, \bar{K}_{i,A}) \\ Q_{i,F} &= f(L_{i,F}, \bar{K}_{i,F}) \\ Q_{i,D} &= d(L_{i,D}, \bar{K}_{i,D}) \end{aligned}$$

that display positive but diminishing marginal product of labor ($f_L \equiv \frac{\partial f(\cdot)}{\partial L_{i,F}} > 0$ and $f_{LL} \equiv \frac{\partial^2 f(\cdot)}{\partial L_{i,F}^2} < 0$, and similarly for $a(\cdot)$ and $d(\cdot)$). 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 $\phi_{F,F} = \frac{f_L(L_{i,F}) \times L_{i,F}}{Q_{i,F}}$ denotes labor's share of manufacturing output and $\phi_{F,FD} = \frac{f_L(L_{i,F}) \times L_{i,F}}{Q_{i,F}+Q_{i,D}}$ denotes manufacturing labor's share of *total* output $Q_{i,F} + Q_{i,D}$).[11]

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

$$\max_{L_{i,j}, L_{i,D}} p_j \times Q_{i,j}(L_{i,j}) + p_D \times Q_{i,D}(L_{i,D}) - w^* \times (L_{i,j} + L_{i,D})$$

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

$$a_L(L_{i,A}) = w^*, \tag{2}$$

$$f_L(L_{i,F}) \times p_F = w^*, \text{ and} \tag{3}$$

$$d_L(L_{i,D}) \times p_D \geq w^*. \tag{4}$$

Because output in the distribution sector is constrained under a quota, the last equation holds with a generally strict inequality under quotas. The first order conditions determine sector level employment, $\sum_{i=1}^{n_j} L_{i,j} = L_j$, and output, $\sum_{i=1}^{n_j} Q_{i,j} = Q_j$.

When analyzing the differing prospects for cooperation under the tariff and quota regimes in later sections, we distinguish between "normal" rents, Π, and "excess" rents, π, of specific factor owners (equivalently, firms) in terms of their distribution sector activities (or, analogously, the agriculture or manufacturing sector). Letting W denote the total wage bill, the left-hand side of Figure 1 depicts

[11] In our symmetric equilibrium, $\phi_{i,j}$ and η_j are invariant across specific factor owners within sector j.

these concepts for an individual firm with respect to the number of workers hired in the distribution sector under quotas. The firm maximizes profits under free trade or a tariff regime by hiring labor until the prevailing wage equals the marginal revenue product $w^* = p_D \times d_L(L_{i,D})$. However, the firm will be constrained under the binding quota regime to hire a lower amount of labor, denoted by $\bar{L}_{i,D}$ in Figure 1, so that $w^* < p_D \times d_L(\bar{L}_{i,D})$. The resulting difference $p_D \times d_L(\bar{L}_{i,D}) - w^*$ represents the excess rent on each unit of labor hired. In other words, the excess rents from distribution, $\pi_{i,D}$, vanish if the firm's labor hiring decisions are unconstrained as under free trade or the tariff regime.

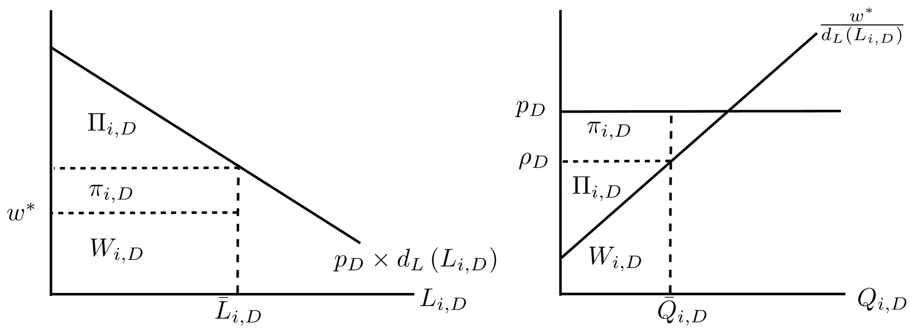

Figure 1: Normal and excess rents, distribution sector

Conversely, 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 components. One part, ρ, compensates the firm for labor costs incurred based on the marginal unit of output. A second part

$$\tau_D \equiv p_D - \frac{w^*}{d_L(L_{i,D}(Q_{i,D}))} = p_D - \rho_D \tag{5}$$

represents the excess rent on the *marginal* unit of output. Again, if the firm is unconstrained in its labor hiring decisions, it will hire until $\rho_D = p_D$ in which case the excess rent on the marginal unit of output, τ_D, vanishes. Thus, $\rho_D < p_D$ and $\tau_D > 0$ under the quota regime, but $\rho_D = p_D$ and $\tau_D = 0$ under free trade or the tariff regime. It is also useful to note that, by construction, the quota-equivalent tariff is equal to the value of τ_D under the quota in the absence of rent-seeking.[12]

For the consumption side of the economy, we assume a representative consumer with homothetic

[12]A firm would choose to produce $\bar{Q}_{i,D}$ units of the distribution service if the price it receives 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 policy regimes, as would all endogenous variables in the model.

preferences. Demand for the manufactured good is

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

where Y is aggregate income, $\frac{\partial c}{\partial Y} > 0$, $\frac{\partial c}{\partial p_F} < 0$, and $\frac{\partial (C_F/C_A)}{\partial p_F} < 0$ where C_A denotes consumption of A.[13] Finally, aggregate income is

$$Y = Q_A + p_F \times Q_F + (p_D + t) \times Q_D \tag{7}$$

with each worker's income given by w^* and the income for a specific factor owner given by firm profits (revenues net of wages paid to workers) plus any share of tariff revenue that may be allocated in the case of tariffs.

2.2 Quotas, Tariffs, Rent- and Revenue-seeking

In the absence of 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, the tariff revenue $TR = t \times M$ is distributed so that each specific factor owner i receives $TR_i = \frac{TR}{n}$. Analogously, the restricted level of imports under the (binding) quota is $\bar{M}$ with the import licence allocation denoted by $\bar{M}_{i,D} = \frac{\bar{M}}{n}$, giving specific factor owner i the right to import and sell this amount of F.[14] 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.[15]

Specific factor owners must hire workers to carry out rent- or revenue-seeking; we denote the amount of rent-seeking labor $L_{i,R}$ (rent-seeking expenditures are thus $L_{i,R} \times w^*$). Our assumptions on tariff revenue allocation and allocation of the specific factor in the distribution sector imply that all specific factor owners can engage in rent-seeking under the quota and revenue-seeking under the tariff.[16] Assuming a contest function determines the allocation of tariff revenue and import licences

[13] Recall, $p_A = 1$.

[14] We assume that the quota remains binding throughout the paper. Moreover, we assume that a given trade policy is time-invariant; Brainard and Verdier 1993 and Fernandez and Rodrik 1997 model this persistence.

[15] 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 two trade policies, the quota and tariff.

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

in the presence of rent- and revenue-seeking, then $\bar{M}_{i,D} = \frac{L_{i,R}}{\sum_{i'=1}^{n} L_{i',R}} \times \bar{M}$ and $TR_i = \frac{L_{i,R}}{\sum_{i'=1}^{n} L_{i',R}} \times TR$.

Under tariffs, a rent-seeking specific factor owner in sector j faces the following optimization problem:

$$\max_{L_{i,R}, L_{i,j}, L_{i,D}} p_j \times Q_{i,j}(L_{i,j}) + p_D \times Q_{i,D}(L_{i,D}) + \frac{L_{i,R}}{\sum_{i'=1}^{n} L_{i',R}} \times TR - w^* \times (L_{i,j} + L_{i,D} + L_{i,R}).$$

The first order conditions with respect to $L_{i,j}$ and $L_{i,D}$ produce equations (2)-(4). Assuming a symmetric Nash equilibrium, the first order condition with respect to the level of rent-seeking $L_{i,R}$ yields

$$L_{i,R} = \frac{n-1}{n^2} \times \frac{1}{w^*} \times V, \tag{8}$$

where $n = n_A + n_F$ and $V \equiv TR = t \times M$ represents the tariff revenue or, more generally, the "rents" being sought under the tariff.[17]

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

$$\begin{aligned} \max_{L_{i,R}, L_{i,j}, L_{i,D}} \quad & p_j \times Q_{i,j}(L_{i,j}) + p_D \times Q_{i,D}^* - w^* \times (L_{i,j} + L_{i,D} + L_{i,R}) \\ \text{s.t.} \quad & \bar{M}_{i,D} = \frac{L_{i,R}}{\sum_{i'=1}^{n} L_{i',R}} \bar{M} \\ & Q_{i,D} = d\left(L_{i,D}, \bar{K}_{i,D}\right) \\ & Q_{i,D}^* = \min\left\{\bar{M}_{i,D}, Q_{i,D}\right\}. \end{aligned}$$

The last constraint conveys that firm i can only distribute imports for which it has a license and must produce the distribution service in order to distribute a unit of imports. Clearly, $Q_{i,D}^* = \bar{M}_{i,D} = Q_{i,D}$ in order to maximize profits (otherwise some labor is wasted). Letting $L_{i,D}\left(L_{i,R}, \sum_{i'=1}^{n} L_{i',R}\right)$ denote the amount of labor needed to distribute the $\bar{M}_{i,D}$ imports allocated to specific factor owner i based on rent-seeking of $L_{i,R}$ by firm i and $\sum_{i'=1}^{n} L_{i',R}$ by all firms, the specific factor owner's optimization problem can be rewritten as:

[17] See section 5.2 for a discussion of the situation when less than the full amount of tariff revenue is available for allocation and thus subject to revenue-seeking.

$$\max_{L_{i,j},L_{i,R}} \; p_j \times Q_{i,j}(L_{i,j}) + p_D \times \frac{L_{i,R}}{\sum_{i'=1}^{n} L_{i',R}} \bar{M} - w^* \times \left(L_{i,j} + L_{i,D}\left(L_{i,R}, \sum_{i'=1}^{n} L_{i',R} \right) + L_{i,R} \right).$$

The first order condition for $L_{i,j}$ merely produces (2)-(3). The first order condition for $L_{i,R}$, again imposing a symmetric Nash equilibrium, yields the Nash equilibrium level of rent-seeking

$$L_{i,R} = \frac{n-1}{n^2} \times \frac{1}{w^*} \times V \tag{9}$$

where $V \equiv \tau_D \times \bar{M}$ represents the total excess rents under the quota regime.[18]

Thus, equations (8) and (9) give the same general expression for a firm's level of rent-seeking, $L_{i,R}$, regardless of whether "rents" are tariff revenues or quota rents. Naturally, $L_{i,R}$ is proportional to the rents available. Additionally, $L_{i,R}$ is higher when the cost of hiring labor to undertake such activities, w^*, is lower. And, finally, a larger size of the group competing for rents increases the competition for rent-seeking and thus increases aggregate rent-seeking, $L_R \equiv \sum_{i=1}^{n} L_{i,R} = n \times L_{i,R}$, but decreases the rent-seeking of an individual specific factor owner, $L_{i,R}$.

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. Equilibrium in the markets for the consumption goods and the distribution service imply that in all three sectors, consumption must equal production net of trade, so that

$$C_A = Q_A - X \tag{10}$$

$$C_F = Q_F + M \tag{11}$$

$$M = Q_D. \tag{12}$$

Labor market equilibrium is characterized by full employment and wage equality resulting from labor mobility:

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

$$
\begin{aligned}
\bar{L} &= L_A + L_F + L_D + L_R \qquad (13)\\
w^* &= a_L(L_{i,A}) = f_L(L_{i,F}) \times p_F \leq d_L(L_{i,D}) \times p_D \qquad (14)
\end{aligned}
$$

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, the full employment condition (13) and the inverted versions of the profit-maximization first-order conditions (14) yield an optimal labor demand for each sector that depends only on p_D. Using (1) and (6) together with (11)-(12) yields

$$c\,(1 + p_D, Y) = Q_F + Q_D, \qquad (16)$$

which represents goods market equilibrium. Substituting (7), the production aggregation identities, and the optimal labor demands into (16) then yields

$$
\begin{aligned}
& c\left(1 + p_D, n_A Q_{i,A}(L^*_{i,A}(p_D)) + (1 + p_D) \times n_F Q_{i,F}(L^*_{i,F}(p_D)) + (p_D + t) \times n Q_{i,D}(L^*_{i,D}(p_D))\right)\\
= \; & n_F Q_{i,F}(L^*_{i,F}(p_D)) + n Q_{i,D}(L^*_{i,D}(p_D)) \qquad (17)
\end{aligned}
$$

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 only creates 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 where the labor supply effectively falls. We consider two scenarios.

First, suppose rent-seeking does not occur but distribution sector labor exogenously increases from $\bar{L}_D$ to $\bar{L}'_D$. Then, the effective labor supply available for producing A and F falls from $\bar{L}-\bar{L}_D$ to $\bar{L}-\bar{L}'_D$. A standard result of the specific factors model is that the output reallocation response is given by $\frac{dQ_F/Q_F}{dQ_A/Q_A} = \frac{\phi_{F,F}\eta_F}{\phi_{A,A}\eta_A}$. That is, $\frac{Q_F}{Q_A}$ rises if and only if $\frac{dQ_F/Q_F}{dQ_A/Q_A} < 1$ 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.[19] Intuitively, when the labor share of output is higher in the agricultural than the manufacturing sector then, all else equal, the "labor-intensive" agricultural sector contracts proportionately more than the manufacturing sector when the available labor falls. This intuition remains valid unless the elasticity of labor demand is sufficiently biased towards the manufacturing sector.[20]

Second, suppose rent- or revenue-seeking labor exogenously rises exogenously from $\bar{L}_R$ to $\bar{L}'_R$. The effective labor supply available for producing A, F and D then falls from $\bar{L}-\bar{L}_R$ to $\bar{L}-\bar{L}'_R$. The output reallocation response can be represented as $\frac{d(Q_F+Q_D)/(Q_F+Q_D)}{dQ_A/Q_A}$ with *total* relative supply of the manufactured good, $\frac{Q_F+Q_D}{Q_A}$, rising if and only if $\frac{d(Q_F+Q_D)/(Q_F+Q_D)}{dQ_A/Q_A} > 1$. Similar to the expression in the previous paragraph $\frac{d(Q_F+Q_D)/(Q_F+Q_D)}{dQ_A/Q_A} > 1$ reduces to $\phi_{A,A}\eta_A > \phi_{F,FD}\eta_F$ under the quota and $\phi_{A,A}\eta_A > \phi_{F,FD}\eta_F + \phi_{D,FD}\eta_D$ 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.[21] 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 (i.e. tariff or quota), level of instrument and

[19]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 3.3, footnote 22.

[20]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 merely the exponent on labor in the production function.

[21]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 $\phi_{F,F} > \phi_{F,FD}$.

informs firms of tariff revenue or quota allocation rules.

- Stage 1 of periods $1, 2, \ldots$: each specific factor owner i in sector $j = A, F$ chooses labor hired for rent-seeking $L_{i,R} \geq 0$, distribution $L_{i,D} \geq 0$, and production $L_{i,j} \geq 0$.

- Stage 2 of periods $1, 2, \ldots$: quotas are allocated, goods are produced, imported, and distributed, and any tariff revenue is distributed.

Throughout Section 3, we take the policy instrument (i.e. tariff or quota) chosen by the government in period 0 and its level as exogenous (we investigate the governments' optimal policy 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 lies in finding out how the sustainability of cooperation, where cooperation means $L_{i,R} = 0$ for every firm i, depends on the government's choice of policy instrument in period 0. Further, given our interest in whether tariffs and quotas are equivalent, we assume the level of the tariff and quota chosen by the government in period 0 are such that import levels under the two policies are identical 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 $v_{i,j}^{r,\theta}$ denote the payoff for firm i in sector j when the outcome of the stage game is $\theta \in \{d, c, N\}$ where d, c, and N denote that firm i deviates from the cooperative outcome, all firms cooperate, or all firms choose the Nash equilibrium level of rent-seeking (see, respectively, (8) and (9) under the tariff and quota regimes). We use similar superscript notation hereafter. Then, letting δ denote the (common) discount factor, cooperation can be sustained under policy regime r via grim trigger strategies when $\delta \geq \max\left\{\bar{\delta}_{i,F}^r, \bar{\delta}_{i,A}^r\right\} \equiv \bar{\delta}^r$ where

$$\bar{\delta}_{i,j}^r \equiv \frac{v_{i,j}^{r,d} - v_{i,j}^{r,c}}{\left(v_{i,j}^{r,d} - v_{i,j}^{r,c}\right) + \left(v_{i,j}^{r,c} - v_{i,j}^{r,N}\right)}. \tag{18}$$

That is, eliminating rent-seeking through cooperation is possible when δ exceeds each firm's threshold value $\bar{\delta}_{i,j}^r$. The constraint on cooperation, $\bar{\delta}_{i,j}^r$, is slacker (tighter) when the threat of punishment in every period after cheating, $v_{i,j}^{r,c} - v_{i,j}^{r,N}$, is larger (smaller) relative to the one shot deviation incentive in the current period, $v_{i,j}^{r,d} - v_{i,j}^{r,c}$.

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 $\max\left\{\bar{\delta}^q_{i,j}, \bar{\delta}^t_{i,j}\right\}$, we compare the constraints across policy regimes for each sector by comparing cooperation, deviation, and Nash equilibrium rent-seeking payoffs across policy regimes.

3.2 Cooperative Payoffs

We first establish that the cooperative (no rent-seeking) outcomes are equivalent under the tariff and quota regimes. This follows easily upon recognizing that the quota is the tariff-equivalent quota meaning that, under cooperation, the level of imports under the quota and the tariff are identical.

The difference between the cooperative payoffs across the two regimes for firm i in sector j is given by

$$\begin{aligned} v^{t,c}_{i,j} - v^{q,c}_{i,j} &= \left[p^{t,c}_j Q^{t,c}_{i,j} + p^{t,c}_D Q^{t,c}_{i,D} - w^{t,c}\left(L^{t,c}_{i,j}(Q^{t,c}_{i,j}) + L^{t,c}_{i,D}(Q^{t,c}_{i,D})\right) + \frac{t\bar{M}}{n}\right] \\ &\quad - \left[p^{q,c}_j Q^{q,c}_{i,j} + p^{q,c}_D Q^{q,c}_{i,D} - w^{q,c}\left(L^{q,c}_{i,j}(Q^{q,c}_{i,j}) + L^{q,c}_{i,D}(Q^{q,c}_{i,D})\right)\right]. \end{aligned} \tag{19}$$

Absent rent-seeking, $M^{t,c} = M^{q,c} = \bar{M}$ and thus firm-level demand for distribution and production labor is identical across policies. In turn, wages, prices, and labor and production allocations are also identical across policies. Recalling that $\rho^{q,c}_D + \tau^{q,c}_D = p^{q,c}_D = p^{t,c}_D + t$ and $p^{t,c}_D = \frac{w}{d_L(L_{i,D})} \equiv \rho^{q,c}_D$, we have $t = \tau^{q,c}_D$ and hence

$$v^{t,c}_{i,j} - v^{q,c}_{i,j} = \frac{t\bar{M}}{n} - \tau^{q,c}_D \frac{\bar{M}}{n} = 0. \tag{20}$$

Therefore, firm-level cooperative payoffs within a sector do not depend on the policy regime.

3.3 Deviation Payoffs

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

$$\begin{aligned} v^{t,d}_{i,j} - v^{q,d}_{i,j} &= \underbrace{\left[p^{t,d}_j Q^{t,d}_{i,j} + p^{t,d}_D Q^{t,d}_{i,D} - w^{t,d}\left(L^{t,d}_{i,j} + L^{t,d}_{i,D}\right)\right]}_{\Pi^{t,d}_{i,j}+\Pi^{t,d}_{i,D}} + \underbrace{t\bar{M}}_{\pi^{t,d}_i} \\ &\quad - \underbrace{\left[p^{q,d}_j Q^{q,d}_{i,j} + p^{q,d}_D Q^{q,d}_{i,D} - w^{q,d}\left(L^{q,d}_{i,j} + L^{q,d}_{i,D}\right)\right]}_{\Pi^{q,d}_{i,j}+\Pi^{q,d}_{i,D}+\pi^{q,d}_{i,D}}. \end{aligned} \tag{21}$$

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

When cooperation prevails under the tariff regime, firms refrain from rent-seeking and tariff revenues are split evenly among firms. A deviating firm could therefore capture the entire tariff revenue by hiring an arbitrarily small amount of rent-seeking labor $L_{i,R} = \epsilon$. Aggregate rent-seeking would then be $L_R = L_{i,R} = \epsilon$ and the allocation of tariff revenue would be $TR_i^{t,d} = TR$ for the deviating firm i and $TR_{i'}^{t,d} = 0$ for firms $i' \neq i$. However, given the arbitrarily small amount of rent-seeking labor, all other outcomes are (essentially) identical under deviation and cooperation with tariffs. That is, $p_j^{t,d} = p_j^{t,c} = p_j^{q,c}$, $w^{t,d} = w^{t,c} = w^{q,c}$, $Q_{i,j}^{t,d} = Q_{i,j}^{t,c} = Q_{i,j}^{q,c}$, and $Q_{i,D}^{t,d} = Q_{i,D}^{t,c} = Q_{i,D}^{q,c}$.

When a firm deviates from cooperation under the quota regime then, similar to the tariff regime, it can gain all import licences by hiring an arbitrarily small amount of rent-seeking labor $L_{i,R} = \epsilon$. However, unlike under the tariff regime, the deviating firm must also hire additional labor to distribute the additional licences. Moreover, $L_D^{q,d} > L_D^{q,c}$ follows from diminishing marginal product of labor and the additional labor required by the distribution sector triggers general equilibrium effects. Deviation under the quota thus has two effects on the deviating firm's payoffs: the direct impact of hiring extra labor for distribution, and the indirect impact via general equilibrium effects.

To determine the sign of the right hand side of equation (21), we initially abstract from the general equilibrium effects of deviation under the quota (i.e. we set $p_D^{q,d} = p_D^{q,c}$ and $w^{q,d} = w^{q,c}$). The difference in deviation profits across regimes in (21) due to normal production rents is then $\Pi_{i,j}^{t,d} - \Pi_{i,j}^{q,d} = 0$. The remainder of the difference is

$$\begin{aligned}\left(\Pi_{i,D}^{t,d} + \pi_i^{t,d}\right) \quad &- \quad \left(\Pi_{i,D}^{q,d} + \pi_{i,D}^{q,d}\right) \geq \\ w^{q,c} \quad L_{i,D}\left(\bar{M}\right) &- w^{q,c}\left[L_{i,D}\left(\frac{1}{n}\bar{M}\right) + \frac{\bar{M}}{d_L\left(L_{i,D}\left(\frac{1}{n}\bar{M}\right)\right)}\frac{n-1}{n}\right] > 0. \qquad (22)\end{aligned}$$

Figure 2 illustrates this inequality.

Parts (a) and (b) of Figure 2 break down normal rents, Π, excess rents, π, and the wage bill, W, in the distribution sector for the deviating firm under the tariff and quota regimes respectively (superscripts and subscripts omitted). The first term in (22), $w^{q,c}L_{i,D}\left(\bar{M}\right)$, represents the total wage bill under the quota and is areas $W_1 + W_2 + W_3$ in Figure 2(b). The second term in (22),

$w^{q,c} L_{i,D}\left(\frac{1}{n}\bar{M}\right)$, is the wages present under either policy and is area W_1 in Figures 2(a) and (b). The third term in (22), $w^{q,c} \frac{\bar{M}}{d_L\left(L_{i,D}\left(\frac{1}{n}\bar{M}\right)\right)} \frac{n-1}{n}$, is area W_2 in Figure 2(b) and represents the part of quota wages that are not rents under the tariff. Thus, the difference between the sum of normal and excess rents in distribution across the two deviation outcomes, i.e. the right-hand side of (22), is W_3 in Figure 2(b).

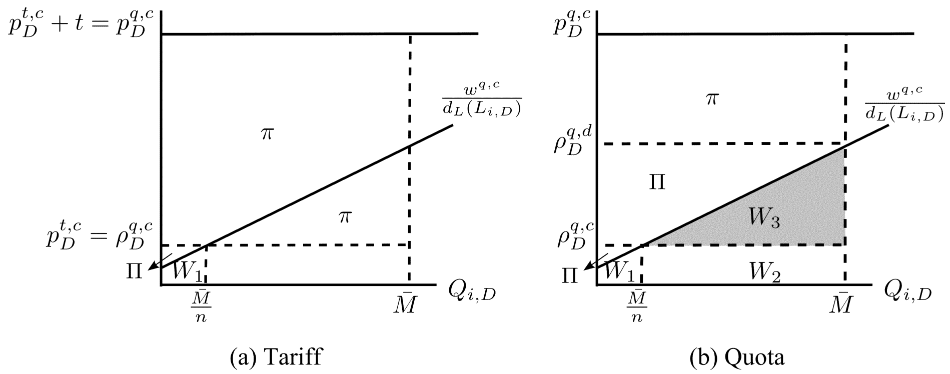

Figure 2: The deviation payoffs in distribution under the tariff and quota regimes

The area W_3 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 by the deviating firm to distribute the imports associated with the additional quota licenses. In contrast, deviating under the tariff does not require additional labor in order to consume the additional tariff revenue. W_3 represents the additional labor cost required to distribute the additional licenses relative to the cost incurred if the firm could expand output at a constant marginal product of labor. That is, it is not costly distribution per se that creates W_3 but rather the rising marginal cost of distribution.

General equilibrium effects reinforce the result that deviating from cooperation under the quota erodes rents. Specifically, the additional labor required by the deviating firm to distribute the entire quota affects w and p_D under the quota regime.

First, consider p_D. In general, the effect on $p_D^{q,d}$ depends upon the economy's output allocation response across A and F once distribution absorbs a larger part of the economy's labor supply. If the relative output $\frac{Q_F+Q_D}{Q_A}$ increases, the relative supply curve (i.e. total supply of the manufactured good relative to the agricultural good) shifts and lowers $p_D^{q,d}$. Indeed, Section 2.4 said this is true under our assumption that $\phi_{A,A}\eta_A > \phi_{F,F}\eta_F$. When labor's share of output in A is higher than in 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 as more labor is allocated to the D sector.[22]

Now consider the wage. The assumption $\phi_{A,A}\eta_A > \phi_{F,F}\eta_F$, and thus the lower p_D, implies the wage must rise upon deviation under the quota regime.[23] Thus, the general equilibrium effects of $p_D^{q,d} > p_D^{q,c}$ and $w^{q,d} > w^{q,c}$ further decrease the benefit of deviation under quotas. Applying these changes to Figure 2(b) reveals a rising wage bill and a deterioration in normal and excess rents for the deviating firm under the quota. Thus, general equilibrium effects exacerbate the costly distribution effect.

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 rise in the distribution price cannot offset the increased wage bill stemming from the costly distribution effect. Lemma 1 summarizes the comparison of deviation payoffs.

Lemma 1. *If the marginal product of labor is diminishing and $\phi_{A,A}\eta_A > \phi_{F,F}\eta_F$, then the deviation payoff 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. the quota licenses, entails costly distribution whereas enjoying the fruits of deviation under the tariff regime, i.e. the tariff revenue, does not.

3.4 Rent-Seeking Payoffs

This section provides a sufficient condition ensuring the rent-seeking payoff is greater, and thus the punishment threat weaker, under tariffs than quotas. The difference in rent-seeking payoffs for firm

[22]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.

[23]A fall in the wage results in a contradiction. If the wage falls then L_A rises. With the increase in L_D (since the entire binding quota is now supplied by a single firm), L_F must then fall. But, given the binding quota, this would imply a decrease in the consumption ratio $\frac{C_F}{C_A}$ which can only happen if p_D^q rises, which is a contradiction. Thus, $\phi_{LA}\eta_{LA} > \phi_{LF}\eta_{LF}$ is not only a sufficient condition for the distribution price to fall upon deviation but also for the wage to rise upon deviation.

i in sector j is

$$\begin{aligned} v_{i,j}^{t,N} - v_{i,j}^{q,N} \quad = \quad & \left[p_j^{t,N} Q_{i,j}^{t,N} + p_D^{t,N} Q_{i,D}^{t,N} - w^{t,N} \left(L_{i,j}^{t,N}(Q_{i,j}^{t,N}) + L_{i,D}^{t,N}(Q_{i,D}^{t,N}) + L_{i,R}^{t,N} \right) + \frac{tM}{n} \right] \\ & - \left[p_j^{q,N} Q_{i,j}^{q,N} + p_D^{q,N} Q_{i,D}^{q,N} - w^{q,N} \left(L_{i,j}^{q,N}(Q_{i,j}^{q,N}) + L_{i,D}^{q,N}(Q_{i,D}^{q,N}) + L_{i,R}^{q,N} \right) \right]. \end{aligned} \quad (23)$$

Equation (23) comprises three elements: normal rents from producing good j, normal distribution rents plus excess distribution rents or tariff revenue receipts, and rent-seeking expenditures.

While rent-seeking outcomes and therefore punishment threats in general differ across regimes, the punishment threat will be positive under either regime: $v_{i,j}^{t,c} > v_{i,j}^{t,N}$ and $v_{i,j}^{q,c} > v_{i,j}^{q,N}$. By reducing the labor supply available for productive purposes, our assumptions on the technological parameters η_j and $\phi_{j,k}$ imply rent-seeking reduces the price of manufactured output, $p_F^{t,N} < p_F^{t,c}$ and $p_F^{q,N} < p_F^{q,c}$, and therefore distribution services, $p_D^{t,N} < p_D^{t,c}$ and $p_D^{q,N} < p_D^{q,c}$. Furthermore, part of the rent-seeking labor comes from the agricultural sector which raises wages: $w^{t,N} > w^{t,c}$ and $w^{q,N} > w^{q,c}$.[24] 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, $M^{t,N} < M^{t,c} = \bar{M}$, and hence tariff revenue.[25] These three implications on top of the rent-seeking expenditures themselves imply the rent-seeking payoff under either policy is lower than under cooperation. That is, the punishment threat $v_{i,j}^{r,c} - v_{i,j}^{r,N}$ is always positive.

The next lemma provides a sufficient condition for the rent-seeking payoff to be higher under tariffs than quotas. For this purpose, we define the following variables that compare equilibrium values across policy regimes with rent-seeking: the price gap $\Delta p \equiv p_F^{q,N} - p_F^{t,N}$, wage gap $\Delta w \equiv w^{q,N} - w^{t,N}$, and rent-seeking gap $\Delta L_R \equiv L_R^{q,N} - L_R^{t,N}$.

Lemma 2. *A sufficient condition for the Nash equilibrium rent-seeking payoff under the tariff policy to exceed that under the quota policy is* $M^{t,N} \in \left(\underline{M}\left(\Delta p, \Delta w, \Delta L_R\right), \bar{M}\right]$ *where* $\underline{M}\left(\Delta p \leq 0, \Delta w, 0\right) < \bar{M}$.

This lemma says that the rent-seeking payoff is higher under the tariff regime than the quota regime when equilibrium imports under the tariff do not fall too far below the quota level $\bar{M}$.

[24]See Appendix for a proof.

[25]In contrast, $M^{q,N} = M^{q,c}$ because the binding quota implies $p_D^{q,N} > \frac{w^{q,N}}{d_L(L_{i,D})}$.

To understand the threshold import level $\underline{M}(\Delta p, \Delta w, \Delta L_R)$, consider a zero rent-seeking gap $\Delta L_R = L_R^{q,N} - L_R^{t,N} = 0$. Then, either policy incurs the same loss of productive labor to rent-seeking. Our assumption on the technological parameters ensures that relative output $\frac{Q_F + Q_D}{Q_A}$ rises because the "labor intensive" agricultural sector bears the brunt of a smaller productive labor force. Section 2.4 implies this rise is identical across policies if $\left(\frac{\phi_{F,FD}\eta_F + \phi_{D,FD}\eta_D}{\phi_{A,A}\eta_A}\right)^{t,N} = \left(\frac{\phi_{F,FD}\eta_F}{\phi_{A,A}\eta_A}\right)^{q,N}$; that is, the labor intensity in distribution is "just right".[26] In this special case, the price gap is $\Delta p \equiv p_F^{q,N} - p_F^{t,N} = 0$ (due to homothetic preferences) and thus the only difference in labor demand between policies at a given wage stems from different labor demand for distribution. In particular, $\bar{M} > M^{t,N}$ implies weaker distribution labor demand under the tariff and, thus, maintenance of full employment under both regimes requires lower wages under the tariff, $\Delta w \equiv w^{q,N} - w^{t,N} > 0$. Thus, $\Delta L_R = 0$ and the special case of the technological parameters imply a zero price gap $\Delta p = 0$ and a positive wage gap $\Delta w > 0$.

The nature of the import threshold $\underline{M}(\Delta p = 0, \Delta w > 0, \Delta L_R = 0)$ now becomes clear. First, $\Delta L_R = 0$ and $\Delta w > 0$ imply rent-seeking *expenditures* are higher under the quota. Second, $\Delta p = 0$ and $\Delta w > 0$ imply agricultural and manufacturing normal rents are lower under quotas ($\Pi_{i,j}^{q,N} < \Pi_{i,j}^{t,N}$ for $j = A, F$). This leaves a comparison of (total) distribution rents under each policy: $\Pi_{i,D}^{t,N} + \pi_i^{t,N}$ versus $\Pi_{i,D}^{q,N} + \pi_{i,D}^{q,N}$. Figure 3 illustrates this as the difference between areas B and C; the former represents efficiency savings under the tariff from $\Delta w > 0$ and the latter represents extra rents under the quota from higher output (areas A are rents under both policies). Thus, distribution sector rents, and hence the entire rent-seeking payoff, are higher under the tariff when imports lie in an interval $\left(\underline{M}(0, \Delta w > 0, 0), \bar{M}\right]$. That is, for the prices, wages, and rent-seeking in the case under consideration, there is some $\underline{M}(\Delta p = 0, \Delta w > 0, \Delta L_R = 0)$ such that the rent-seeking payoff is higher under tariffs than quotas when imports under the tariff lie in the interval $\left(\underline{M}(0, \Delta w > 0, 0), \bar{M}\right)$.[27]

General equilibrium effects complicate the comparative statics of the threshold import level $\underline{M}(\Delta p, \Delta w, \Delta L_R)$. To illustrate, suppose $\Delta L_R = 0$ still holds but $\left(\frac{\phi_{F,FD}\eta_F + \phi_{D,FD}\eta_D}{\phi_{A,A}\eta_A}\right)^{t,N} >$

[26]For example, consider the case of Cobb-Douglass technology in all sectors. Then, $\eta_j = 1$ for $j = A, F, D$ and $\left(\frac{\phi_{F,FD}\eta_F + \phi_{D,FD}\eta_D}{\phi_{A,A}\eta_A}\right)^{t,N} = \left(\frac{\phi_{F,FD}\eta_F}{\phi_{A,A}\eta_A}\right)^{q,N}$ reduces to $\alpha_F \frac{Q_F^{t,N}}{Q_F^{t,N} + Q_D^{t,N}} + \alpha_D \frac{Q_D^{t,N}}{Q_F^{t,N} + Q_D^{t,N}} = \alpha_F \frac{Q_F^{q,N}}{Q_F^{q,N} + Q_D^{q,N}}$ where the α_j terms are the exponents on labor in their respective production functions.

[27]When $M^{t,N}$ is too far below $\bar{M}$ then areas C outweigh areas B but when $M^{t,N}$ is close to $\bar{M}$ then areas B outweigh areas C.

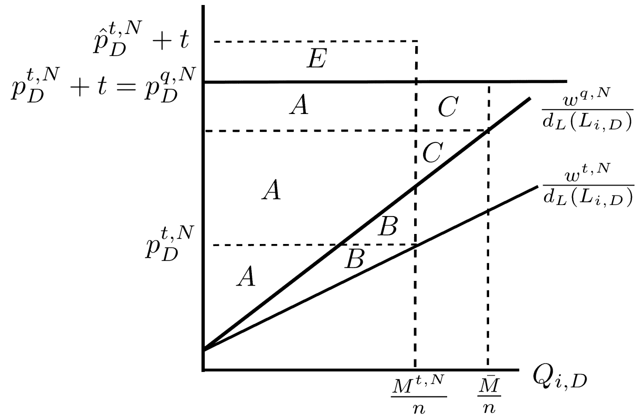

Figure 3: Comparison across policies of total distribution sector rents under rent-seeking

$\left(\frac{\phi_{F,FD}\eta_F}{\phi_{A,A}\eta_A}\right)^{q,N}$ and, hence, $\Delta p < 0$.[28] *All else equal*, this relaxes the threshold $\underline{M}(\cdot)$ because distribution sector rents under the tariff now include area E in Figure 3 where $\hat{p}_D^{t,N}$ now denotes the price of distribution services under the tariff. However, in general equilibrium, this price gap affects the wage gap ($w^{t,N}$ rises) and partially offsets the increased attractiveness of rent-seeking under the tariff relative to the quota. While Δw remains non-negative, the efficiency savings under the tariff fall.[29,30]

Similarly, $\Delta L_R > 0$ would, *all else equal*, increase Δw and thus relax the threshold $\underline{M}(\cdot)$ by reducing the tariff wage bill. But, $\Delta L_R > 0$ leads to $\Delta p < 0$ and so the net effect on the threshold $\underline{M}(\cdot)$ depends on the general equilibrium interaction between the various gaps.

Nevertheless, it is important to emphasize that $M^{t,N} \in \left(\underline{M}(\Delta p, \Delta w, \Delta L_R), \bar{M}\right]$ in Lemma 2 is a *sufficient* condition for rent-seeking to be more attractive under the tariff relative to the quota. We illustrate this when $\Delta L_R = 0$ and $\Delta p \leq 0$ only to highlight the intuition of imports lying in the interval $\left(\underline{M}(\Delta p, \Delta w, \Delta L_R), \bar{M}\right]$. Thus, the rent-seeking payoff can be higher under the tariff than the quota regardless of the sign on Δp and ΔL_R (conditional on $\Delta w > 0$). Hence, the interval $\left(\underline{M}(\cdot), \bar{M}\right]$ remains non-empty in cases outside those discussed above. In turn, rent-seeking payoffs will be greater under tariffs than quotas as long as imports under the tariff lie in the specified

[28] Given footnote 26, a sufficient condition is $\alpha_D > \alpha_F$.

[29] For $p_F^{q,N} \leq p_F^{t,N}$, homothetic preferences require $\left(\frac{Q_F+Q_D}{Q_A}\right)^{q,N} \geq \left(\frac{Q_F+Q_D}{Q_A}\right)^{t,N}$. Since $L_R^{q,N} = L_R^{t,N}$ by assumption in this case, then (along with full employment and the FOCs for profit maximization) $Q_F^{q,N}+Q_D^{q,N} \geq Q_F^{t,N}+Q_D^{t,N}$ and $Q_A^{q,N} \leq Q_A^{t,N}$. But the latter implies $w^{q,N} \geq w^{t,N}$ in equilibrium.

[30] Despite these offsetting effects, Δw remaining non-negative under the negative price gap explains why no restriction is needed on Δw in the condition $\underline{M}(\Delta p \leq 0, \Delta w, 0) < \bar{M}$ of Lemma 2.

interval.

To summarize, the intuition behind a stronger punishment threat under the quota regime has three components. Each component revolves around $\bar{M} > M^{t,N}$. First, the quantitative nature of the quota keeps imports higher under the quota, $\bar{M} > M^{t,N}$, but pushes the importable price lower under the quota. Second, when rent-seeking shrinks the size of the productive economy, the bigger distribution sector under the quota reduces the labor withdrawn from the agricultural sector and keeps the wage higher under the quota. Thus, fixing these price and wage movements, the rent-seeking payoff is lower under the quota. But third, $\bar{M} > M^{t,N}$ implies excess rents are collected on a larger quantity under the quota. Thus, ultimately, given the price and wage movements, the rent-seeking payoff remains lower under the quota (and hence the punishment threat stronger) as long as imports under the tariff do not fall too far below the quota level of imports.

3.5 Near Equivalence

We now formally state our main result. This is based on Section 3.2, which established that cooperative payoffs do not differ across regimes for a given firm, and Lemmas 1 and 2 which, respectively, established conditions where deviation is less attractive and the punishment threat stronger under the quota regime.

Proposition 1. *If the following three conditions hold, 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)* $M^{t,N} \in \left(\underline{M}\left(\Delta p, \Delta w, \Delta L_R\right), \bar{M}\right]$.

By construction, the quota is a tariff-equivalent quota absent any rent-seeking. Thus, *conditional* on cooperation arising in the repeated game, aggregate and individual outcomes are identical across policies and, in this sense, the policies are equivalent. However, we label tariffs and quotas as *near*-equivalent because, while equilibrium outcomes are equivalent conditional on sustaining cooperation, the conditions under which cooperation is sustainable differ. Specifically, when the sufficient conditions in Proposition 1 hold and $\delta \in \left(\bar{\delta}^q, \bar{\delta}^t\right)$ then cooperation is sustained only under the quota regime. 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 previous sections, we investigated the equivalence of tariffs and quotas in an environment where firms could cooperate to eliminate wasteful rent-seeking. To highlight the role of cooperation and the comparison of 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 optimal policy choice regarding both the policy instrument itself and its level.

Let μ^r denote the policy level μ under regime r so that $\mu^t \equiv t \in [0, t^{pro}]$ and $\mu^q \equiv \bar{M} \in [0, M^{FT}]$ denote tariffs and quotas where t^{pro} is the prohibitive tariff leading to zero imports. Thus, $\bar{\delta}^r(\mu^r) \equiv \max\left\{\bar{\delta}^r_{i,A}(\mu^r), \bar{\delta}^r_{i,F}(\mu^r)\right\}$ represents the critical discount factor under regime r above which cooperation is sustained given policy μ^r.

Letting x denote the vector $\left(\mu^r, \bar{\delta}^r(\mu^r), \delta\right)$, we assume the government's payoff can be represented by a reduced form weighted welfare function $W(x) = \sum_{s=0}^{\infty} \delta^s \omega_s(x)$ where $\omega_s(x) = CS_s(x) + \sum_j \sum_i (1+\rho) v_{i,j,s}(x) + TR_s(x)$. In the one-period payoff $\omega_s(x)$, $\rho > 0$ denotes the extra weight attached by the government to firm profits and $CS_s(x)$, $v_{i,j,s}(x)$ and $TR_s(x)$ denote period s consumer surplus, profits of firm i in sector j, and tariff revenue, respectively. This approach is motivated by the "representation theorem" of Baldwin (1987). For any government payoff function V depending on the components of welfare (i.e. CS, v_{ij}, TR) *and* lobbying, Baldwin shows there is a reduced form weighted welfare function W (i.e. a function that depends on the welfare components but *not* on lobbying) such that the government's optimal policy under V is identical to that under W. Moreover, the weight placed by the government on lobbying in V appears as extra weight on firm profits in W; intuitively, firm lobbying is higher when policies increase firm profits and this biases government preferences towards firm profits.[31]

The weighted welfare function $W(x)$ admits an interpretation consistent with our infinitely repeated rent-seeking game with cooperation (naturally, $W(x)$ could also admit other interpretations). Firms will lobby over the policy μ^r chosen in period 0 because they earn rents in periods $s \geq 1$

[31]For example, given a government objective function $V = CS(\mu^r) + \sum_i v_i(\mu^r) + \sum_i \rho \times R_i(\mu^r) + TR(\mu^r)$, where R_i denotes firm i lobbying, Baldwin shows the policy μ^{r*} that maximizes V is the policy that maximizes $W = CS(\mu^r) + (1+\rho)\sum_i v_i(\mu^r) + TR(\mu^r)$.

for policies μ^r that deviate from free trade. However, since rent-seeking in periods $s \geq 1$ largely dissipates rents (completely when $n \to \infty$), firms want the policy chosen in period 0 to sustain cooperation in periods $s \geq 1$.[32] In turn, since period 0 lobbying depends on rents in periods $s \geq 1$, the government also has an incentive to choose a policy that sustains cooperation in periods $s \geq 1$. Since the government cares about welfare, the lobbying that takes place in period 0 compensates the government for the efficiency costs of non-free trade policies in periods $s \geq 1$ (and also offsets the period 0 welfare loss via labor being used for rent-seeking rather than producing output). What value does the government actually get in this scenario from otherwise wasteful lobbying? Given a government motivated (in part) by near-term electoral interests, lobbying might provide campaign services such as canvassing or calling voters or advertising on behalf of the government candidate(s), all of which influence votes but do not generate consumer surplus or profit.[33]

Given the weighted welfare function, the government chooses a policy that solves the following optimization problem:

$$\begin{aligned} &\max_{\mu^r \in \left\{t^*, \bar{M}^*\right\}} && W\left(\mu^r, \bar{\delta}^r\left(\mu^r\right), \delta\right) \\ &\text{s.t.} && t^* = \operatorname*{argmax}_{t \in [0, t^{pro}]} W\left(t, \bar{\delta}^r\left(t\right), \delta\right) \\ &&& \bar{M}^* = \operatorname*{argmax}_{\bar{M} \in [0, M^{FT}]} W\left(\bar{M}, \bar{\delta}^r\left(\bar{M}\right), \delta\right). \end{aligned} \tag{24}$$

$\bar{M}^*$ and t^* represent the optimal quota and tariff conditional on setting such a policy with the optimal policy μ^{r*} given by the policy $\bar{M}^*$ or t^* that maximizes $W(x)$. The policy μ^{r*} chosen by the government in period 0 induces a stationary subgame perfect equilibrium thereafter that we analyzed in Section 3.

In understanding the solution to (24), it is useful to define $\hat{W}(x) \equiv W(x|L_{R,s} = 0 \text{ for } s \geq 1)$ meaning that, regardless of whether $\delta \lesseqgtr \bar{\delta}^r\left(\mu^r\right)$, L_R is exogenously set at zero (alternatively, cooperation is exogenously imposed) in periods $s \geq 1$. In turn, $\hat{\bar{M}}^*$ and $\hat{t}^*$ maximize $\hat{W}\left(x\right)$ under quotas and tariffs. We also make the following assumption where $\underline{\delta} = \min\left\{\bar{\delta}^r\left(\mu^r\right) | \mu^r \in \left[0, M^{FT}\right] \text{ or } \mu^r \in [0, t^{pro}]\right\}$ is the minimum value of δ that can possibly sustain cooperation under some policy.

[32] (8) and (9) show that rents remaining after lobbying are $V - w^* \sum_i L_{i,R} = V - \frac{n-1}{n} V = \frac{1}{n} V$.

[33] This resembles the independent expenditure-only committees, colloquially known as "super PACs", in U.S. politics.

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

(ii) $\hat{W}(\mu^r,\cdot)$ *is strictly quasi-concave in* μ^r.

(iii) If $CS_s(\mu^r,\cdot) = CS(\mu^{r\prime},\cdot)$, $v_{ij,s}(\mu^r,\cdot) = v_{ij,s}(\mu^{r\prime},\cdot)$ *for all* i, j *and* $TR_s(\mu^r,\cdot) = TR_s(\mu^{r\prime},\cdot)$ *for some* μ^r *and* $\mu^{r\prime}$ *in* $s \geq 1$ *then this is also true for* μ^r *and* $\mu^{r\prime}$ *in* $s = 0$.

(iv) If $\mu^{r*} = \bar{M}'$ *and* $\delta > \bar{\delta}^q(\bar{M}')$ *then* $W(\bar{M}',\cdot) > W(\mu^r,\cdot)$ *for all* μ^r *such that* $\delta \in (\underline{\delta}, \bar{\delta}^r(\mu^r))$.

Part (i) of Assumption 1 simply depends on the continuity of the individual payoff functions underlying $\bar{\delta}^r(\mu^r)$ (see (18)). Part (ii) ensures that with cooperation in periods $s \geq 1$, there exists a unique optimal policy under regime r and that the government prefers smaller deviations from this policy. Given the minimal structure placed on period 0 outcomes, part (iii) enables comparisons of period 0 outcomes across policies: if two policies μ^r and $\mu^{r\prime}$ generate the same values of consumer surplus, firm profits and tariff revenue in periods $s \geq 1$ then the two policies generate the same values of consumer surplus, firm profits and tariff revenue in period 0 (the values in period 0 may differ from those in periods $s \geq 1$). Finally, part (iv) imposes a uniqueness requirement: if the *optimal* policy is a quota that sustains cooperation, then there is no alternative policy that generates the same government welfare without cooperation.

The following proposition is our main result on optimal policy.

Proposition 2. *Suppose Lemmas 1 and 2 and Assumption 1 hold. Then, a quota is an optimal policy whenever cooperation is possible under the optimal policy.* $\hat{\bar{M}}^*$ *and* $\hat{t}^*$ *are the equivalent optimal policies when* $\delta \geq \bar{\delta}^t(\hat{t}^*)$. *A quota is the unique optimal policy when (i)* $\delta \in \left[\bar{\delta}^q\left(\hat{\bar{M}}^*\right), \bar{\delta}^t(\hat{t}^*)\right)$, *in which case* $\hat{\bar{M}}^*$ *is the optimal quota, or (ii)* $\delta < \bar{\delta}^q\left(\hat{\bar{M}}^*\right)$ *and cooperation prevails under the optimal policy.*

Proposition 2 is quite intuitive.[34] As described above, the government has an incentive to impose policies that sustain cooperation in subsequent periods because this creates firm profits and generates lobbying in period 0. Thus, if a policy can sustain cooperation then such a policy is optimal. Given Proposition 1 says cooperation is easier to sustain under quotas than tariffs, $\hat{\bar{M}}^*$ and $\hat{t}^*$ are equivalent optimal policies when both sustain cooperation ($\delta > \bar{\delta}^t(\hat{t}^*)$) but $\hat{\bar{M}}^*$ is unique when sustaining cooperation is only possible under the quota ($\bar{\delta}^q\left(\hat{\bar{M}}^*\right) < \delta < \bar{\delta}^t(\hat{t}^*)$).

[34] The Appendix contains its proof.

Once $\delta < \bar{\delta}^q\left(\hat{\bar{M}}^*\right)$, cooperation is unsustainable for $\hat{t}^*$ or $\hat{\bar{M}}^*$. Nevertheless, cooperation may still emerge under the *optimal* policy, and such a policy must be a quota. The reasoning is twofold. First, the quota constraint on sustaining cooperation is slacker than the tariff constraint (Proposition 1). Second, part (ii) of Assumption 1 says the government prefers smaller deviations from $\hat{\bar{M}}^*$ and $\hat{t}^*$. Thus, the quota constraint on cooperation is non-binding for any $t' \neq \hat{t}^*$ sustaining cooperation. In turn, cooperation can be sustained under the quota regime via a smaller deviation from $\hat{\bar{M}}^*$ than is required from $\hat{t}^*$ to sustain cooperation under a tariff.

Figure 4 illustrates this possibility. Suppose $\delta = \bar{\delta}^q\left(\bar{M}_1\right) = \bar{\delta}^q\left(\bar{M}_2\right)$ but $\delta < \bar{\delta}^q\left(\bar{M}\right)$ when $\bar{M} < \bar{M}_1$ or $\bar{M} > \bar{M}_2$. In other words, cooperation only prevails when $\bar{M} \notin \left(\bar{M}_1, \bar{M}_2\right)$.[35] Applying Proposition 1, the constraint on cooperation is slacker under $\bar{M} = \bar{M}_1, \bar{M}_2$ than the associated quota equivalent tariffs $t(\bar{M}_1)$ and $t(\bar{M}_2)$ which implies cooperation cannot be sustained under these quota equivalent tariffs. Thus, if rent-seeking takes place, the optimal policy is $\bar{M}_3$.[36] However, Figure 4(a) depicts the quotas $\bar{M} = \bar{M}_1, \bar{M}_2$ as the optimal policy since $W_1 > W_3$, and cooperation prevails under either quota. Nevertheless, cooperation need not prevail under the optimal policy if cooperation requires a quota deviating too far from $\hat{\bar{M}}^*$. In Figure 4(b), $W_3 > W_1$ and hence $\bar{M}_3$ is the optimal policy despite failing to sustain cooperation.

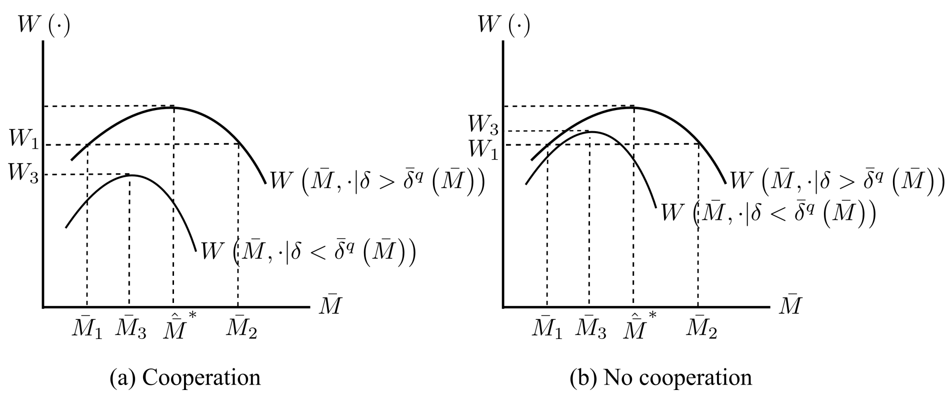

Figure 4: Sustainability of cooperation when $\delta < \bar{\delta}^q\left(\hat{\bar{M}}^*\right)$

[35]If $\delta > \bar{\delta}^q\left(\hat{\bar{M}}^*\right)$ then $\left(\bar{M}_1, \bar{M}_2\right)$ is empty.

[36]That is, $W(\bar{M}_3, \cdot|\delta < \bar{\delta}^q\left(\bar{M}_3\right)) > W(\bar{M}', \cdot|\delta < \bar{\delta}^q\left(\bar{M}'\right))$ for any $\bar{M}' \neq \bar{M}_3$. Note that $W\left(\mu^r, \cdot\right)$ is not the same under a quota and its quota-equivalent tariff when cooperation does not occur.

5 Extensions

5.1 Distinct Owner of Distribution Capital

So far, we 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 specific factor. Thus, the relevant $\bar{\delta}^r_{i,j}$ determining sustainability of cooperation under tariffs is $\max\left\{\bar{\delta}^t_{i,D}, \bar{\delta}^t_{i,F}, \bar{\delta}^t_{i,A}\right\}$ but under quotas is $\bar{\delta}^q_{i,D}$. Nevertheless, the cooperation constraint is tighter under quotas than tariffs if $\bar{\delta}^q_{i,D} < \bar{\delta}^t_{i,D}$. Moreover, the size of the group engaging in rent-seeking is higher under the tariff than the quota and this "group size effect" is the key implication of a distinct group owning the distribution capital.

The group size effect influences both the deviation incentive and the punishment threat. Underlying Proposition 1, the 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. The 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, 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.

5.2 Non-Discretionary Tariff Revenue

While quota rents accrue directly to distribution firms through market mechanisms, the government directly allocates tariff revenue across various uses. Moreover, some portion of revenue will likely be non-discretionary which reduces the amount of tariff revenue whose allocation can be influenced by lobbying.[37] Of course, 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 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.[38] 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

We contribute 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 eliminate

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

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

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

In the flavor of the prior literature, tariffs and quotas are equivalent if cooperation obtains under both policies. However, the conditions under which cooperation is sustained differ across policies and thus we say tariffs and quotas are near-equivalent. 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 optimal policy choice in light of this near-equivalence result. Because the constraint on cooperation has more slack under quotas, a quota is the optimal policy for any policy that produces cooperation in equilibrium. This contrasts with the general preference for tariffs over quotas in the current institutional environment.

Our analysis suggests some additional questions of interest. First, we assume that the specific factors are uniformly distributed across specific factor owners. But 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.

Appendix

A Proofs

Proof of Equation (9)

The FOC for $L_{i,R}$ is

$$\frac{\sum_{i'\neq i} L_{i',R}}{\left(\sum_{i'=1}^{n} L_{i',R}\right)^2} p_D \bar{M} - w^* \left(1 + \frac{\partial L_{i,D}\left(L_{i,R}, \sum_{i'=1}^{n} L_{i',R}\right)}{\partial L_{i,R}}\right) = 0. \tag{25}$$

Moreover,

$$\begin{aligned}
\frac{\partial L_{i,D}\left(L_{i,R},\sum_{i'=1}^{n}L_{i',R}\right)}{\partial L_{i,R}} &= \frac{\partial L_{i,D}\left(\cdot\right)}{\partial \bar{M}_{i,D}}\times\frac{\partial \bar{M}_{i,D}}{\partial L_{i,R}} \\
&= \frac{\partial L_{i,D}\left(\cdot\right)}{\partial Q_{i,D}}\times\frac{\partial \bar{M}_{i,D}}{\partial L_{i,R}} \\
&= \frac{1}{d_{L}\left(L_{i,D}\left(Q_{i,D}\right)\right)}\times\frac{\sum_{i'\neq i}L_{i',R}}{\left(\sum_{i'=1}^{n}L_{i',R}\right)^{2}}\bar{M}.
\end{aligned}$$

Substituting into (25), imposing a symmetric solution $L_{i',R}=L_{i,R}$ for all i', using the definition of τ_D in (5) and rearranging yields:

$$\begin{aligned}
\frac{\sum_{i'\neq i}L_{i',R}}{\left(\sum_{i'=1}^{n}L_{i',R}\right)^{2}}\bar{M}\left(p_{D}-\frac{w^{*}}{d_{L}\left(L_{i,D}\left(Q_{i,D}\right)\right)}\right)-w^{*} &= 0 \\
\frac{n-1}{n^{2}}\frac{1}{L_{i,R}}\bar{M}\tau_{D}-w^{*} &= 0 \\
L_{i,R} &= \frac{n-1}{n^{2}}\frac{1}{w^{*}}V.
\end{aligned}$$

Proof that wages rise with rent-seeking The proof is by contradiction. First, consider a binding quota. Given a symmetric equilibrium, $Q_{i,D}^{q,N}=\frac{\bar{M}}{n}$ 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 implies $L_{F}^{q,N}<L_{F}^{q,c}$. In turn, $f_{L}(L_{i,F}^{q,N})>f_{L}(L_{i,F}^{q,c})$ which, via the FOC (3), implies $p_{F}^{q,N}<p_{F}^{q,c}$. However, since $\bar{M}=Q_{D}$ remains constant while Q_F falls and Q_A rises upon rent seeking (due to changes in sectoral labor), $\frac{Q_{F}+Q_{D}}{Q_{A}}=\frac{C_{F}}{C_{A}}$ falls due to rent-seeking implying, via homothetic preferences, $p_{F}^{q,N}>p_{F}^{q,c}$. This is a contradiction.

Second, consider a tariff. Suppose $w^{t,c}>w^{t,N}$. Then, via symmetry, $L_{i,A}^{t,N}>L_{i,A}^{t,c}$ and $L_{A}^{t,N}>L_{A}^{t,c}$. Since $L_{R}^{t,N}>0$, full employment implies 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, $\frac{Q_{F}+Q_{D}}{Q_{A}}$ falls upon rent-seeking and thus, via homothetic preferences, $p_{F}^{t,N}>p_{F}^{t,c}$. But, given symmetry, the FOC(3) implies $p_{F}^{t,N}<p_{F}^{t,c}$ given $f_{L}\left(L_{i,F}^{t,N}\right)>f_{L}\left(L_{i,F}^{t,c}\right)$ 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 $\Delta f_{L}\equiv f_{L}\left(L_{i,F}^{t,N}\right)-f_{L}\left(L_{i,F}^{t,c}\right)$. Then, given symmetry, $\Delta f_{L}>0$ and $\Delta d_{L}<0$. In turn, given $w^{t,c}>w^{t,N}$, the FOC (3) requires $\Delta p_{D}<0$. Moreover, given $p_{F}=1+p_{D}+t$, the FOCs (3)-(4) require $f_{L}\left(L_{i,F}\right)<d_{L}\left(L_{i,D}\right)$ and $\Delta p_{F}f_{L}\left(\cdot\right)\equiv p_{F}^{t,N}f_{L}\left(L_{i,F}^{t,N}\right)-p_{F}^{t,c}$

$f_L\left(L_{i,F}^{t,c}\right) = \Delta p_D d_L(\cdot) \equiv p_D^{t,N} d_L\left(L_{i,D}^{t,N}\right) - p_D^{t,c}\ d_L\left(L_{i,D}^{t,c}\right)$. But, $\Delta p_F f_L(\cdot) = f_L\left(L_{i,F}^{t,c}\right)\Delta p_D + \left(1+p_D^{t,N}+t\right)\Delta f_L > d_L\left(L_{i,D}^{t,c}\right)\Delta p_D + p_D^{t,N}\Delta d_L = \Delta p_D d_L(\cdot)$ 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 proof. First, $\Delta L_D < 0$ and $\Delta L_F > 0$. Second, $w^{t,N} < w^{t,c}$ implies $\Delta L_A > 0$, $\Delta Q_A > 0$ and, using the FOC (4), $\Delta p_D < 0$ and $\Delta p_F < 0$. Third, the FOCs (3)-(4) require $f_L\left(L_{i,F}^{t,c}\right) < d_L\left(L_{i,D}^{t,c}\right)$ which, in turn, implies $f_L(L_{i,F}) < d_L(L_{i,D})$ for any $L_{i,F} > L_{i,F}^{t,c}$ and $L_{i,D} < L_{i,D}^{t,c}$. Fourth, given $\Delta L_A > 0$ and $L_R^{t,N} > 0$, full employment requires $\Delta L_D < -\Delta L_F < 0$. Letting $\mathrm{d}L_D < 0$ and $\mathrm{d}L_F > 0$, these four observations imply $\mathrm{d}Q_F\left(L_F^{t,c}\right) = n_F \times f_L(L_{i,F}^{t,c}) \times \mathrm{d}L_{i,F} = f_L(L_{i,F}^{t,c}) \times \mathrm{d}L_F < -\left(d_L(L_{i,D}^{t,c}) \times \mathrm{d}L_D\right) = -\left(n \times d_L(L_{i,D}^{t,c}) \times \mathrm{d}L_{i,D}\right) = -\mathrm{d}Q_D$. Since the third observation implies the previous expression holds for any marginal changes $\mathrm{d}L_D < 0$ and $\mathrm{d}L_F > 0$ then $\Delta Q_F < -\Delta Q_D < 0$. However, we now have a contradiction because $\Delta\left(\frac{Q_F+Q_D}{Q_A}\right) < 0$ which, via homothetic preferences, requires $\Delta p_F > 0$ and contradicts the second observation.

Proof of Proposition 2:

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

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

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

Second, let $\hat{\mu}^{r*} \neq \mu^{r*}$ but $\delta > \bar{\delta}^r\left(\mu^{r*}\right)$ so that cooperation prevails under μ^{r*} even though Proposition 1 implies $\delta < \bar{\delta}^t(\hat{\bar{M}}^*) < \bar{\delta}^t(\hat{t}^*)$. We want to show $\mu^{r*} \neq t$ for any t. Take any tariff $t' \neq \hat{t}^*$ yielding cooperation (i.e. $\delta > \bar{\delta}^t\left(t'\right)$). Then, Proposition 1 implies $\delta > \bar{\delta}^t\left(t'\right) > \bar{\delta}^q(\bar{M}(t'))$ where $\bar{M}\left(t'\right)$ is the tariff equivalent quota of t'. Assumption 1(i) implies there exists $\bar{M}'$ such that $\left|\hat{\bar{M}}^* - \bar{M}'\right| < \left|\hat{\bar{M}}^* - \bar{M}(t')\right|$ and $\bar{\delta}^q\left(\bar{M}'\right) < \delta < \bar{\delta}^t\left(t(\bar{M}')\right)$. Parts (ii)-(iii) of Assumption 1 imply $W\left(\bar{M}',\cdot\right) = \hat{W}\left(\bar{M}',\cdot\right) = \hat{W}\left(t\left(\bar{M}'\right),\cdot\right) > \hat{W}\left(\bar{M}\left(t'\right),\cdot\right) = \hat{W}\left(t',\cdot\right) = W\left(t',\cdot\right)$. Thus,

$W\left(\bar{M}', \cdot\right) > W\left(t', \cdot\right)$. Hence, $\mu^{r*} \neq t'$ for any $t' \neq \hat{t}^*$ such that $\delta > \bar{\delta}^t(t')$ because there exists $\bar{M}'$ such that $\delta > \bar{\delta}^t(\bar{M}')$ and $W\left(\bar{M}', \cdot\right) > W\left(t', \cdot\right)$. Finally, Assumption 1(iv) implies $\mu^{r*} \neq \mu^r$ for any μ^r such that $\delta < \bar{\delta}^r(\mu^r)$.

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