**Sleeping Quotas, Pre-emptive Quota
Bidding and Monopoly Power**

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JEL Classification Number: D44, F13, L12

Key Words: Quota equivalence, endogenous-valuations auctions, pre-emption.

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1 Introduction

The vast literature on the equivalence between different sorts of trade restrictions was triggered by the seminal paper of Bhagwati (1965), followed by Shibata (1968) and Bhagwati (1968). There it is shown that the presence of only one domestic producer makes tariffs and auctioned quotas non-

*Thanks are due to J. Anderson, P. P. Barros, J. Bhagwati, L. Cabral, J. Caskey, A. Courakis, C. Corado, R. Findlay, A. Leite, C. Seabra, G. Talmain, two anonymous referees and seminar participants at SATPEG-92 (Lisbon) and ESEM93 (Uppsala) for helpful comments and encouragement. Remaining errors are of course our own.

equivalent instruments. This is because with a quota the producer gains monopoly power, something that does not occur under a tariff.¹

Pickford (1985, p. 156) argues for the practical significance of this framework in an empirical study of inefficiency in New Zealand's manufacturing industry. He stresses that "monopoly in domestic production and competition amongst import licence holders ... seems more realistic than competition for New Zealand manufacturing industries." In many instances this appears to be a reasonable setup for small economies.

Krishna (1990) analyzes a situation where a *foreign* monopolist sells in the domestic market constrained by a quota on imports. She concludes that, unless the quota is very restrictive, the foreign monopolist has an incentive to increase the price of its quota-constrained exports, thus rendering the quota licenses valueless.

Our paper has its roots in Bhagwati (1965) but takes up a quite different issue. We ask whether the single firm has an incentive to buy the auctioned quota itself, and show that in most instances this is in fact the case. Again, in Pickford (1985, p. 163) it is mentioned that that is the case for industries such as rubber tires and tubes in New Zealand. In the same vein, Bergsten

¹Other sources of non-equivalence have also become apparent. It is well known that the equivalence also breaks down in the presence of uncertainty or growth [Fishelson and Flatters (1975), Pelcovits (1976), Young (1979)]. The problem was also studied when retaliation is a possibility [Rodriguez (1974), Tower (1975), Falvey (1985)]. Most of this research was extended to include not only tariffs and quotas but also VERs as in Melvin (1986). Those issues were also studied by Dei (1985a,b), Buffie (1985), Neary (1988), and Neary and Ruane (1988) in the context of general equilibrium and immiserizing growth.

et al. (1987, p. 95) stress: "Concerns about quota abuse arise in large part because Australian industry is so concentrated." The possibility of the monopolist buying the auctioned quota, something we somewhat loosely call pre-emption, brings up another channel of non-equivalence between tariffs and quotas.

This pre-emption may be total—the monopolist buys all of the quota—or partial. We show that the degree of divisibility of the quota is a crucial determinant of the monopolist's pre-emptive strategy. Moreover, the amount of imports may end up being strictly less than the quota. Hence, it is shown that the quota may become a sleeping quota.² This goes against the supposition that the existence of a partially used quota constitutes *prima facie* evidence that the quota does not constitute an impediment to trade.

There exists empirical evidence pertaining to sleeping quotas. In Faini *et al.* (1992, p. 33) quota-utilization rates for major textiles and clothing exporting countries *vis-à-vis* the larger EC countries are shown to be well below 100%. They report, for instance, that Hong Kong in 1985 and 1989 had quota-utilization rates for textiles ranging from 8% to 71%; also, from all the data reported for 1989, only 6 out of 24 quota utilization rates are above 80%. Furthermore, Faini *et al.* found significant international price differences which enabled them to assert that those quotas were indeed binding. We regard these facts as raising the issue of unutilized quota licenses deserving

²This behavior is also termed "shortshipping." See Bergsten *et al.* (1987, p. 53).

to be theoretically analyzed. After all, it is rather puzzling to find countries imposing quotas that turn out to be both binding and not fully utilized.

We do not claim our model to be the sole explanation for this, but nonetheless it fits the stylized facts. The same puzzling findings have elicited an altogether different answer by Anderson (1987). There quotas are seen as having option value in an environment with uncertainty; an auctioned quota remains unused in a bad state of nature (low demand) simply because its owner wants to retain the possibility of exercising the right to import at a later time, in a high-demand state of nature. In this way, the premia difference between states of nature induces the appearance of what we term "sleeping quotas."

The possibility of sleeping quotas has a policy counterpart in countries that have implemented quota auctions. This gives rise to measures, generally called "use-it-or-lose-it" (U/L) clauses, that try to mitigate this phenomenon.³ We discuss U/L clauses at length.

Furthermore, the US Congress has recently discussed the implementation of quota auctions.⁴ Even though the size of the US economy suggests that there is less scope for the emergence of monopolies and sleeping quotas, the interest of understanding the economics of sleeping quotas seems patent.

Interestingly enough, these issues are related to the problem of pre-

³Deposit forfeiture and exclusion from future auctions are examples of such clauses.

See Bergsten *et al.* (1987, pp. 104-5) for details.

⁴See Bergsten *et al.* (1987, p. 3).

emption studied in the Industrial Organization literature by, among others, Gilbert and Newbery (1982), Lewis (1983), and Krishna (1993). Gilbert and Newbery (1982) show how an incumbent monopolist has an incentive to preempt an entrant in a race for a patent, thereby avoiding having to share the market. This result is shown to hold if a weak condition is met, namely, that industry profits are higher with a monopoly than with a duopoly market structure. Moreover, it is conceivable that the patent, once acquired by the monopolist, will not be used, thus becoming a sleeping patent. We contrast these with our own results.

In a related paper, Krishna (1993) discusses an auction of what she terms "capacity," a term that also encompasses quota licenses. As we do, she studies auctions with "endogenous valuations," that is, auctions where valuations are a function of the auction-determined allocation of "capacity," and where the bidding strategies are themselves functions of what the players anticipate the final allocation to be. Unlike ours, her treatment considers the post-auction stage in reduced form, which is not suitable for analyzing how "capacity" is used by the players. Because we explicitly model such post-auction stage, we can discuss whether such capacity is actually used (thus analyzing the emergence of sleeping quotas), and how the bidding strategies are affected by an exogenous requirement that capacity be actually used in the post-auction stage (thus analyzing quotas with associated U/L clauses).

Also unlike ours, her discussion focuses on a particular auction format,

namely, a sequential auction, whereas we consider a simultaneous auction. In her sequential auction the allocation of "capacity" generated by the auction depends on the specific order in which "capacity lumps" are auctioned, this being exogenous to the model. By using a simultaneous format we avoid having these other considerations impinge on the discussion of quotas.

Finally, her analysis shows that a "capacity lump" can be allocated to a given bidder even when other bidders exist whose valuation for the "lump" in question is higher. This does not seem a satisfactory modeling strategy when discussing quotas. The existence of a posterior stage where decisions are made as to how much to import and sell implies that a "secondary market" in quotas would correct any misallocation resulting from the auction. Simultaneous auctions do not suffer from this deficiency.

This paper is organized as follows. In the next section we present the problem and intuitively obtain the most relevant results. In section 3, we formulate the model and formally derive results considering that the monopolist obtains all or part of the quota, without specifying how that situation came about. In section 4, we study the circumstances under which the monopolist has an incentive for total or partial pre-emption when the quota is indivisible (section 4.1), perfectly divisible (section 4.2), and imperfectly divisible (section 4.3). In section 5 the possibility of sleeping quotas is analyzed, and some final remarks are made in section 6.

2 The Problem

Let us start with what we term the Bhagwati equilibrium: one domestic producer with a quota, q , on imports of a perfect substitute for the domestically produced good.⁵ The Bhagwati equilibrium is depicted in Figure 1, where the single domestic producer with marginal cost given by curve C , with $0 \leq C' < +\infty$, operates in a market with demand curve D , with $D' < 0$ and decreasing marginal revenue.⁶ The monopolist faces the residual demand curve, RD , defined as $RD = D - q$, with associated marginal revenue curve R' . The horizontal line P^* represents the supply of imports.⁷ The following quantities and prices describe the Bhagwati equilibrium: quantity sold, Q_0 ; quantity produced domestically, $\bar{Q}_0$; quantity imported, $q = Q_0 - \bar{Q}_0 = OM - ON$; domestic price, P_0 ; implicit price of a unit quota license, $P_0 - P^*$.

⁵We further restrict attention to case 2 in Bhagwati (1965), characterized by the existence of competitive supply from abroad, monopoly in domestic production, and perfect competition among quota-holders.

⁶This last assumption implies that D'' cannot be too positive. This is sufficient to ensure that the monopolists' marginal revenue is decreasing in output, thus ensuring, together with the assumption of a non-decreasing marginal cost, that the second-order condition to the monopolist's problem is met. See Lemma 2's proof.

⁷We assume throughout that q is small enough so that a price-taking behavior in the domestic market by the quota buyer is warranted. As a consequence, the small-country hypothesis is the natural assumption in our framework. In fact, since we assume the amount of the quota to be small enough to justify a price-taking behavior on the part of importers in the domestic market (even if the quota is held by a single importer), it is hardly reasonable to model imports up to the quota as affecting the world price.

Furthermore, the small-country assumption streamlines the analysis. Lastly, by virtue of the small-country hypothesis, we ensure that our results are neither driven nor obscured by home-country monopoly power in world trade. We return to this issue in the Conclusion.

FIGURE 1. *The Bhagwati equilibrium.*

The monopolist's profits are given by area $[cBeP_0]$. Note that the Bhagwati equilibrium implicitly assumes that the quota is held by someone—the importers—other than the monopolist.⁸

Does the monopolist have an incentive to buy the auctioned quota? Let us start with an alternative question. Suppose for the moment that the monopolist is given both the right to set the quota and the right to be the sole user of the quota licenses. This turns the monopolist into the sole provider of the good. It is enlightening to think of this situation as analogous to that of a producer with two plants: domestic production and imports. What is the optimal quota from the monopolist's viewpoint? Its marginal cost curve is now given (see Fig. 2) by chP^* , and the relevant marginal revenue curve is R . The equilibrium is at F , and total quantity is Q_1 . The monopolist's optimal quota is $Q_1 - \tilde{Q}_1$.⁹

This resembles the problem studied by Findlay and Lundahl (1987). There it was shown that in an Apartheid labor market the optimal quantity of "black" labor is not zero from the point of view of the "white" labor, as long as the rent of the implicit quota on immigrants from the "Bantustans" accrues to the "white" labor. The same result emerges in our model. Total profits (rents included) for the single producer/importer are given by

⁸Importers is simply a term that allows us to distinguish other quota-holders from the monopolist. This does not mean that the monopolist does not hold part or all of the quota.

⁹Obviously, the quota considered in Figure 1, $Q_0 - \tilde{Q}_0$, can be either smaller or larger than the optimal quota, $Q_1 - \tilde{Q}_1$, and Q_0 can be smaller or larger than Q_1 .

FIGURE 2. *The Findlay-Lundahl equilibrium.*

the area $[cP_1e'Fh]$. For simplicity's sake, we term this the Findlay-Lundahl equilibrium.

Now suppose the government takes this monopolist's optimal quota, $Q_1 - \tilde{Q}_1$, and auctions it. The Bhagwati equilibrium (B) would be different from the Findlay-Lundahl equilibrium (F). Figure 3 depicts both equilibria, juxtaposing Figures 2 and 1 for the case where the auctioned quota equals the optimal quota defined above. In other words, in Figure 3, $Q_1 - \tilde{Q}_1 = Q_0 - \tilde{Q}_0 = OM - ON = q$. Note that in the B equilibrium, profits are equal to the area $[cBeP_0]$ and rents equal area $[ee''d'd]$, whereas in the F equilibrium, profits equal area $[cP_1e'Fh]$.

Now we can answer our original question: does the monopolist have an incentive to buy this auctioned quota? In this example, the monopolist will pre-emptively buy the quota as long as

$$[cP_1e'Fh] > [cBeP_0] + [ee''d'd], \quad (1)$$

in other words, whenever the bidding price of the quota (rents $[ee''d'd]$), is less than the increase in profits.

This is the case. To see it, note that in the F equilibrium the monopolist could always choose to behave as in the B equilibrium, collecting the rents and exploiting its monopoly power only over the residual demand. Since it does not choose to do so, it can certainly do better by acting differently. Thus, the above inequality holds.

The purpose of this example is to show that there are circumstances where

FIGURE 3. *The Bhagwati and Findlay-Lundahl equilibria compared.*

the monopolist chooses to buy the quota and monopolize the whole market. In the following sections, the argument will be shown to hold in general for any quota. For now, note that it was implicitly assumed that the quota is indivisible.

The case of a perfectly divisible quota is different, because one cannot so easily determine the amount of the rent per unit to be paid, since it is not constant. Rather, it increases with the amount of the quota bought by the monopolist. In this case, it might not even be optimal for the monopolist to buy the whole quota. As the monopolist acquires part or all of the quota and restricts production, it raises the domestic price. This, in turn, increases the rents. Making use of Figure 3 again, starting from the B equilibrium (with associated price P_0) the economy will move towards the F equilibrium (with associated price P_1). Therefore, total rents will lie between $q \times (P_0 - P^*)$ and $q \times (P_1 - P^*)$. This obviously reduces the incentive for the monopolist to buy the quota, since its cost will increase as the monopolist buys quota licenses.

In the next sections it will be demonstrated that these results hold in general. Furthermore, it will become apparent that in most instances a sleeping quota will appear.

3 The Game

The problem can be formalized as a two-stage game. In the first stage, players compete at auction for the quota, and in the second stage they decide on the quantities to be produced domestically and to be imported. The player set involves $N + 1$ players, the monopolist plus N importers. We assume N to be large enough for the importers to adopt a price-taking behavior in the second stage of the game. This implies a significant simplification of their optimal strategies. We thus have to center the analysis on the monopolist's strategy choice.

In the first stage of the game players simultaneously and independently bid for units of the quota. The valuations are a function of the second-stage *market equilibrium*. This equilibrium determines the domestic price which, in conjunction with the (exogenous) world price, is needed to compute the value of a unit-quota license and thus the bidding strategies of the players. It is in this sense that this auction is said to involve endogenous valuations.

Crucially, at the beginning of the first stage, all players can compute the market equilibrium resulting from a given allocation of the quota and thus the valuation of the portion of the quota held by each player in that equilibrium. An *equilibrium of the overall game* is reached when the valuations implicit in a given market equilibrium are such that they induce bids that in turn result in the allocation behind that market equilibrium.

Since valuations are common knowledge, this auction is trivial from the

point of view of the auctions literature, where valuations are not common knowledge. Therefore, whatever the specific format used to implement the auction, players best strategies have to be such that the object being auctioned is awarded to the player with the highest valuation, for a price essentially equal to the second best valuation.¹⁰

3.1 The Second Stage

In this section we deal with the second stage of the game. Following the precepts of subgame perfection, we deal with the first stage in the following sections.

Suppose that the monopolist obtains all or part of the quota. Let its marginal cost be $C_\alpha(\cdot)$, when αq of the quota is at its disposal, with $\alpha \in [0, 1]$.¹¹ Thus C_0 represents the marginal cost of domestic production. The following notation is used: quantity sold is Q_α , quantity produced domestically is $\tilde{Q}_\alpha$, domestic price is P_α , and the portion of the quota actually used by the monopolist to import is $\tilde{\alpha}$.

Before stating the main results, we prove the following lemmata since they will be useful in the sequel. Lemma 1 states formally some features of the marginal-cost function of the monopolist when it acquires part or all

¹⁰See Fudenberg and Tirole (1991, pp. 10–13) for an example of our type of auction where valuations are common knowledge. In this example the optimal strategies can be obtained by iterated deletion of weakly dominated strategies due to the second-price auction format which is assumed.

¹¹Note that C_α is simply the horizontal summation of two marginal cost curves, C , and P^* up to αq . See Figure 4.

of the quota. Lemma 2 shows that market output is smaller, the larger the portion of the quota which is held by the monopolist.

Defining $\hat{Q}$ such that

$$C_0(\hat{Q}) = P^*, \quad (2)$$

note that, for $\alpha < \alpha'$, two marginal-cost curves are related in the following way (see Figure 4):

$$C_\alpha(Q) = C_{\alpha'}(Q), \text{ iff } Q \leq \hat{Q} + \alpha q; \quad (3)$$

$$C_\alpha(Q) > C_{\alpha'}(Q), \text{ iff } Q > \hat{Q} + \alpha q. \quad (4)$$

Lemma 1 *Let $\alpha q, \alpha \in [0, 1]$, denote the amount of the quota the monopolist has obtained. Then,*

$$C_\alpha(Q + \alpha q) \leq C_{\alpha'}(Q + \alpha' q), \text{ if } \alpha < \alpha'. \quad (5)$$

Proof (The proof should be followed with the help of Figure 4.) Two cases have to be considered: (i) If $Q + \alpha q < \hat{Q}$, then $C_\alpha(Q + \alpha q)$ is located along C_0 to the left of $\hat{Q}$ [part (a) of the figure]. Noting that $\alpha < \alpha'$, then $Q + \alpha' q$ is located to the right of $Q + \alpha q$, implying

$$C_\alpha(Q + \alpha q) < C_{\alpha'}(Q + \alpha' q). \quad (6)$$

(ii) If $Q + \alpha q > \hat{Q}$, then $C_\alpha(Q + \alpha q)$ is located either along the horizontal section [part (b)] or above P^* [part (c)]. In the first instance, $C_{\alpha'}(Q + \alpha' q)$ also equals P^* , as depicted in part (b) of the figure; in the second, $C_\alpha(Q + \alpha q) =$

(a)

(b)

(c)

FIGURE 4. *Marginal cost curves.*

$C_{\alpha'}(Q + \alpha'q)$, as shown in part (c). In both instances we get

$$C_{\alpha}(Q + \alpha q) = C_{\alpha'}(Q + \alpha'q). \quad (7)$$

Note that, by construction, above P^* the horizontal distance between $C_{\alpha}(\cdot)$ and $C_{\alpha'}(\cdot)$ is equal to the horizontal distance between $Q + \alpha q$ and $Q + \alpha'q$. This precludes the possibility of $Q + \alpha q$ lying on the horizontal section of C_{α} and $Q + \alpha'q$ lying on the upward section of $C_{\alpha'}$.

Therefore, (6) and (7) together yield (5), the desired result. ■

Lemma 2 *Total quantity supplied is larger, the smaller the portion of the quota which is held by the monopolist, that is,*

$$Q_{\alpha} > Q_{\alpha'}, \quad \text{if } \alpha < \alpha'.$$

Proof Let the efficient total cost of the monopolist be

$$TC_{\alpha}(Q) \equiv \int_0^Q C_{\alpha}(x)dx = \min_{\tilde{Q}_{\alpha}, \tilde{\alpha} \in [0, \alpha]} \left\{ \int_0^{\tilde{Q}_{\alpha}} C(x)dx + P^* \tilde{\alpha} q | Q = \tilde{Q}_{\alpha} + \tilde{\alpha} q \right\}, \quad (8)$$

Noting that $Q_{\alpha} = \tilde{Q}_{\alpha} + \tilde{\alpha} q + (1 - \alpha)q$, the monopolist's problem when it has obtained αq of the quota can be written as

$$\max_{Q_{\alpha}} \{ D[Q_{\alpha}](Q_{\alpha} - (1 - \alpha)q) - TC_{\alpha}(Q_{\alpha} - (1 - \alpha)q) \}. \quad (9)$$

The first-order condition to this problem is

$$D[Q_{\alpha}] + D'[Q_{\alpha}](Q_{\alpha} - q) + D'[Q_{\alpha}]\alpha q = C_{\alpha}(Q_{\alpha} - (1 - \alpha)q). \quad (10)$$

Suppose the monopolist has acquired $\alpha'q$ of the quota, with $\alpha' > \alpha$. Then, from (10), and noting that $D'[\cdot] < 0$, we get

$$D[Q_\alpha] + D'[Q_\alpha](Q_\alpha - q) + D'[Q_\alpha]\alpha'q < C_\alpha(Q_\alpha - (1 - \alpha)q). \quad (11)$$

By Lemma 1 we finally obtain

$$D[Q_\alpha] + D'[Q_\alpha](Q_\alpha - q) + D'[Q_\alpha]\alpha'q < C_{\alpha'}(Q_\alpha - (1 - \alpha')q). \quad (12)$$

The last expression is just the first-order condition to the monopolist's problem when it has obtained $\alpha'q$ of the quota, evaluated at Q_α . Note that marginal revenue is less than marginal cost, hence $Q_\alpha > Q_{\alpha'}$. ■

4 Pre-emption and "Use-it-or-lose-it" Clauses

Actual implementation of auctioned quotas is sometimes accompanied by a "use-it-or-lose-it" (U/L) requirement. Roughly, this requirement amounts to the imposition of significant penalties on quota-license holders that do not exercise their right to import (through the loss of some deposit or the exclusion from future quota auctions, for instance).¹² Even though some of these costs are of a dynamic nature, we can model them simply as an infinite cost associated with the existence of sleeping quotas. Hence, it is optimal to use the totality of quota licenses acquired.

¹²See Bergsten *et al.* (1987), p. 91.

The monopolist's two-stage problem is as follows. The second stage's maximum profit is

$$\pi(\alpha) \equiv \max_{\tilde{Q}_\alpha, \tilde{\alpha}} \left\{ D[\tilde{Q}_\alpha + (1 - \alpha + \tilde{\alpha})q](\tilde{Q}_\alpha + \tilde{\alpha}q) - P^*\tilde{\alpha}q - TC_0(\tilde{Q}_\alpha) \right\} \quad (13)$$

s.t. $0 \leq \tilde{\alpha} \leq \alpha$.

The monopolist's overall problem can then be written as

$$\max_{\alpha} \{ \pi(\alpha) - r(\alpha)q\alpha \}, \quad (14)$$

where $r(\alpha)$ stands for the price of a unit-quota license.

Note, crucially for the remainder of the paper, that $r(\cdot)$ is increasing in α . Intuitively, the larger the part of the quota possessed by the monopolist in the second stage, the lower will be total output (Lemma 2) and the higher will be market price, and hence the higher the value of a unit-quota license in the first stage.¹³

In what follows, let $\tilde{Q}_{\alpha^*}^*, \tilde{\alpha}^*$ denote the solution to (13), α^* denote the solution to (14), and $Q_{\alpha^*}^* = \tilde{Q}_{\alpha^*}^* + (1 - \alpha^* + \tilde{\alpha}^*)q$ denote total output and $D[Q_{\alpha^*}^*]$ denote the domestic price associated with those solutions.

¹³In the clarifying words of an anonymous referee: "The first-stage license price, $r(\cdot)$, is the perfect foresight estimate by the competitive fringe of importers of the value of a license in the second period. The monopolist knows that r is rising in α because it knows the competitive fringe sees through to the second-stage behavior of the monopolist, governed by Lemma 2."

4.1 Indivisible Quotas

In the first stage, how much is the monopolist willing to bid for the quota? Consider the case of an indivisible quota, where the monopolist must decide whether to bid for the whole quota (total pre-emption) or not at all. Then,

Proposition 1 *The monopolist always outbids importers in an auction of an indivisible quota, even under a U/L clause.*

Proof The indivisibility of the quota implies that (14) is subject to the restriction $\alpha \in \{0, 1\}$.

Consider first the case without the U/L clause. We claim that $\alpha^* = 1$. Suppose not. Then $\alpha^* = 0$. In this case, the monopolist produces domestically $\bar{Q}_0^*$, the domestic price equals $D[Q_0^*]$, and the importers' bids for the quota equal $(D[Q_0^*] - P^*)q$. Consider the following deviation. The monopolist bids $(D[Q_0^*] - P^*)q$ for the quota, produces $\bar{Q}_0^*$ domestically and imports and sells q . Total output will still be Q_0^* and price will remain equal to $D[Q_0^*]$. Hence, from (14) and (13) respectively, the monopolist's first stage cost and its second stage revenue will vary by $(D[Q_0^*] - P^*)q$. However, this is not the optimal deviation since Lemma 2 shows that full re-optimization leads to a decrease of total output below Q_0^* . Therefore, full re-optimization allows the monopolist to increase its overall profit (increasing revenue with total bidding cost constant, due to the indivisibility). This, in turn, ensures that it outbids importers. Hence, $\alpha^* = 1$, rather than $\alpha^* = 0$, is the solution to

(14).

Without the clause, the equilibrium of the game comprises two cases: (i) it is optimal for the monopolist to import the whole quota: (ii) it is optimal for the monopolist to import less than the whole quota. In case (i), the introduction of the U/L clause is redundant. In case (ii), the U/L clause alters the equilibrium, but it continues to be optimal for the monopolist to outbid importers. The monopolist can always buy the quota and reproduce the Bhagwati equilibrium. However, in the Bhagwati equilibrium the rents associated with the quota are received by the importers, whereas in this case the monopolist owns the quota and receives the rents. Hence, it has an incentive to restrict domestic production beyond what is optimal in the Bhagwati equilibrium, thus increasing the rents. This, in turn, implies that the monopolist outbids the importers as claimed. ■

The monopolist has more to gain from pre-emptively buying the indivisible quota, thus further increasing its market power, than the importer has to gain from buying it. This is termed the efficiency effect [Fudenberg and Tirole (1986)], and arises due to the non-cooperative nature of the game generating the market equilibrium in the case where the importers buy the quota. This phenomenon also underlies the main result in Gilbert and Newbery (1982).

An obvious corollary to Proposition 1 is that the domestic market will become completely monopolized when the quota is indivisible.

4.2 Perfectly Divisible Quotas

We consider the case where the quota is perfectly divisible in the following proposition. It also allows us to easily address the effect of U/L requirements. We show that the monopolist will not buy the quota at all, and thus will not enlarge its monopoly power by pre-emption.

Proposition 2 *In the first stage, the monopolist does not outbid importers for any amount of a perfectly divisible quota whenever, in the second stage, it is optimal to import the total amount of the quota licenses acquired.*

Proof Formally, we want to prove that $\bar{\alpha} = \alpha$ implies $\alpha^* = 0$. Replacing $\bar{\alpha} = \alpha$ in (13), one obtains

$$\pi(\alpha) \equiv \max_{\tilde{Q}_\alpha} D[\tilde{Q}_\alpha + q](\tilde{Q}_\alpha + \alpha q) - P^* \alpha q - TC_0(\tilde{Q}_\alpha). \quad (15)$$

Making use of the envelope theorem, the left-hand side of the first-order condition to (14) equals

$$D[\tilde{Q}_\alpha + q]q - P^* q - r'(\alpha)q\alpha - r(\alpha)q. \quad (16)$$

Finally, noting that for a perfectly divisible quota the bidding price of a unit-quota license equals the difference between the domestic and the world price, which, in this case, implies $r(\alpha) = D[\tilde{Q}_\alpha + q] - P^*$, one concludes that the first-order condition to (14) is negative. Hence, $\alpha^* = 0$ is the solution to (14). ■

Under a U/L clause, modeled as an infinite cost associated with unused quotas, it is always optimal to use any amount of the quota acquired. Therefore, by Proposition 2, the U/L clause prevents the monopolist from acquiring any amount of the quota.

An obvious corollary to Proposition 2 is that the domestic market does not become completely monopolized when the quota is perfectly divisible.

The result above hinges on the fact that if the quota is perfectly divisible, the larger the amount of the quota held by the monopolist, the higher the output price will be, and hence the value of holding licenses to import. This is so because market price is inversely related to the amount of production supplied by the importers: they sell every unit they have the right to import, whereas the monopolist restricts production to avoid infra-marginal losses. This result is reminiscent of Lewis (1983), where a dominant firm and entrants compete to discover sources of an input.

4.3 Imperfectly Divisible Quotas

We now discuss the case of an imperfectly divisible quota.

Proposition 3 *In the first stage, the monopolist partially or totally outbids importers in an imperfectly divisible quota auction, even under a U/L clause.*

Proof Here α^* , the solution to (14), represents the sum of the “lumps” bought at auction by the monopolist. We claim that $\alpha^* > 0$. Suppose not. Then, $\alpha^* = 0$, domestic production equals Q_0^* , and the domestic price equals

$D[Q_0^*]$. Hence, importers' bids for all quota lumps equal $D[Q_0^*] - P^*$ on a per unit quota license basis. Let $\bar{\alpha}$ be any quota lump and consider the following deviation. The monopolist bids $(D[Q_0^*] - P^*)\bar{\alpha}$ for $\bar{\alpha}$, imports $\bar{\alpha}$, and produces domestically Q_0^* . *Ergo*, total output still equals Q_0^* and domestic price remains equal to $D[Q_0^*]$. Therefore, from (14) and (13) respectively, the monopolist's first-stage cost and its second-stage revenue will vary by $(D[Q_0^*] - P^*)\bar{\alpha}$. However, this is not the optimal deviation, since Lemma 2 shows that full re-optimization leads to a decrease of total output below Q_0^* . Therefore, full re-optimization allows the monopolist to strictly increase its profit. This, in turn, implies that it does outbid importers for $\bar{\alpha}$. Hence, $\alpha^* > 0$, rather than $\alpha^* = 0$, is the solution to (14).

The argument in the second part of the proof of Proposition 1 suffices, *mutatis mutandis*, to show that the optimal solution is still $\alpha^* > 0$ under a U/L clause. ■

Note that this result does not imply that the monopolist will only buy a single lump, but rather that it will buy *at least one* such lump. Whether the monopolist buys more than one lump depends on the net result of two opposite effects. On the one hand, it would like to acquire more lumps in order to further its monopoly power (by the mechanism made explicit above). On the other hand, by doing so it increases the bid cost of *all* quota lumps (by a mechanism similar to that highlighted in the discussion of perfectly

divisible quotas in section 4.2).

5 Sleeping Quotas

Whenever U/L clauses are absent, sleeping quotas are a possibility. We now state the main results concerning the occurrence of sleeping quotas.

Proposition 4 *The monopolist does not use whatever portion of a perfectly divisible quota it has bought at auction ($\bar{\alpha}^* = 0$ with $\alpha^* > 0$).*

Proof The Lagrangean associated with (13) can be written as

$$\mathcal{L} = D[\bar{Q}_{\alpha^*} + (1 - \alpha^* + \bar{\alpha})q](\bar{Q}_{\alpha^*} + \bar{\alpha}q) - P^* \bar{\alpha}q - TC_0(\bar{Q}_{\alpha^*}) + \lambda_0 \bar{\alpha} + \lambda_{\alpha}(\alpha^* - \bar{\alpha}). \quad (17)$$

The first-order conditions are

$$\begin{aligned} \frac{\partial \mathcal{L}}{\partial \bar{\alpha}} &= (D'(\bar{Q}_{\alpha^*} + \bar{\alpha}^*q) + D - P^*)q + \lambda_0 - \lambda_{\alpha} \leq 0 (= 0), \\ \bar{\alpha}^* &\geq 0 (> 0); \end{aligned} \quad (18)$$

$$\frac{\partial \mathcal{L}}{\partial \bar{Q}_{\alpha}} = D'(\bar{Q}_{\alpha^*} + \bar{\alpha}^*q) + D - C_0'(\bar{Q}_{\alpha^*}) = 0; \quad (19)$$

$$\frac{\partial \mathcal{L}}{\partial \lambda_0} = \bar{\alpha}^* \geq 0 (= 0), \quad \lambda_0 \geq 0 (> 0); \quad (20)$$

$$\frac{\partial \mathcal{L}}{\partial \lambda_{\alpha}} = \alpha^* - \bar{\alpha}^* \geq 0 (= 0), \quad \lambda_{\alpha} \geq 0 (> 0). \quad (21)$$

Note that by construction

$$\lambda_0 \lambda_{\alpha} = 0. \quad (22)$$

Suppose that the claim is false, i.e., $\bar{\alpha}^* > 0$. Then (18) holds with equality.

Making use of the envelope theorem, the first order condition associated with

problem (14) is

$$-D'(\bar{Q}_\alpha^* + \bar{\alpha}^* q)q - r(\alpha^*)q - r'(\alpha^*)\alpha^* q = 0. \quad (23)$$

Replacing this equation in (18), and noting that $r(\alpha) = D - P^*$, one obtains

$$-r'(\alpha^*)\alpha^* q = \lambda_\alpha - \lambda_0. \quad (24)$$

The left-hand side of this equation is negative (recall, from section 4, that $r'(\cdot) > 0$), implying $\lambda_\alpha < \lambda_0$. This, together with (22), leads to $\lambda_\alpha = 0$. Hence, $\lambda_0 > 0$, i.e., $\bar{\alpha}^* = 0$, a contradiction. *Ergo*, whatever units of a perfectly divisible quota are bought by the monopolist at auction end up sleeping. ■

The following proposition answers the same query regarding imperfectly divisible quotas.

Proposition 5 *The monopolist imports less than the smallest of the lumps of an imperfectly divisible quota it has bought at auction.*

Proof Now α^* , the solution to (14), represents the sum of the lumps bought at auction by the monopolist. Let $\underline{\alpha}$ denote the smallest of the lumps acquired by the monopolist. Note that, by Proposition 3, $\alpha^* > 0$ and therefore $\underline{\alpha}$ is well defined.

We claim that $\bar{\alpha}^* < \underline{\alpha}$. Suppose not. Then $\bar{\alpha}^* \geq \underline{\alpha}$. Take another situation where the monopolist does not bid for $\underline{\alpha}$, acquires only $\alpha^* - \underline{\alpha}$ in the

first-stage auction, produces domestically $\bar{Q}_\alpha^*$ and imports $\tilde{\alpha}^* - \underline{\alpha}$. Total production will still be Q_α^* , the only difference being that imports associated with $\underline{\alpha}$ will be made by an importer, rather than the monopolist. Hence, domestic price will still equal $D[Q_\alpha^*]$. Therefore, the importers' bids for $\underline{\alpha}$ equal $D[Q_\alpha^*] - P^*$ per unit quota license. *Ergo*, the monopolist will save $(D[Q_\alpha^*] - P^*)\underline{\alpha}q$ by not bidding for $\underline{\alpha}$ in the first stage. Also, using (13), its second-stage revenue will vary by $-(D[Q_\alpha^*] - P^*)\underline{\alpha}q$. However, the deviation just outlined does not describe the full re-optimization possible. By Lemma 2 we know that total production increases beyond Q_α^* when the monopolist acquires $\alpha^* - \underline{\alpha}$ of the quota. Hence, the deviation considered above can be improved upon. This in turn ensures that the monopolist's profit was not maximal in the initial situation. Therefore, $\tilde{\alpha}^* < \underline{\alpha}$. ■

One may wonder whether a similar proposition can be derived for the indivisible quota case. The answer is No. The crucial element for establishing Propositions 4 and 5 is that each additional quota unit bought by the monopolist does not directly contribute towards its profit but increases market price (since the monopolist, unlike importers, has an incentive to reduce quantity) and hence the cost of the infra-marginal quota units bought at auction by the monopolist. However, when the quota is indivisible, such effect cannot occur.

Regarding the last two propositions, it is interesting to ask why the monopolist, once in the possession of part of or all the quota, does not use it to import, particularly if imports are cheaper than the domestic price. After all, the amount paid at auction for the quota licenses is sunk. The explanation is simple.¹⁴ The monopolist can buy a quota unit either to import or to restrict total quantity sold. In the perfectly divisible quota case any quota license used to import does not increase profits, since the equilibrium domestic price equals the price of a unit-quota license plus the price of imports.¹⁵ Hence, the only reason why the monopolist may want to buy a quota license is to restrict total quantity sold. Here, subgame perfection tells us that the smaller P^* is, the higher the price will be of a quota license at auction, and hence the less interesting it is for the monopolist to reduce total supply by controlling imports through the quota auction. The monopolist might even opt for not buying the quota at all. Proposition 7 below deals with this issue.

It is of interest to characterize conditions under which the quota is totally used to import. In the indivisible quota case, once in the possession of the quota, the monopolist is in a situation analogous to that of a monopolist with two plants. Hence, the lower P^* is, the higher will be the proportion of the quota that is used to import. It is easy to construct examples where the monopolist uses all, part, or none of the indivisible quota bought at auction.

¹⁴We will restrict attention to the perfectly divisible quota case. The argument applies similarly, *mutatis mutandis*, to the imperfectly divisible quota case.

¹⁵Note again that this argument depends crucially on the divisibility of the quota.

Proposition 6 gives a necessary and sufficient condition for the quota to be fully utilized, i.e., for the absence of a sleeping quota.

In the imperfectly divisible quota case we have seen that the monopolist always buys at least one lump (Proposition 3), and the quota is never fully used (Proposition 5).

It is easy to characterize the condition for an indivisible quota to be totally used to import.

Proposition 6 *An indivisible quota is totally used to import by the monopolist if and only if*

$$C_1(Q^*) > P^*. \quad (25)$$

Proof The monopolist's second-stage problem is analogous to that of a monopolist with two plants, in which one of the plants (imports) is capacity constrained (by the quota). This capacity is fully utilized (absence of sleeping quotas) as long as marginal cost in the domestic plant is higher in equilibrium than the marginal cost of the constrained plant. ■

Finally, in the perfectly divisible case the following proposition gives a sufficient condition for the quota to be totally used to import.

Proposition 7 *A perfectly divisible quota is completely bought by the importers, and thus used to import, if*

$$P^* < C_0(\bar{Q}_0).$$

Proof Suppose not. Then the monopolist buys part of or all the quota, say αq , $\alpha \in (0, 1]$, which by Proposition 4 it does not use to import. It thus loses $P_\alpha - P^*$ per unit of the quota bought at auction. Suppose instead that the monopolist bids for slightly less of the quota and simultaneously decreases domestic production by the same amount. Total production will remain constant, and thus the domestic price will still be P_α . By doing so, the monopolist avoids a loss of $P_\alpha - P^*$ per unit quota license, but incurs a loss of profit of $P_\alpha - C_0(\tilde{Q}_\alpha)$ per unit reduction of output of domestic production. Note that $P^* < C_0(\tilde{Q}_0) < C_0(\tilde{Q}_\alpha)$, where the hypothesis explains the first inequality, and Proposition 4 and noting that the monopolist's total supply is positively related to its share of the quota, explains the second one. Finally, these inequalities imply

$$P_\alpha - P^* > P_\alpha - C_0(\tilde{Q}_\alpha). \quad (26)$$

Hence, it cannot be optimal for the monopolist to buy any quota units at auction. ■

6 Conclusions

The main results of the analysis are the following: A perfectly divisible quota will not be used by the monopolist whatever share it has bought at auction, thus becoming a partially or totally sleeping quota. An imperfectly divisible quota will always be at least partially bought by the monopolist and will

be used only up to its smallest "lump," thus becoming a partially or totally sleeping quota. An indivisible quota will always be bought by the monopolist. The emergence of a sleeping quota depends on the relative costs of importing versus producing domestically.

It is clear from the analysis that the more divisible the auctioned quota is, the smaller the incentive for pre-emption will be.

U/L clauses prevent the appearance of sleeping quotas but, apart from the perfectly divisible quota case, at least partial pre-emption will occur.

Can the trade authority prevent the monopolist from buying the quota by excluding it from the quota auction? That can hardly be the case. The incentive for the monopolist to acquire it in a secondary market from the importers, after they have bought it from the government, is exactly the same as in the analysis above, as long as transactions costs are negligible. Hence, unless the monopolist is somehow prevented from holding the quota, all of the analysis presented in this paper, particularly the possibility of a sleeping quota, remains valid.

Interestingly enough, Krishna's (1993) main theorems are closely related to our Proposition 3. In fact, she argues that the monopolist will always buy the *last* lump, (as noted above, whether it buys the others depends upon the relative size of the different lumps, and the order in which they are auctioned) whereas we show that the monopolist will buy *at least one* such lump. The two results are related, again, the difference resulting from

the particular nature of the auction format assumed by Krishna, namely its sequential nature.

Our simplifying small-country assumption does not render our results less general. In fact, in a two country framework, in the absence of retaliation, the monopolist would have another incentive to let quotas sleep, because by so doing it can reduce the import price and earn a higher rent. This, in turn, implies that it has an extra incentive to pre-empt in the first stage.

One may wonder about the reasonableness of assuming price-taking behavior by the importers in the domestic market. In particular, in the case of an indivisible quota, it is certainly true that an importer holding the quota can behave as a duopolist *vis-à-vis* the "monopolist," rather than import and sell the amount of the quota at the ongoing market price. This does not alter some of our conclusions. To see this, denote the profit (per time period for which the quota is issued) made by the monopolist when it holds the quota Π^M , its profit when an importer holds the quota Π^m , and the importer's profit when it holds the quota Π^i . As long as $\Pi^M - \Pi^m > \Pi^i$, i.e., $\Pi^M > \Pi^m + \Pi^i$ the monopolist has an incentive to outbid the importers in the auction for the quota. This condition certainly holds since the non-cooperative nature of the game between the monopolist and the quota-holder, when the latter holds the quota, implies some profit dissipation, or, to use an argument similar to that made in the proof of Proposition 1, the monopolist can certainly match the importers' bids and reproduce the duopoly outcome. Since it can

do better than that, it will outbid the importer in the auction for the quota.

Things get more complex, in terms of modeling strategy, when we consider a perfectly divisible or imperfectly divisible quota, since the value of the quota licenses is now not only a function of the quota licenses held by the monopolist, but also of how many importers bid successfully, and the distribution of quota licenses among them. We will not dwell upon these complexities in this paper.

We have implicitly assumed that there is no capital mobility. Had we assumed the possibility of FDI, the domestic monopolist might refrain from exercising its monopoly power (both as a producer and a quota bidder) to reduce the incentive for foreign competitors to enter the home market. Again, these complexities are beyond the scope of our paper since they would involve an altogether different game-theoretical model.

Finally, some policy implications emerge from the analysis. The problems highlighted in this paper concerning auctioned quotas can be seen as another argument for the preference for tariffs over quotas as trade instruments.

Moreover, if auctioned quotas are to be used, then the more divisible they are, the smaller the scope for monopolization. Also, U/L clauses are in some instances effective in preventing monopolization of the domestic market.

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