NBER WORKING PAPER SERIES

# MAKING ALTRUISM PAY IN AUCTION QUOTAS

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Working Paper No. 3230

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
January 1990

Financial support from The World Bank and the Center for International Affairs at Harvard is gratefully acknowledged as is support from the National Science Foundation under Grant No. SES8822204. I am indebted to Phillip Swagel for excellent research assistance, and to Peter Neary for very valuable comments on an earlier draft. This paper is part of NBER's research program in International Studies. Any opinions expressed are those of the author not those of the National Bureau of Economic Research.

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## ABSTRACT

With imperfectly competitive product markets, producers react to the auction of quota licenses by adjusting price upwards from the free trade level. As a result, license revenues are significantly lower than if markets were perfectly competitive. In fact, they are often zero unless quotas are very restrictive. In such markets, giving part of these revenues to the producers reduces the incentive to raise product prices and leads to the reappearance of revenues from auctioning quota licenses. With a foreign monopoly and no price discrimination, such a policy can lead to a *Pareto improvement* over free trade. The conditions under which such altruism raises welfare both from free trade and from the status quo are explored.

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## 1. INTRODUCTION

One of the most common criticisms of voluntary export restrictions (VERs) and the way that quotas are currently allocated is that they allow foreigners to reap the rents associated with the quantitative constraints. It has been suggested that auctioning import quotas would remedy this. It is claimed that:

> "this would leave the price support features of quotas intact but deliver the higher profits to the U.S. economy instead of abroad."[1]

In an article in Business Week, Alan Blinder argues that:

> "Auctioning import rights is one of those marvelous policy innovations that create winners, but no losers, or, more precisely, no American losers. The big winner is obvious: the U.S. Treasury, . . ."[2]

An article in Time magazine quotes C. Fred Bergsten as saying that:

> "Quota auctions might bring in revenues as high as $7 billion a year."[3]

A Congressional Budget Office (CBO) memorandum estimates quota rents possible in 1987 to be about 5 billion dollars.[4] It compares this to the Bergsten et al. (1987) estimate for the Institute for International Economics (IIE) of $9 billion. Part of the difference, $2.2 billion, arises because the CBO does not include a VER on automobiles while the IIE does. The remainder of the difference arises from differences in procedure. Both estimates assume perfect competition everywhere. Takacs (1987) points out that proposals to auction quotas have become increasingly frequent.[5] She states: "Commissioners Ablondi and Leonard of the U.S. International Trade Commission (ITC) recommended auctioning sugar quota licenses in 1977. The ITC recommended auctioning footwear quotas in 1985. Studies by Hufbauer and Rosen (1986) and Lawrence and Litan (1986) suggested auctioning quotas and earmarking the funds for trade adjustment assistance."[6] There is even a recent book (Bergsten, et al, 1987) devoted entirely to auction quotas.

Despite the importance of the issues involved, the intuition behind such statements and the procedure used in the estimates is based on models of perfect competition.[7] In such models, the level of the quota determines the domestic price, and the difference between the domestic price and the world price determines the price of a license. If the country is small, then the world price is given. If the country is large, then the world price changes with a quota. How the world price changes is determined by supply and demand conditions in the world market.

However, when markets are imperfectly competitive, this analysis is misleading. The reason is that in such environments, prices are chosen by producers, so that there is no supply curve. Producers' responses to the constraint must therefore be taken into account when determining the price of an auctioned license. For example, if profit maximizing producers adjust their prices upwards to exactly clear the quota-constrained market, then there is no benefit to be derived from owning a license to import, so that its auction price must be zero!

In previous work (Krishna, 1988, 1988a, 1989, 1989a) I develop a series of models of monopoly and oligopoly that show how the way in which licenses are sold, demand conditions, and market structure influence the resulting price of a license. The results indicate that the price of a license in imperfectly competitive industries may be much lower than that indicated by applying models of perfect competition. Revenue estimates such as those of the IIE and CBO may thus be far too large. I further show that no revenues are raised from auctioning quotas in the absence of uncertainty unless they are quite restrictive.

In this paper I show that giving away a portion of the import licenses to the foreign firm is one way of raising revenue from the auctioning of quota licenses. This, in turn, affects the comparison between the optimal policy and free trade, and between auctioning existing quotas and a VER. Both these comparisons are dealt with below.

The point that "altruism" may be in the nation's best interest is made in the simplest possible model: that of foreign monopoly. The model used is basically that of Krishna (1988a). The point, generally, is that giving some of the licenses away to the foreign producer affects his pricing decision. The producer must now consider not only gross profits but also the value of the licenses given to him by the government. Giving away some of the quota licenses thus makes it more costly for the firm to extract the quota rents from the domestic market by raising his price, which limits his attempts to do so. This in turn raises the price of licenses that remain in the hands of the government. I show that such policies can lead to a Pareto improvement over free trade. The reason for this is that if the equilibrium price of a license is positive, the quota allows the foreign monopolist to effectively segment the domestic and foreign markets. The price to consumers at home differs from that to consumers abroad by the amount of the license price. This price discrimination raises world welfare while the license allocation causes a positive license price which allows segmentation and permits redistribution of gains in a Pareto improving manner.

In this way the paper is part of a small but growing literature which examines the optimal behavior of a small open economy facing a foreign monopoly supplier. The adjective "small" refers to the fact that the home country cannot directly affect the monopolist's objectives and cost conditions or the demand it faces in other foreign markets it serves.

The early papers in this literature implicitly assumed that markets were internationally segmented, so that, with constant costs, the home country's policies could be considered independently of demand conditions abroad.[8] The present paper pursues an approach pioneered by Jones and Takemori (1987). Here, markets are "naturally" integrated, in the sense that there are no transport costs or other impediments to goods arbitrage, but trade policy can potentially induce market segmentation. In the case of a tariff, considered by Jones and Takemori (1987), this raises the potential of a welfare gain whenever the monopolist can be induced to discriminate in favor of the home country. In the case of the present paper, it raises the potential of a positive price for quota licenses which allows for some market segmentation. The results of the two papers are therefore related to one another.

In this paper I assume that the market for licenses is competitive and thus side step many interesting issues raised by the auction design literature. I do this because this literature is not well suited to my purpose. The main problem is that it deals with an exogenously specified distribution of values of object(s) being auctioned.[9] However, these valuations are better specified as endogenous here as they are derived from the operation of a secondary market--that for the imported good. In this setup, valuations cannot be defined independently of the allocation of the object. Thus one would need to deal with endogenous valuations and multiple objects in the design of auctions. As my interest here is on the behavior of producers, I choose to avoid the implications of strategic behavior in the market for licenses by assuming competition.[10]

In section 2 the model is set up. I show that if markets are segmented license revenues remain zero even when the monopolist obtains some of the licenses. Section 3 analyzes the case when markets are not segmented. I first examine the base case where the monopolist gets all the licenses. I show that if home demand is more elastic than that abroad, a license will have a zero price unless the quota is quite restrictive[11]. If the reverse is true, a license has a positive price, and markets are effectively segmented by the quota. In the first case the price charged by the firm rises with a quota, and in the second case it falls. This is related to Jones and Takamori's result in that in the former case the price charged by the firm is unchanged for a small tariff, but can fall for a large enough tariff, and in the latter case it falls for all tariffs.

Section 4 examines the effect of varying the allocation of licenses and the level of the quota. The behavior of the firm is characterized and it is shown that if the home demand is more elastic than the rest of the world's demand, then no allocation of licenses can raise welfare. If the reverse is true, then auctioning quota licenses can lead to a Pareto improvement over free trade. Section 5 contains some simulation results for this case. The optimal levels of the quota and the share of licenses to the monopolist are calculated so as to maximize a weighted sum of license revenues and consumer surplus. Their sensitivity to parameter values is also calculated.

Section 6 summarizes the results, draws out their implications, and suggests directions for future work.

## 2. THE MODEL

Let $Q(P)$ and $q(p)$ denote the demand functions facing the foreign firm in the home market and in the rest of the world, respectively. Let $C(q + Q)$ denote its cost function, and assume constant marginal costs equal to $C$. Similar results obtain when marginal costs are not assumed constant.

Assume that the firm's profit function in the domestic country, $R(P)$, is concave in $P$ and is maximized at $P^M$. Similarly, let $r(p)$ be the profits from sales in other market(s), and let $r(p)$ be maximized at $p^m$. It is easy to see that $P^M = \frac{E}{(E-1)}C$ and $p^m = \frac{e}{(e-1)}C$, where $E$ and $e$ are the respective demand elasticities. In the absence of arbitrage the monopolist would choose to charge a higher price in the market with less elastic demand. With costless arbitrage, the monopolist will choose one price which will be between the two prices he would have set in the absence of arbitrage possibilities. The optimal price for him to set maximizes $\pi(P) = R(P) + r(P)$, and is given by:

$$P^* = \frac{\bar{E}}{\bar{E}-1}C$$

where $\bar{E} = \theta E + (1-\theta)e$ and $\theta = \frac{Q}{q+Q}$. This is the "free trade" price $P^*$. The monopolist chooses price as if he were faced with one market where the elasticity of demand is a share weighted combination of the elasticities of the two markets. Of course, the existence of a monopoly is a distortion so that the free trade equilibrium is not first best. The question then is how a quota affects the price charged by the monopolist when the quota licenses are auctioned off. I first consider the base case where the monopolist receives all the licenses.

At this point it is important to be clear about exactly what constitutes a license, how licenses are sold, and what the timing of moves is. With market segmentation, a license is defined as a piece of paper which entitles its possessor to buy one unit of the product in question at the price charged by the seller in the license-holder's market. If arbitrage is possible, then the possessor buys at the lower of the prices charged by the seller in the home and the world market. However, it is a dominated strategy for the monopolist to attempt to charge different prices in his different markets, since sales will only be made at the lower of the two prices. For this reason, the monopolist can be restricted to choosing only one price.

The licenses are sold in a competitive market to either competitive domestic retailers with zero marginal costs of retailing or directly to consumers. I assume that the timing of moves is as follows. First, the government sets the quota and allocates the licenses. Then the monopolist sets his price and chooses how many licenses to use. Finally, the market for licenses clears. This timing is consistent with the idea that the market for licenses clears more frequently than the monopolist sets his choice variables, and that the government sets the quota even less frequently than the monopolist sets prices.

The model is then solved backwards as usual. First consider the market for licenses. If the price charged by the monopolist is $P$ and the price of a license is $L$, then the demand for licenses must be the same as the demand for the good at price $P+L$, $Q(P+L)$. The total number of licenses is $V$, the level of the quota. The monopolist gets a proportion $\lambda$ of these and chooses a fraction $u$ of these to use.[12] Hence, he chooses $u \leq \lambda V$. The remainder of the licenses, $(1-\lambda)V$ are always put on the market by the government.

The equilibrium price of a license is given by $L(P,u;\lambda,V)$.[13] $L(\cdot)$ is defined by the market for licenses clearing: $Q(P+L) = V(1-\lambda) + u$. Notice that if $Q(P) < (1-\lambda)V + u$, then $L(\cdot) < 0$ as defined thus far. However, since a quota is not binding if such a high price is charged, $L(\cdot)$ is defined to be zero in this case. Let $P(u;\lambda,V)$, the "virtual price" which corresponds to the quota level $(1-\lambda)V + u$ be defined by $Q(P) = (1-\lambda)V + u$ so that $L(P,u;\lambda,V) > 0$ and the quota is binding if $P \leq P(u;\lambda,V)$. By the definition of $L(\cdot)$, it is apparent that if $P < P(\cdot)$, then demand at home equals $V(1-\lambda) + u$, although this is less than $Q(P)$. $P(u;\lambda,V)$ is the "virtual price" of the quota level $(1-\lambda)V + u$. It is the price at which the amount offered for sale, $V(1-\lambda) + u$, is demanded.[14]

The monopolist chooses $P$ and $u$, which is constrained to be weakly below $\lambda V$, to maximize his total profits, which include license revenues for the given levels of $\lambda$ and $V$. Note that the price charged by the monopolist, $P$, is weakly below the price consumers face, the virtual price $P(\cdot)$ which equals $P + L(\cdot)$.

## 3. GIVING AWAY ALL THE LICENSES

Before we analyze how the monopolist sets $P$ and $u$ in the base case where he receives all the licenses $(\lambda = 1)$ and markets are not segmented, consider what their optimal values would be were the markets already segmented. Since markets are already segmented, there is no gain in using a positive license price to segment them. It is therefore optimal for the monopolist simply to choose $P$ and $u$ so as to appropriate all the license rents available. For any value of $\lambda$, and for any $V$ below the free trade level $Q(P^*)$, the monopolist chooses to use all of his licenses $(u = \lambda V)$, and sets price at $P(V)$ where $Q(P(V)) = V$. Because all licenses are sold $(u = \lambda V)$ and the price is set so that the market exactly clears, $L(\cdot) = 0$.

Now turn to the base case where markets are not segmented and $\lambda = 1$. It is useful to consider the cases of $e > E$ and $e \leq E$ separately.

Case A: $e > E$

Here the home market demand is less elastic than that abroad. In this case Figure 1a depicts the profits in the two markets and total profits under free trade. $P^M$, the profit maximizing price for the home market alone lies above $P^*$, the free trade price, which in turn lies above $P^m$, the profit maximizing price for the rest of the world alone.

FIGURE 1 HERE

Consider the profits of the firm if it chooses to use $u$ licenses and charge price $P$ when the quota is set at the free trade level, $V^* = Q(P^*)$.

$$\pi(P,u;1,V) = r(P) + (P-C)Q(P+L(P,u)) + L(P,u)u \quad \text{if} \quad P \leq P(u)$$
$$= r(P) + R(P) \quad \text{if} \quad P \geq P(u)$$

where:

$L(P,u) \equiv L(P,u;\ 1,V)$ is defined by $Q(P+L(\cdot)) = u$ as long as it is positive, and by zero, otherwise. Note that if $P$ exceeds the virtual price, then $L(\cdot) = 0$.

$P(u) \equiv P(u;\ 1,V)$ is defined by $Q(P(\cdot)) = u$.

Hence:

$$\pi(\cdot) = r(P) + [P(u) - C]u \quad \text{if} \quad P \leq P(u) \qquad (1)$$

$= r(P) + R(P) \qquad\qquad \text{if} \quad P \geq P(u)$ .

As $[P(u) - C]u$ can be represented by $R(P)$, the optimal $u$ and $P$ are apparent by inspection. Since $[P(u) - C]u$ is the only component of profit which depends on $u$, $u$ should be set at the level which maximizes profit subject to $u \leq V$. As is apparent from Figure 1a, this corresponds to $u = Q(P^M)$ if $V = V^*$. Given this, the optimal choice of $P$ maximizes $r(P)$, e.g., is $P^m$. This yields a license price of $L = P^M - P^m$. Notice that the profits under this policy are exactly those of a price discriminating monopolist. These policies are optimal for all $V \geq V^*$; that is, the monopolist ignores being "allowed" to sell more than he would have chosen to in the absence of the quota.

If $V < V^*$, but more than $Q(P^M)$, the profit maximizing policies are unchanged as is the maximized level of profits. If $V < Q(P^M)$, then it is optimal to set $u = V$, and $P = P^m$ so that $L(\cdot) = P(V) - P^m > P^M - P^m$. However, the maximized level of profits falls with $V$.

Case B: $e \leq E$

If on the other hand, $e \leq E$, then $P^M < P^* < P^m$, as depicted in Figure Ib. The monopolist would like to discriminate in favor of the home country but cannot under either free trade or a quota. In this case, it is again optimal to choose $u$ to maximize $[P(u) - C]u$. As this occurs when $Q(P^M) = u$, this level of $u$ exceeds $V$ when $V = V^*$. Hence, the optimal level of $u$ equals $V^*$. However this reduces profits of the firm below its free trade level for $P \leq P^*$ and makes $P^*$ the optimal price. Hence, $L(\cdot) = 0$ if $V = V^*$. It is easy to verify that the optimal $P$ and $u$ are as follows:

| V | P | u | L |
|---|---|---|---|
| $V \le Q(P^m)$ | $P^m$ | V | $P(V) - P^m$ |
| $Q(P^m) < V < V^*$ | P(V) | V | 0 |
| $V^* \le V$ | $P^*$ | $V^*$ | 0 |

Figures 2a and 2b depict the path of optimal price charged by the firm for every V and the price paid by consumers.

FIGURE 2 HERE

The main results so far are summarized in Proposition 1.

Proposition 1: If $e > E$ and $\lambda = 1$, the license price is positive for all V. If $e \le E$ and $\lambda = 1$, the license price is zero unless $V < Q(P^m) < V^*$.

The consideration of these base cases, and the use of continuity arguments, shows that the government derives revenues from the auction of licenses for $\lambda$ close to 1 if $e > E$, but not if $e \le E$.

## 4. VARYING THE QUOTA AND THE PROPORTION GIVEN TO THE MONOPOLIST

When $e > E$ and all licenses are allocated to the monopolist, he acts like a price discriminating monopolist and obtains the profits of such a monopolist by allowing the license price to be positive. However, in this case the government earns no revenues. The question then is whether the license price remains positive when the government retains some licenses. If this is so, the government can obtain non-negative revenues by retaining some licenses.

When the monopolist gets a proportion, $\lambda$, of the quota V, his profits, which are continuous in P and u, are given by:

$$\pi(P,u;\ \lambda,V) = r(P) + (P-C)Q(P+L(\cdot)) + L(\cdot)u \quad \text{if} \quad P \leq P(u;\lambda,V) \tag{2}$$

$$= r(P) + R(P) \quad \text{if} \quad P \geq P(u;\lambda,V)$$

where $L(P,u;\ \lambda,V)$ is defined by $Q(P+L(\cdot)) = u + (1-\lambda)V$, and $P(u;\lambda,V)$ by $Q(P(\cdot)) = u + (1-\lambda)V$ with $u \leq \lambda V$. In other words, $P(u;\lambda,V) = P + L(\cdot)$, so that $P(\cdot)$ is again the "virtual price".

First consider the firm's choice of $u$. Rewriting profits yields:

$$\pi(\cdot) = r(P) + (P-C)(1-\lambda)V + (P(u;\lambda,V) - C)u \quad \text{if} \quad P \leq P(u;\lambda,V)$$

$$= r(P) + R(P) \quad \text{if} \quad P \geq P(\cdot) \quad .$$

Hence $u$ is chosen to maximize $[P(u;\lambda,V) - C]u$. Note that

$$\frac{dP(u;\lambda,V)}{du} = \frac{1}{Q'(P(u;\lambda,V))} \ .$$

Thus, if $[P(\cdot) - C]u$ is concave in $u$,[15] it is maximized at $u = \lambda V$ if at $u = \lambda V$:

$$\frac{1}{Q'(P(u;\lambda,V))} u + [P(\cdot) - C] \geq 0 \ .$$

If at $u = \lambda V$, the above is $< 0$, $[P(\cdot)-C]u$ is maximized at the $u$, denoted by $\tilde{u}(\lambda,V)$, which solves:

$$\frac{[P(\cdot) - C]}{P(\cdot)} = \frac{1}{E} \frac{u}{[u + (1-\lambda)V]} \ , \tag{3}$$

as $Q(P(\cdot)) = u + (1-\lambda)V$ by definition.

In addition, notice that:

$$[P(u;\lambda,V) - C]u = [P(\cdot) - C](u + (1-\lambda)V)\frac{u}{(u + (1-\lambda)V)}$$

$$= R(P(u;\lambda,V))\frac{u}{(u + (1-\lambda)V)}$$

$$= R(P(u;\lambda,V))\phi(u)$$

where $\phi(u) = \frac{u}{(u + (1-\lambda)V)}$ is increasing in $u$. Differentiating this with respect to $u$ gives:

$$\phi(u)R'(P(u;\lambda,V))P_u(u;\lambda,V) + R(P((u;\lambda,V)\phi'(u) \quad (4)$$

Note that if $P(u;\lambda,V) > P^M$, $R'(p(\cdot)) < 0$ and since $P_u(u;\lambda,V) < 0$ and $\phi'(u) > 0$, the sign of (4) is positive. If $P(\cdot) < P^M$, it is not determinate for all u, but is positive if $u$ is small enough, and could be negative if $u$ is large. Recall that if $E > e$ then $P^M < P^* < P^m$.

Since $P(\cdot)$ must exceed $P^*$ for any quota below the free trade level and any $u \leq \lambda V$, $P(\cdot)$ must exceed $P^M$ in this case. Hence, when $E > e$ the expression in (4) is positive for all $u \leq \lambda V$, and hence for $u = \lambda V$ so that the optimal value of $u$, $u(\lambda,V)$ equals $\lambda V$ independent of $\lambda$ and $V$, as long as $V$ is below the free trade level.

If $E < e$, then $P^M > P^* > P^m$. Hence (4) is positive at $u = \lambda V$ if $V < Q(P^M)$ as in this case $R'(P(\cdot))$ negative for $u = \lambda V$. If $V$ lies between $Q(P^M)$ and $Q(P^*)$, then $R'(P(\cdot))$ is positive at $u = \lambda V$ and (4) is positive if $\lambda$ is small but is negative if $\lambda$ is large since at $u = \lambda V$, (4) is given by:

$$\lambda R'(P(V))P_u(\lambda V;\lambda,V) + R(P(V))\frac{(1-\lambda)}{V}.$$

The critical value of $\lambda$ is of course implicit in the above equation. Hence $u(\lambda,V) = \lambda V$ if $\lambda$ is small and equals $\tilde{u}(\lambda,V)$ if $\lambda$ is large. This gives Lemma 1.

Lemma 1.

If $E > e$ then $u(\lambda,V) = \lambda V$ for all $\lambda$ and $V \leq V^*$. If $E < e$ and $V \leq Q(P^M)$ then again $u(\lambda,V) = \lambda V$. If $V$ is an element of $[Q(P^M),Q(P^*)]$, then $u(\lambda,V) = \lambda V$ if $\lambda$ is small and $u(\lambda,V) = \tilde{u}(\lambda,V)$ if $\lambda$ if large.

Since the profit maximizing choice of $u$ does not depend on $P$, but only on $\lambda$ and $V$, we denote this value of $u$ by $u(\lambda,V)$. Hence, the system which solves for the profit maximizing levels of $P$ and $u$ is recursive.

Now consider the optimal choice of P. We rewrite profits in yet another way to focus on this choice.

$$\begin{aligned}\pi(P,u;\lambda,V) &= r(P) + [P(u;\lambda,V) - C][u + (1-\lambda)V] - (1-\lambda)VL(\cdot) \\ &\qquad \text{if } P \leq P(u;\lambda,V) \\ &= r(P) + R(P) \quad \text{if } P \geq P(u;\lambda,V) \ .\end{aligned}$$

The second term in this expression for profits equals $R(P(\cdot))$ when $P \leq P(\cdot)$ and is not a function of $P$, but only of $u$. Also, as the optimal choice of $u$, $u(\lambda,V)$ is independent of $P$, the choice of $P$ need only be determined at $u = u(\cdot)$. In addition, since $P$ only enters the first and third terms in the above expression for profit, only these components are relevant in the choice of $P$.

The optimal choice of $P$ is a bit complex as the profit function is not concave. I will first outline the algorithm for determining $P$, and then explain it.

Lemma 2.

Assume that $r(P)$ and $R(P)$ are concave. Then, the optimal $P$ denoted by $P(\lambda,V)$ is determined as follows. First, replace $u$ by $u(\lambda,V)$ as determined above. Let $\tilde{P}(\lambda,V)$ be defined as the $P$ for which $r'(P) +(1-\lambda)V = 0$. In other words, $\tilde{P}(\lambda,V)$ maximizes $r(P) - (1-\lambda)VL(\cdot)$, which is the only component of profits which depends on $P$.

(a) If $r'(P) + (1-\lambda)V \geq 0$ at $P = P(u(\lambda,V);\lambda,V)$ and $P^* > P(u(\lambda,V);\lambda,V)$, then $P(\lambda,V) = P^*$.

(b) If $r'(P) + (1-\lambda)V \geq 0$ at $P = P(u(\lambda,V);\lambda,V)$ and $P^* \leq P(u(\lambda,V);\lambda,V)$, then $P(\lambda,V) = P(u(\lambda,V);\lambda,V)$.

(c) If $r'(P) + (1-\lambda)V < 0$ at $P = P(u(\lambda,V);\lambda,V)$ and $P^* > P(u(\lambda,V);\lambda,V)$, then compare $\pi(P^*)$ to $\pi(\tilde{P}(\lambda,V),u(\lambda,V);\lambda,V) = \pi(\tilde{P}(\lambda,V))$.
If $\pi(P^*) \geq \pi(\tilde{P}(\lambda,V))$, then $P(\lambda,V) = P^*$.
If $\pi(P^*) < \pi(\tilde{P}(\lambda,V))$, then $P(\lambda,V) = \tilde{P}(\lambda,V)$.

(d) If $r'(P) + (1-\lambda)V < 0$ at $P = P(u(\lambda,V);\lambda,V)$ and $P^* \leq P(u(\lambda,V);\lambda,V)$, then $P(\lambda,V) = \tilde{P}(\lambda,V)$.

Proof: The proof follows from examining Figures 3a - 3d, which depict profits in the four cases. $\bar{R}$ in each of these is that component of profits which is independent of $P$:

$$[P(u(\lambda,V);\lambda,V) - C][u(\lambda,V) + (1-\lambda)V]$$

which equals $[P(\cdot) - C]Q(P(\cdot))$ and hence is the value of $R(P)$ at $P(\cdot)$. Profits to the left of $P(\cdot)$ are the sum of $\bar{R}$ and $r(P) - (1-\lambda)VL(\cdot)$. $L(\cdot)$ is zero at $P(\cdot)$ and has slope $-1$. It is clear from inspection of Figure 3 that in each case the profit maximum corresponds to that stated in Lemma 2. ■

FIGURE 3 HERE

The optimal price for the monopolist is better understood from Figure 4(a) and (b) for $e > E$ and $e < E$ respectively. Since the price $P(\lambda,V)$ is either $P^*$, $\tilde{P}(\lambda,V)$ or $P(u;\lambda,V)$, these need to be identified. $P^*$ as well as $P^M$ and $P^m$ are labelled in Figure 4. $\tilde{P}$ is also shown. Note that $\tilde{P}(\lambda,V)$ equals $P^m$ when $V = 0$ for all $\lambda$. Also, as $V$ rises, $\tilde{P}(\lambda,V)$ rises. Moreover, $\tilde{P}(\lambda = 0, V = V^*)$ lies above $P^*$ since

$$r'(P^*) + V^* > r'(P^*) + (P^* - C)Q'(P^*) + Q(P^*) = r'(P^*) + R'(P^*) = 0 .$$

FIGURE 4 HERE

In addition, reducing $\lambda$ raises $\tilde{P}(\lambda,V)$ for a given $V$. $\tilde{P}(\lambda,V)$ is depicted for $\lambda = 0$, and $\lambda = 1$. For $\lambda\epsilon(0,1)$, it lies between these curves and is upward sloping. $P(u;\lambda,V)$ is not explicitly shown. However, recall that it must exceed $P(V)$ if $u < \lambda V$ and it equals $P(V)$ if $u = \lambda V$. $P(u;\lambda,V)$ is given by $P$ corresponding to demand equal to $u + (1-\lambda)V$ which exceeds $P^*$ if $V \le V^*$.

First note that for all $V \le V^*$, $P(u;\lambda,V) \ge P^*$. Hence, only cases (b) and (d) are relevant and the optimal price for a given $\lambda\epsilon(0,1)$ is the minimum of $P(u;\lambda,V)$ and $\tilde{P}(\lambda,V)$. If $E > e$, $P(\cdot) = P(V)$ and from 4(b) it is clear that both lie above $P^*$ for $V \le V^*$. Hence the price charged by the monopolist <u>must</u> exceed $P^*$ for <u>all</u> $\lambda$ and $V \le V^*$. But then welfare cannot rise even if $\lambda$ and $V$ are set optimally. This is because if the price charged by the monopolist exceeds $P^*$, even if all license revenues earned go to the government, this gain is outweighed by the loss in consumer surplus. A necessary condition for optimally set auction quotas to raise welfare above free trade is therefore that the price charged by the monopolist falls. This gives:

Proposition 2: If $E > e$, then even if the level of the quota and the share to the foreign firm are set optimally, welfare cannot rise from the free trade level.[16]

However, if the monopolist's price falls below the free trade price and much of the license revenue accrues to the government, welfare may rise above its free trade level. Notice in addition that if the price charged by the monopolist falls, consumers in the rest of the world gain. If the license price is positive, the monopolist can effectively price discriminate. Hence, if $\lambda$ is high, and $L(\cdot) > 0$, the monopolist's profits could also rise. Therefore, it is possible that only domestic consumers lose. If aggregate welfare rises, they can be compensated for this loss.[17]

The possibility that all parties could gain from such policies can be understood by noting that perfect price discrimination by a monopolist leads to maximization of world welfare. As quotas, when the license price is positive, allow price discrimination, world welfare could rise. This gain could possibly be distributed between the home country and the rest of the world so that in some cases all parties gain by the appropriate allocation of licenses.

There are two policy questions that need to be clearly differentiated. First, for a given level of a quota, is auctioning all of the quota better than not auctioning it? The second concerns the optimal levels of $\lambda$ and $V$.

In considering the first question, it is important to be clear about what constitutes the status quo, as the answer to whether auctioning off quotas is a good idea depends crucially on this.

I offer two alternative interpretations of the status quo. Which one, if either, seems more appropriate depends on exactly how existing quotas are implemented.[18] It is often claimed that the present system gives the quota license rents to foreigners. Should this be taken to mean that the status quo would coincide with $\lambda = 1$?[19] If we interpret the status quo as $\lambda = 1$, and auctioning all quotas as $\lambda = 0$, auctioning all quota licenses is quite attractive when $V$ is close to $V^*$. Whether $\lambda = 0$ or $\lambda = 1$, license revenues to the government are zero. Hence, we need only look at the price to consumers when $\lambda = 0$ as opposed to when $\lambda = 1$ to determine welfare effects. If $e > E$, domestic consumer prices are lower when $\lambda = 0$ than when $\lambda = 1$ as $P(V) < P^M$. If $e > E$ and $V$ is close to $V^*$, the price charged is the same when $\lambda = 1$ and $\lambda = 0$, and equals $P(V)$. Hence, when the status quo is $\lambda = 1$, and $V$ is close to $V^*$, auctioning existing quotas raises welfare if $e > E$, and does not affect welfare if $e < E$.

The interpretation that the status quo corresponds to $\lambda = 1$ could be argued to be inappropriate on the grounds that licenses are <u>not</u> awarded to the foreign firm. A more reasonable description might be that the firm is just constrained not to sell more than the quota. If it charges a low price and demand at this price exceeds the quota, whoever is lucky enough to get the good can resell it at the market clearing price and reap the implicit license rents. This corresponds to allocating licenses to foreign or domestic retailers or domestic consumers who resell the good thereby effectively selling these licenses in the competitive market and reap any license revenues that exist.

With this interpretation the status quo corresponds to the case where $\lambda = 0$, but the government does not get any license revenues: if these exist, they go to whoever gets the goods. In this case, auctioning off licenses for existing quotas with $\lambda = 0$ does not affect the firm's behavior. It can transfer rents to the government if the license price is positive. However, the license price with $\lambda = 0$ is unlikely to be positive unless the quota is very restrictive. Moreover, even if the license price is positive, the transfer of rents to the government is a net increase in welfare only if it comes at the expense of foreigners, rather than from domestic agents. For this reason, auctioning <u>all existing</u> quotas (i.e, $\lambda = 0$), will never raise welfare if all the goods were allocated to domestic agents under the status quo, and will raise welfare from the status quo if some of the goods were allocated to foreign agents in the status quo and $L(\cdot) > 0$. This, however, requires the quota to be restrictive.

However, if auctioning the quota involves setting $\lambda$ optimally, auctioning an existing quota becomes much more attractive: welfare when $\lambda$ is set optimally weakly exceeds that when $\lambda = 0$ or 1. Hence, it is always weakly better to auction the quota. Moreover, if the quota is not too restrictive and $e > E$, it is possible for welfare to even exceed that under <u>free trade</u> when $\lambda$ is set optimally. In fact, it is possible for such a policy to be Pareto improving! If $e < E$, the ability to set $\lambda$ optimally for a given quota is less valuable as the firm cannot segment the markets and the quota cannot be welfare improving. Notice that it is not necessary for license revenue to be positive for auctioning quotas to be better than the status quo.

The second policy question, to which the simulations are addressed, is what the optimal levels of $\lambda$ and $V$ are, and how they vary with domestic and foreign market size, demand elasticity, and the weight placed on revenue. Let $N$ and $n$ denote the number of home and foreign consumers. The home and foreign nations have a constant elasticity demand function given by $NP^{-E}$ and $nP^{-e}$, respectively. Let $\beta$ denote the weight on revenue raised in welfare. $\beta$ can be thought of as an estimate of the cost of raising revenue from alternative sources. I then examine how the optimal $\lambda$ and $V$ change with $\beta$. This addresses the desirability of auctioning quotas for revenue raising reasons without eliminating consumer welfare from the objective function. $\beta \to \infty$ corresponds to the revenue maximizing case, while $\beta = 1$ corresponds to maximizing the usual welfare function. Here I focus on the level of welfare when $\lambda$ and $V$ are set optimally compared with that under free trade. Welfare, $W$, is the usual sum of consumer surplus and revenue and is given by:

$$W(\lambda,V) = u(Q(\lambda,V)) - (P(\lambda,V) + L(\lambda,V))Q(\lambda,V) + \beta(1-\lambda)VL(\lambda,V)$$

where

$$Q(\lambda,V) \equiv u(\lambda,V) + (1-\lambda)V$$

and

$$L(\lambda,V) = L(P(u(\lambda,V)),u(\lambda,V);\lambda,V) \ .$$

$P(\lambda,V)$ and $u(\lambda,V)$ are of course the profit maximizing values of $u$ and $P$ chosen by the firm.

In the simulations I first explore the conditions under which welfare rises from free trade. Then, given a weight, $\beta$, on revenues, I find how the welfare maximizing policy varies with $\beta$. This addresses the question of how large $\beta$ has to be to make auction quotas better than free trade. The simulations were run for the interesting case, namely when $e > E$. Recall that when $e \leq E$ and $\beta = 1$, free trade is optimal by Proposition 2.

## 5. SIMULATION RESULTS

First consider the effect of raising $n$, shown in Figure 5. Depicted there are the optimal quota level as a fraction of free trade imports, the proportion of licenses used, and the maximized level of welfare as a proportion of free trade welfare. Note first that the quota is set close to the free trade level and that most licenses allocated are used. This keeps the price consumers face close to that under free trade so that consumer surplus loss due to the quota is limited. The excess of welfare above free trade welfare comes from license revenue. Second, note that welfare relative to free trade first rises and then falls, as the foreign size, $n$, increases. The extent of welfare gains is limited to about 5%. License revenues, not shown here, also rise and then fall as $n$ increases. This occurs because when $n$ is very small it is hard to obtain any license revenues. In this case, the home market is very important to the foreign firm and it sets prices so as to capture license revenues as in the market segmentation case. However, when $n$ becomes very large, $P^*$ gets close to $P^m$ so that the possible license revenues become small though it is easier to capture them. For this reason license revenues and welfare first rise and then fall with $n$. Hence, when $\beta = 1$ such policies are most desirable for large, but not too large countries.

FIGURE 5 HERE

However, it is often argued that there are greater costs of raising revenues from other sources because of induced efficiency losses so that $\beta$ typically exceeds unity. It is commonly thought to lie between 1 and 2[20] in developed countries though it may be higher for developing countries. Figure 6 depicts the effect of changing $n$ as $\beta$ varies. Two points are worth noting. First, that for a given $n$, welfare gains are fairly limited until a critical $\beta$, after which they rise more swiftly with $\beta$. The critical value of $\beta$ lies between 1 and 2 for $n$ between 1,000 and 10,000, and N = 300. Also, welfare gains tend to rise more quickly with $\beta$ when $n$ is large compared to when $n$ is small.

FIGURE 6 HERE

The reason for this seems to be that $\frac{d\tilde{P}(\lambda,V)}{dV}$ gets steeper as $n$ rises so that reducing $V$, given $\lambda$, raises the license price by more when $n$ is large. This works towards having a more restrictive quota when $n$ is large and greater license revenues at the cost of a greater consumer loss. As $\beta$ rises, these revenues are weighted more heavily in welfare which tends to make welfare gains rise faster for high $n$. Thus, these simulations suggest that optimally setting auction quotas could significantly raise welfare if the economy is distorted, so that $\beta$ exceeds unity.

Figure 7 summarizes the simulation results when $e$ changes and $\beta = 1$. As before, the optimal quota is close to free trade and most licenses are used. Also, the extent of welfare gains are limited to about a 6 percent increase. Welfare relative to free trade first rises and then falls with $e$.

This occurs because, on the one hand, possible gains due to price discrimination rise with $e$. On the other hand, foreign sales under this parametrization tend to fall with $e$. This makes the home market more important for the foreign firm and limiting the extent to which the government can appropriate the license revenues. While the former works in favor of raising welfare above free trade in the simulation, the latter works against it! For small $e$ the first effect seems to predominate, while for large $e$, the second does. However, $e$ needs to be quite large, more than three times $E$, for the second to dominate and we restrict attention to the first case below.

FIGURE 7 HERE

Figure 8 shows the simulation results for varying $e$ when $\beta$ changes. Notice that the critical $\beta$ (at which $W/W^F$ starts diverging from unity) lies between 1 and 3 and rises as $e$ falls, and that $W/W^F$, after the critical $\beta$, is steeper for lower $e$'s. Thus optimally designed quota auctions seem to be relatively desirable for an undistorted economy $(\beta = 1)$ when $e$ is neither too large nor too small. They are desirable when $e$ is low only for a very distorted economy. If $e$ is not very low, they they can raise welfare for even a slightly distorted economy.

FIGURE 8 HERE

## 6. CONCLUSION.

Auctioning quota licenses when product markets are imperfectly competitive involves taking into account the strategic response of producers to the policy. This makes the details of the implementation of such policies crucial in determining their effects. In this paper I show that the distribution of license revenues between the government and a foreign monopolist can play a role in raising revenues and can even lead to a Pareto improvement over free trade.

This is clearly only a beginning in explaining how the details of implementation of auctioning quota licenses affect the outcome of such policies. More work on this aspect is needed to help understand how such policies should be implemented. Clearly, the results will depend on the market structure in the product market and in the auction market, the form of the quotas - global versus non-global - as well as on the demand structure and possibility of market segmentation. For example, when product markets are oligopolistic, allocation of licenses to producers affects their pricing incentives. The interaction of firms' behavior then determines equilibrium. Hence, the allocation of licenses would affect the equilibrium and could raise revenues <u>with</u> or <u>without</u> market segmentation. Work on examining this is also underway.

The allocation of licenses could also be designed to affect market structure in the license market. A question that needs to be addressed is whether making the market for licenses imperfectly competitive so as to create "countervailing power" to the market power in the product market is a good idea. In addition, more work on the design of optimal quota auctions is needed although this is likely to be quite difficult. The implications of these issues must be understood for a fully-informed analysis as to the actual benefits of auctioning quotas to be made.

FOOTNOTES

1. *Business Week*, March 16, 1987, p. 64.

2. Ibid, March 9, 1987, p. 27.

3. *Time*, March 16, 1987, p. 59.

4. Memorandum of February 27, 1987, from Stephen Parker (CBO) on revenue estimates for auctioning existing import quotas (publicly circulated).

5. The interested reader should consult Bergsten et al. (1987) and Takacs (1987) for a historical and institutional perspective of work in this area.

6. See Takacs (1987), footnote 7.

7. Macmillan (1988) surveys the auction literature to highlight its implication for quota auctions. However, as I argue later, this literature is not suited to the analysis of this problem when product markets are imperfectly competitive. Also see Feenstra (1988) on the possibility of foreign responses to quota auctions.

8. See, for example, Katrak (1977), de Meza (1979), Svedberg (1979) and Brander and Spencer (1984).

9. Milgrom (1985) nicely summarizes the work on optimal auctions. Wilson (1979) deals with multiple auctions, but considers a "share" auction, and deals with exogenous valuations. Maskin and Riley (1987) deal with multiple object auctions but consider exogenous valuations. The only work I am aware of in the auction literature that can deal with endogenous valuations is that of Bernheim and Whinston (1985); however, they do not deal with sequential auctions. In their model objects need not be identical so that their model is more general than the one needed to study endogenous valuations. They also focus on the complete information case.

10. See Krishna (1989a) for some preliminary work on these issues.

11. How restrictive it must be for a license to have a positive price depends on the demand elasticities at home and abroad and on relative market size.

12. The firm is allowed to choose not to use all its licenses. If it were forced to use them all then the virtual price would be independent of $\lambda$ and equal $P(V)$. Notice that in this case the pricing behavior of the firm and the price charged to consumers would not correspond to that given below.

13. To denote that $P$ and $u$ are choice variables for the monopolist, they appear before the semicolon in $L(\cdot)$ and $P(\cdot)$. That $\lambda$ and $V$ appear after the semicolon indicates that these are choice variables for the government and are taken as given by the firm.

14. See Neary and Roberts (1979) for the use of the "virtual" price.

15. The concavity assumption is satisfied for the constant elasticity parametrization since:

$$\frac{d^2(P(\cdot) - C)u}{du^2} = P_{uu}(\cdot)u + 2P_u(\cdot)$$

$$= \frac{\epsilon(1+\epsilon)NP(\cdot)^{-(2+\epsilon)}}{\epsilon^3N^3P(\cdot)^{-3(1+\epsilon)}}u - \frac{2}{\epsilon NP(\cdot)^{-(1+\epsilon)}}$$

$$= \frac{(1+\epsilon)P(\cdot)^{(1+2\epsilon)}}{\epsilon^2N^2}u - \frac{2P^{(1+\epsilon)}}{\epsilon N}$$

$$= \frac{P(\cdot)^{(1+\epsilon)}}{\epsilon N}\left[\frac{(1+\epsilon)}{\epsilon}\frac{u}{NP(\cdot)^{-\epsilon}} - 2\right]$$

As $u < (1-\lambda)V + u = NP(\cdot)^{-\epsilon}$, $\frac{u}{NP(\cdot)^{-\epsilon}} < 1$ .

Hence, $\frac{(1-\epsilon)}{\epsilon}\frac{u}{NP(\cdot)^{-\epsilon}} - 2 < \frac{(1+\epsilon)}{\epsilon} - 2$

$= \frac{1-\epsilon}{\epsilon} < 0$ for $\epsilon > 1$ as is assumed here.

16. This result obtains even if $u$ is not a choice variable and must equal $\lambda V$. The reason is the same: that the price charged in this case must exceed the free trade price.

17. It is easy to show that if $u$ cannot be chosen, and must equal $\lambda V$, then it is always possible to do better than free trade if $E < e$. This can be achieved by setting $V = V^*$ and $\lambda$ such that the price charged is a bit below the free trade price. This keeps consumer surplus unchanged from that under free trade but raises some licenses revenues. If $u$ is chosen, welfare need not necessarily rise.

18. In reality, the implementation of VERs differs across products. VERs for footwear have explicit licenses associated with them. The VERs on autos do not.

19. $\lambda = 1$ can be the status quo even if no formal licenses exist if <u>under the quota</u> firms can price exports to the restricting country higher than exports to the rest of its markets. This of course presumes that the quota is implemented so that the firm has the sole ability to export, i.e., that transhipments from other markets are not possible.

20. This is evident from estimates of excess burden in public finance. Hausman (1985), in the <u>Handbook of Public Economics</u>, suggest that the ratio of deadweight loss to tax revenue for a 10-30% income tax is about 15-20%. A figure of 20% gives:

$$\beta = \frac{1}{1 - .20} = 1.25$$

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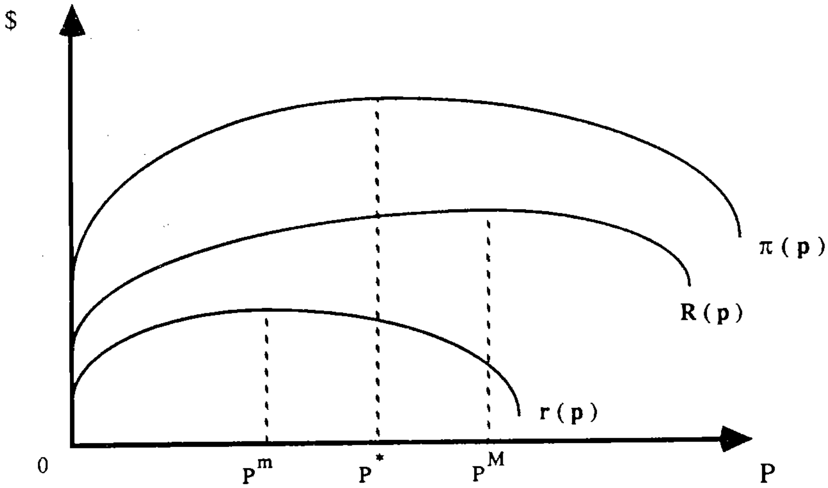
## FIGURE 1a

e > E




## FIGURE 1b

e < E

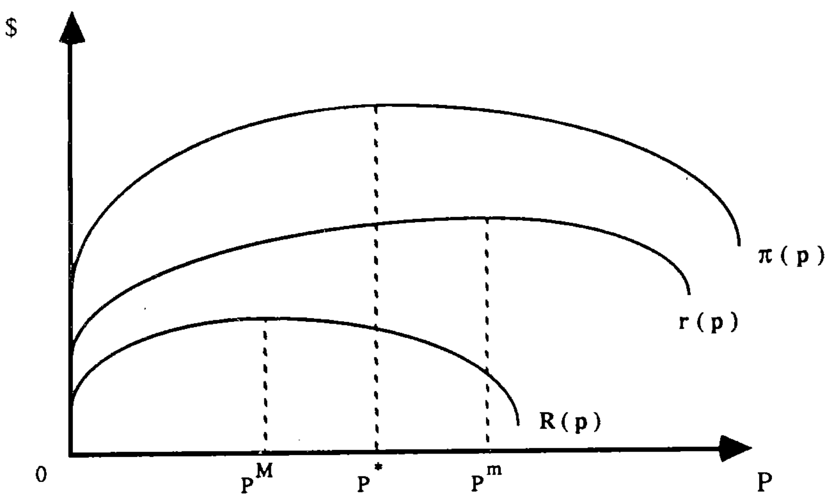


FIGURE 2a

e > E

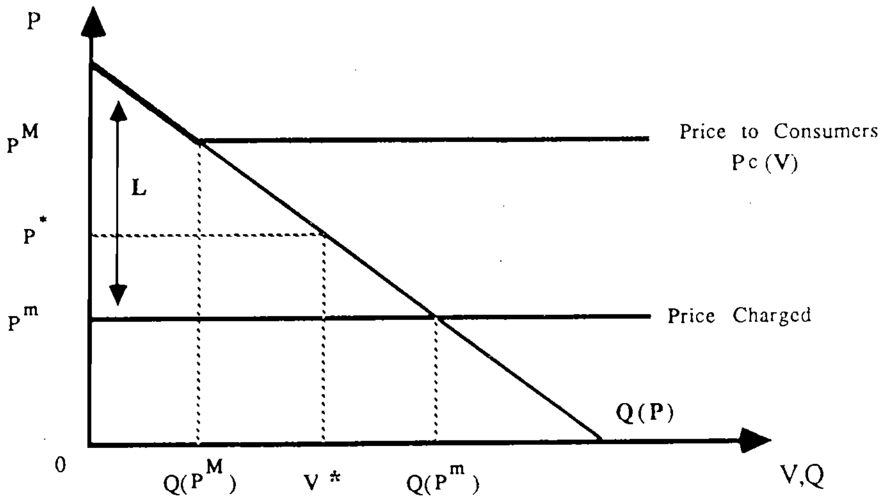



FIGURE 2b

e < E

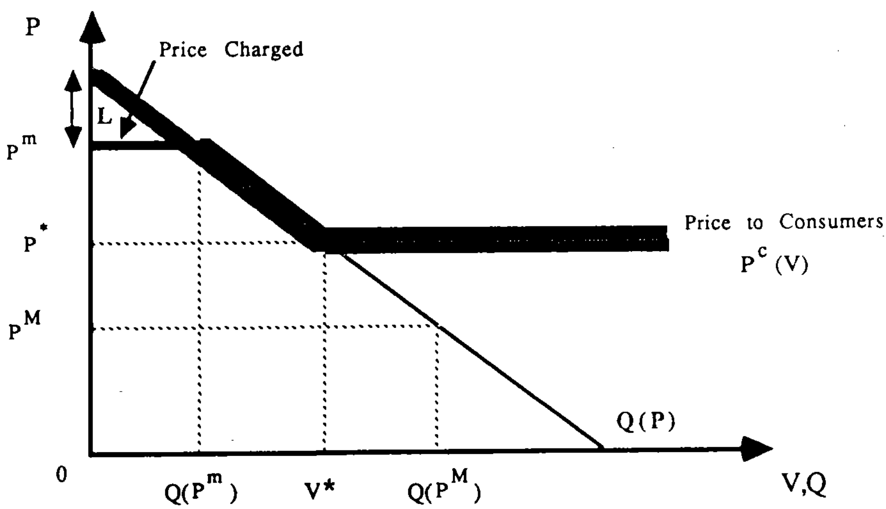


FIGURE 3a

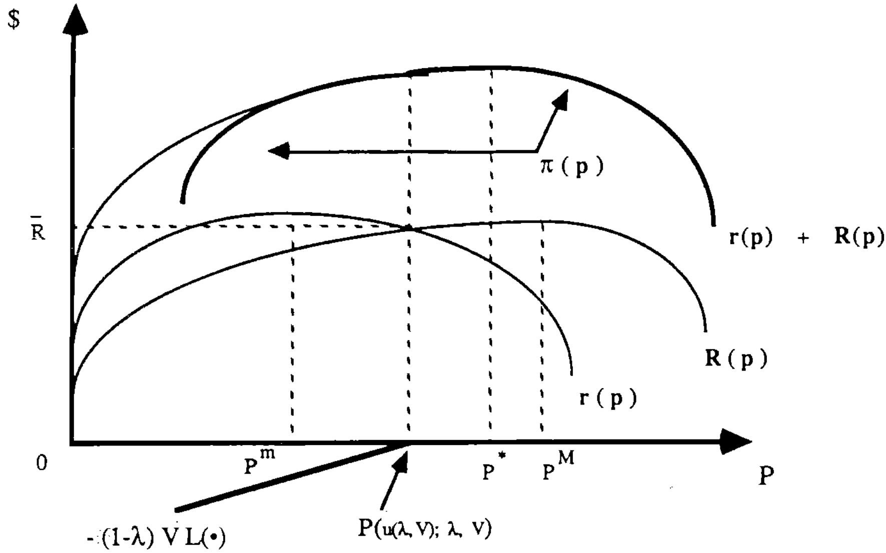



FIGURE 3b

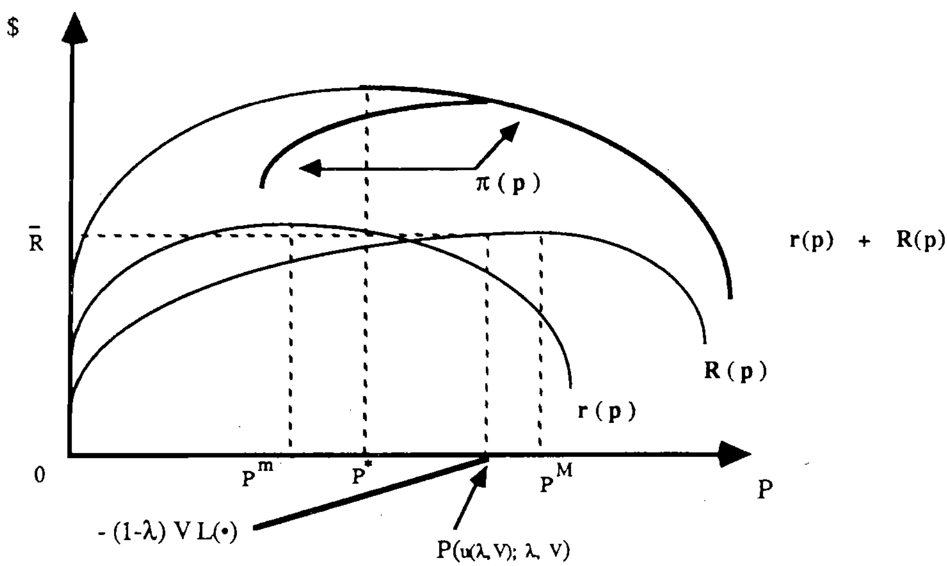


FIGURE 3c

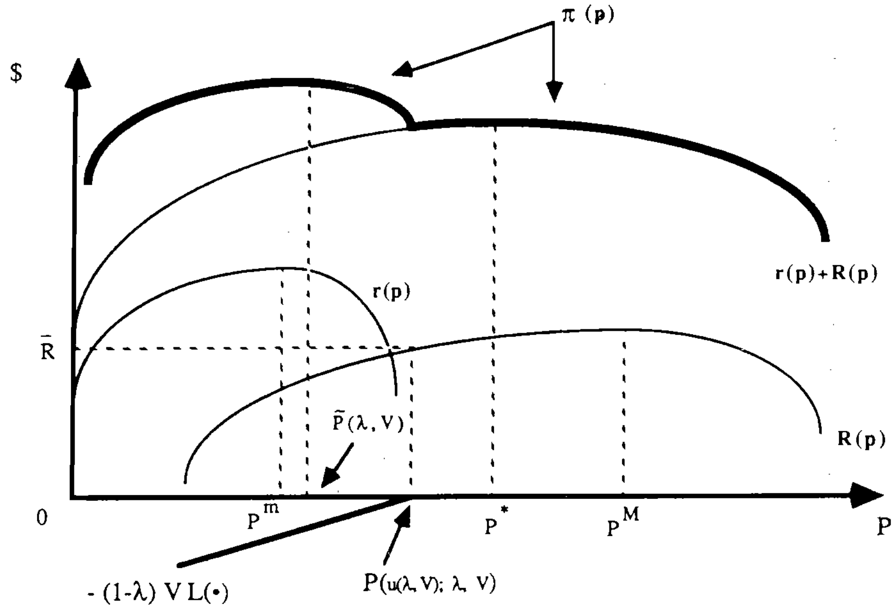



FIGURE 3d

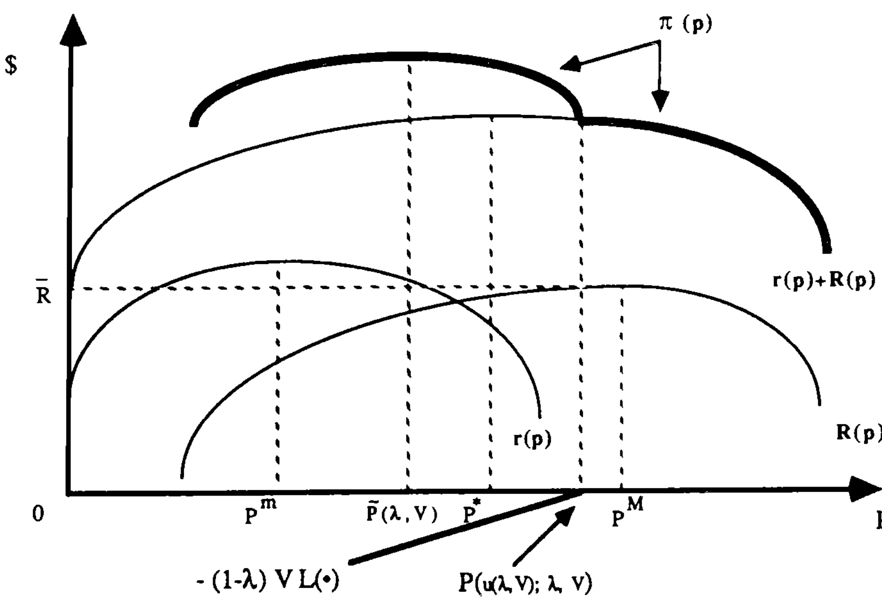


FIGURE 4a

e > E

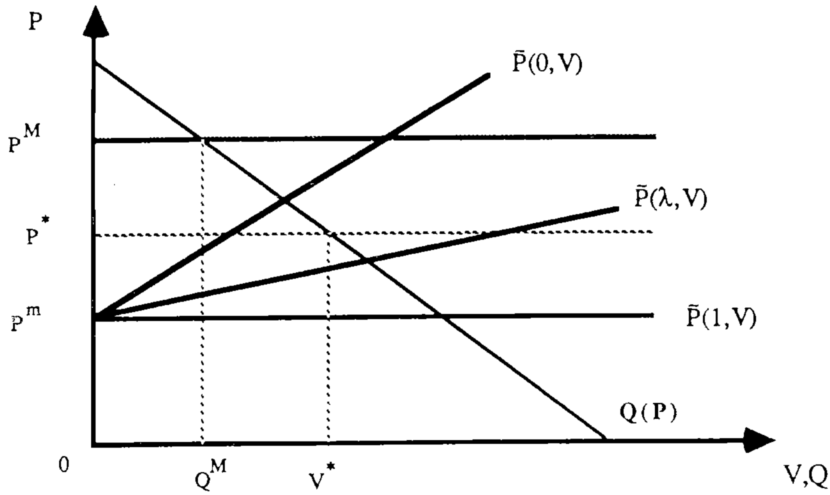
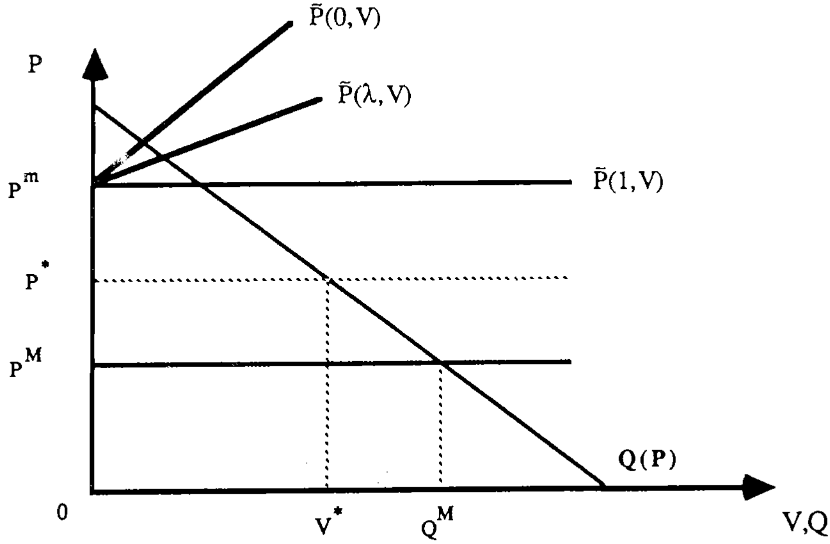
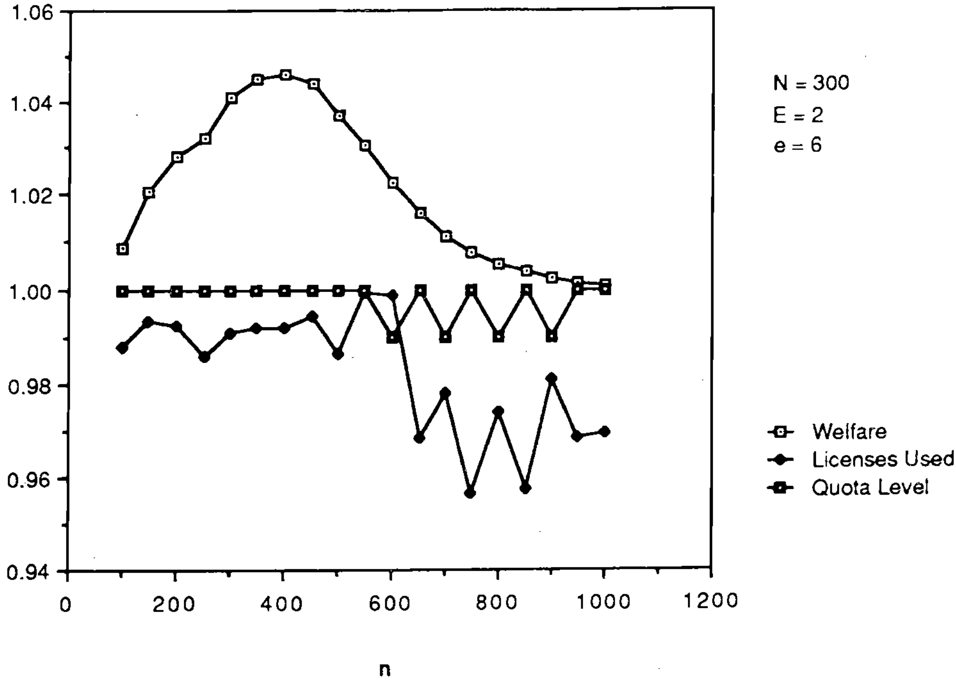



FIGURE 4b

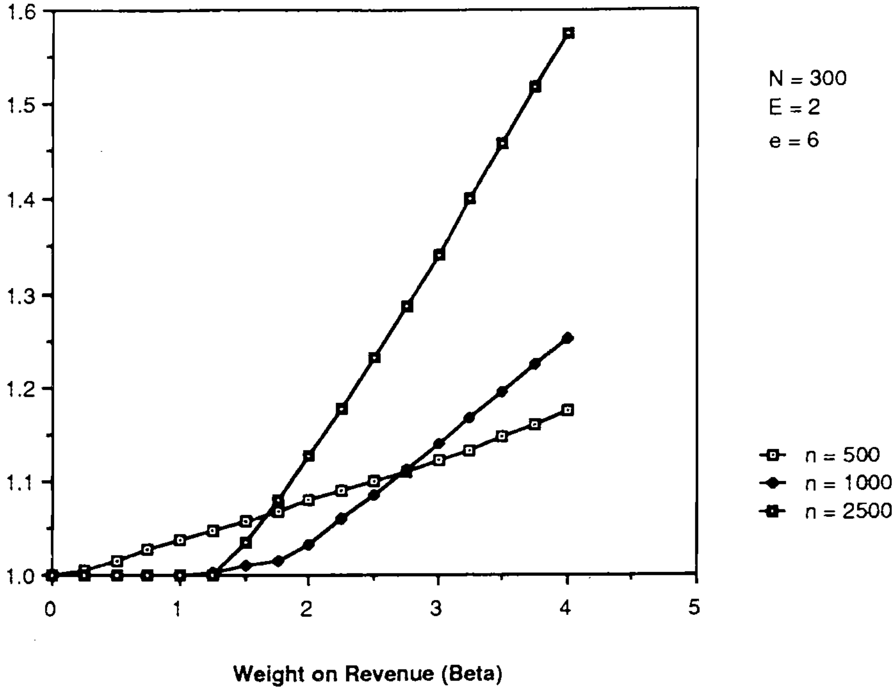
e < E



# Figure 5

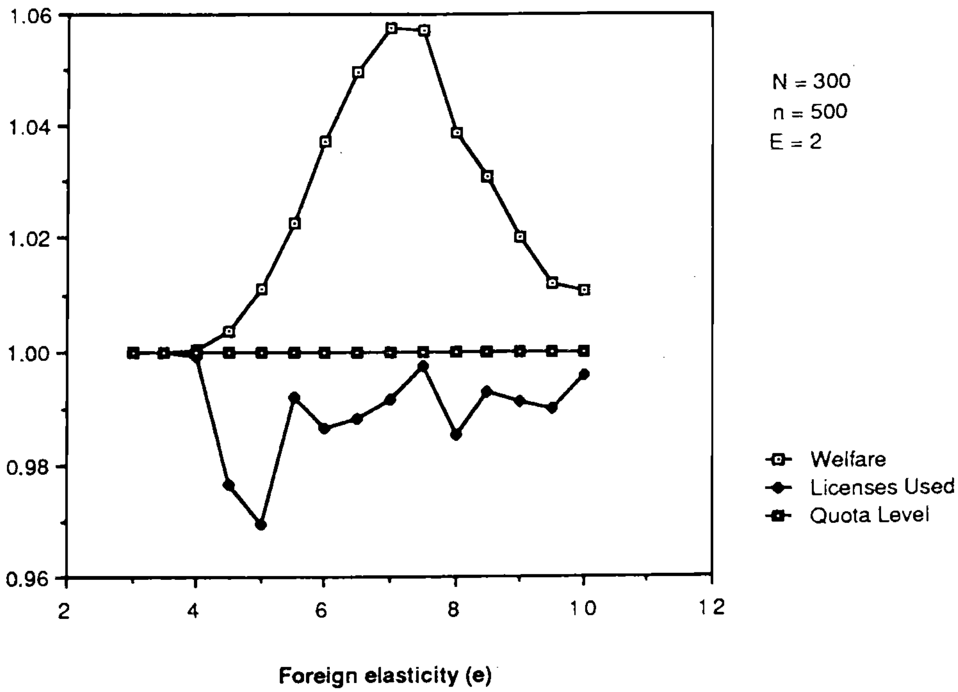

1.06
1.04
1.02
1.00
0.98
0.96
0.94
0
200
400
600
800
1000
1200
n
N = 300
E = 2
e = 6
Welfare
Licenses Used
Quota Level

# Figure 6



1.6
1.5
1.4
1.3
1.2
1.1
1.0
0
1
2
3
4
5
N = 300
E = 2
e = 6
n = 500
n = 1000
n = 2500
Weight on Revenue (Beta)

# Figure 7



1.06
1.04
1.02
1.00
0.98
0.96
2
4
6
8
10
12
N = 300
n = 500
E = 2
Welfare
Licenses Used
Quota Level
Foreign elasticity (e)

# Figure 8