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THE CASE OF THE VANISHING REVENUES: AUCTION QUOTAS WITH MONOPOLY

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ABSTRACT

This paper examines the effects of auctioning quota licenses when monopoly power exists. With a foreign monopoly and domestic competition the sales of licenses will never raise any revenue if domestic and foreign markets are segmented. More surprisingly, the inability to raise revenue is shown to persist even when partial or perfect arbitrage across markets is possible, as long as the quota is not too far from the free trade import level.

In contrast, when there is a home monopoly and foreign competition, the price of a quota license can be positive so that selling licenses can dominate giving them away. However, because of the absence of any profit shifting, welfare falls even when licenses do indeed raise revenue.

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1. INTRODUCTION

In this paper I examine the case for auction quotas when there is either a foreign or domestic monopolist. A companion paper deals with oligolistic markets.[1]

One of the most common criticisms of voluntary export restrictions (VERS) and of the way quotas are presently allocated is that they allow foreigners to reap the rents associated with the quantitative constraint. It has been suggested that auctioning import quotas would be a remedy for 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.[2]

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...[3]

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.[4]

A Congressional Budget Office (CBO) memorandum[5] estimates quota rents possible in 1987 for a group of industries to be 3.7 billion dollars. It compares this to the Bergsten et al. (1987) estimate made for the Institute for International Economics (IIE) of 5.15 billion. These estimates are summarized in Table 1. Both estimates assume perfect competition everywhere. Takacs (1987) points out that proposals to auction quotas have become increasingly frequent.[6] 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 (1985) and Lawrence and Litan (1985) suggested auctioning quotas and earmarking the funds for trade adjustment assistance."[7]

Despite the importance of the issues involved, the intuition behind such statements and the procedure used in the estimation is based on models of perfect competition. 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 when auctioned. If the country is small, then the world price is given. If the country is large, then the world price does change with a quota. How it changes is determined by supply and demand conditions in the world market.

However, when markets are imperfectly competitive, as they are thought to be in the market for autos, this analysis is misleading.[8] In such environments, prices are chosen by producers, i.e. there is no supply curve, and the response of producers to the constraint must be taken into account when determining the price of a license when it is auctioned off. For example, if the response of profit maximizing producers is to adjust their prices so that there is no benefit to be derived from owning a license to import, its auction price must be zero!

Therefore, the question that needs to be addressed concerns the behavior of producers in response to quantitative constraints in such markets, and the impact of this on the price of a license. There are two policy questions that need to be adressed. First, should existing licenses be auctioned off? Second, if quotas are set at their optimal level, can they be welfare improving over free trade? There has been relatively little work in this area. The work on the effects of quantitative restrictions in imperfectly competitive markets is linked to the above question,[9] but to date, no analysis of what this might suggest about the price of a license seems to exist.

In this paper, I develop a series of models of monopoly which address this issue. The models show that the way in which licenses are sold, the demand conditions, and the market structure all influence the resulting price of a license. The results indicate that there is reason to expect that the price of a license may be much lower than that indicated by applying models of perfect competition. Thus, estimates of potential revenues such as those of the CBO and Bergsten may be far too large. Moreover, if no revenues are to be raised from auctioning quotas unless they are very restrictive, the profit shifting effect of such quotas, even when auctioned off, is unlikely to outweigh the loss in consumer surplus of such policies. For this reason, they are likely to have adverse welfare consequences even when set optimally.

I do not argue that in the real world license sales will raise no revenues. In the presence of uncertain demand they will, as licenses have on option value in this case. I merely point out that there is reason to expect revenues to be lower than those estimated under the assumption of perfect competition and make my arguments in the simplest model, one without uncertainty. The uncertainty case is discussed in Krishna (1988a).

Sections 2 and 3 discuss the price of a license with a foreign monopoly. If there is a single foreign supplier of the product, and markets are segmented, the price of a license is clearly zero. It is optimal for the monopolist to raise his price in response to a quota or VER so that the price of a license becomes zero. This model with segmented markets is developed diagramatically in Takacs (1987) and is mentioned in Shibata (1968) as well and most recently in Krugman and Helpman (1989).

However, one would expect that the presence of other markets and the possibility of arbitrage between them would make it optimal for the foreign monopolist to limit his price increase in response to a quota, thereby creating a price for the license. Thus, one might expect non-zero prices for licenses when markets are not segmented even with a foreign monopoly. Somewhat surprisingly, this is not necessarily so! Quotas set close to the free trade level always have a zero price. All that occurs is an increase in the world price! This is the subject of Section 2.

A simple example is developed in Section 3 in order to show how restrictive the quota has to be for the license price to become positive. The way that this varies with the relative size of the markets and demand elasticities is considered in addition to the welfare consequences of such policies.

Section 4 considers the case of a domestic monopoly. Here it is shown that the price of a license is positive and that auctioning quotas can ensure that rents accrue to domestic agents. Despite this, welfare does not increase because of the absence of profit shifting effects. Section 5 analyzes the effect of an alternative timing structure on the results and shows that the spirit of the results remains valid unless consumers are myopic. Section 6 contains some concluding remarks and directions for future research.

2. FOREIGN MONOPOLY WITH COSTLESS ARBITRAGE

In this section I consider the price of a license in a simple case. It is assumed that there is a foreign monopolist who cannot price discriminate between his markets.[10]

Let $Q(P)$ and $q(p)$ be the demand functions facing the foreign firm in the home market and in the other market(s), respectively. Let $C[q + Q]$ be its cost function. Note that marginal costs are assumed constant. Similar results are obtained when marginal costs are not assumed constant.

Assume that $R(P)$ 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 $P^M = \frac{\epsilon}{\epsilon - 1}C$ and $p^m = \frac{e}{e-1}C$, where ϵ and e are the respective demand elasticities, so that the monopolist in the absence of arbitrage would choose to charge a higher price in the market with less elastic demand. Because of arbitrage, the monopolist will choose one price which will be between the two prices he would have set in the absence of arbitrage possibilities. It is easy to show that the optimal price for him to set maximizes $\pi(P) = R(P) + r(P)$, and is given by:

$$P^M = \frac{\bar{\epsilon}}{\bar{\epsilon} - 1}C$$

where $\bar{\epsilon} = \theta\epsilon + (1-\theta)e$ and $\theta = \frac{Q}{q+Q}$. This is also the free trade price P^F. Thus, 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.

The question then is how a quota affects the price charged by the monopolist when the quota licenses are auctioned off.

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 to be 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 his 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 as sales will only be made at the lower of the two prices. For this reason, the monopolist can be restricted to choosing only <u>one</u> price.

The licenses are sold in a competitive market to either competitive domestic retailers with zero marginal costs of retailing or to consumers directly. In sections 2 to 4 I assume that the timing of moves is as follows. First, the government sets the quota. Then the monopolist sets his price. Finally, the market for licenses clears. This timing is consistent with the idea that the market for licenses clears <u>more</u> frequently than the monopolist sets prices, and that the government sets the quota even less frequently than the monopolist sets prices. Section 5 studies the case where the monopolist can adjust prices faster than the rate at which the market for licenses clears.

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 $P+L$, $Q(P+L)$. The supply of licenses is V, the level of the quota. The equilibrium price of a license is given by $L(P,V)$. $L(\cdot)$ is defined by the market for licenses clearing, i.e. $Q(P+L) = V$. Notice that if $Q(P) < V$, then $L(P,V) < 0$ as defined thus far. However, since a quota is not binding if such a high price is charged, $L(P,V)$ is defined to be zero in this case. Let $P^V(V)$ be defined by $Q(P^V) = V$ so that $L(P,V) > 0$ and the quota is binding if $P \leq P^V(V)$. By the definition of $L(\cdot)$, it is apparent that if $P < P^V(V)$, then demand at home equals V, although V is less than $Q(P)$.

Now consider the total demand facing the monopolist with a quota. As demand in the home market has shrunk for $P < P^V(V)$, the total demand curve has a kink in it at $P^V(V)$. This is depicted in Figure 1.

(FIGURE 1 here)

In the absence of any quota, demand is given by AD, and marginal revenue by AF. The monopolist sets price equal to P^M, and sells $Q^M + q^M$. For convenience, Figure 1 is drawn so that $Q(P)$ and $q(p)$ are similar and linear. Hence the marginal revenue corresponding to total demand coincides with $Q(P)$. A quota at the free trade level, $Q(P^M)$, makes the demand facing the monopolist into ABE. This creates a kink in the demand curve at P^M. Marginal revenue is given by AGHR. Therefore, it remains optimal for the monopolist to price at P^M.

Now consider the effect of reducing the quota from $Q(P^M)$ to $\bar{V}$. This raises the price at which the quota binds to $P^V(\bar{V})$ from P^M and the kink in demand occurs at $P^V(\bar{V})$. The demand curve with a quota at $\bar{V}$ is given by AIJ and the corresponding marginal revenue curve by AKLM. Notice that if

V is close to Q^M, the profit maximizing point must occur at the intersection of the vertical part of the marginal revenue curve and marginal cost, C.[11] Therefore, the monopolist will find it optimal to charge $P^V(V)$ so that the price of a license is zero! Only if V is so small that the intersection of the marginal revenue curve (with a quota) and the marginal cost curve occurs on the steeper but not vertical segment of the marginal revenue curve will the price of a license be positive. This can only occur if V is substantially below Q^M. In Figure 1, any V lower than $\bar{V}$, the quota level depicted, gives $L(\cdot) > 0$. Thus, slightly restrictive quotas must reduce welfare because they do not raise revenue and they reduce consumer surplus. Quotas at an even lower level conceivably can raise welfare if the gain in revenue outweighs the loss in consumer surplus. Finally, auctioning quotas is better than giving them away only when the license price is positive, i.e., when the quota is set at a low level. Note also that as the world price rises, a quota by one country reduces the welfare of other importing countries as well as that of the exporting country whose profits also fall with a quota.

Proposition 1. With a foreign monopoly and perfect and costless arbitrage, quotas at or close to the free trade level implemented by auctioning licenses yield no revenues and must reduce welfare. Quotas must be very restrictive if they are to raise welfare over free trade. Moreover, auction quotas dominate VERs at the same level only if the restriction is set at quite a low level.

Three questions naturally arise. First, how restrictive must the quota be before a license commands a positive price. Second, how does the answer to this question depend on demand conditions. And finally, under what conditions can a quota which is auctioned off raise welfare over free trade. A simple example is worked out in Section 3 that sheds some light on these questions.

3. AN ILLUSTRATIVE EXAMPLE

This example focuses on the role of the home market size relative to that of the other market and of demand elasticity in determining the effects of quota auctions.

It is assumed that consumers at home and abroad have identical constant elasticity demand functions given by $P^{-\epsilon}$. There are, however, N consumers at home and n consumers abroad so that market demand in the home market is $Q(P) = NP^{-\epsilon}$ and that in the other market is $q(P) = nP^{-\epsilon}$. As before, marginal costs are constant at C.

Profit maximization in the absence of any quotas results in the monopolist charging $P^M = \frac{C\epsilon}{\epsilon-1}$, and selling $Q^M = N(\frac{C\epsilon}{\epsilon-1})^{-\epsilon}$ at home. As usual, it is assumed that $\epsilon > 1$ so that profits are well behaved.

The smallest quota for which the license price is zero is depicted in Figure 2 by $\tilde{V}$. When $\tilde{V}$ is set as the quota, the marginal revenue curve associated with the market demand curve when the quota is binding intersects the marginal cost curve at exactly the level of the quota.

If the quota is set at $\tilde{V}$, the marginal revenue corresponding to the market demand curve when the quota is binding equals the marginal cost curve where:

$$\frac{\delta[(P-C)V + (P-C)nP^{-\epsilon}]}{\delta P} = 0$$

This implies that:

$$V - (P-C)\epsilon nP^{-(\epsilon+1)} + nP^{-\epsilon} = 0. \tag{1}$$

Moreover, for this to hold at the point where the constraint just binds, it must also be that:

$$NP^{-\epsilon} = V. \tag{2}$$

Substituting (2) into (1) gives:

$$1 - (P-C)\epsilon\frac{n}{NP} + \frac{n}{N} = 0$$

so that the price at which this occurs, $P^V(\bar{V})$, is given by:

$$P^V(\bar{V}) = \frac{C\epsilon}{\epsilon - 1 - \frac{N}{n}}. \tag{3}$$

Hence,

$$\bar{V} = N\left[\frac{C\epsilon}{(\epsilon - 1 - \frac{N}{n})}\right]^{-\epsilon}$$

and

$$\frac{Q^M}{\bar{V}} = \left[\frac{(\epsilon-1)}{(\epsilon - 1 - \frac{N}{n})}\right]^{\epsilon}.$$

There are a few things to notice about this expression. First, Q^M always exceeds $\bar{V}$ so that the quota must be set below the free trade level of imports for a license price to be non-zero. Second, if $n = N$, $\frac{Q^M}{\bar{V}} = (\frac{\epsilon - 1}{\epsilon - 2})^{\epsilon}$. If $\epsilon > 2$, say $\epsilon = 3$, then $\frac{Q^M}{\bar{V}} = 8$ so that the quota needs to be quite restrictive for a license price to be positive. Third, for any ϵ and N, the limit as $n \to \infty$ of $\frac{Q^M}{\bar{V}}$ is 1. Thus, as the home market becomes small relative to the foreign one, the license price becomes positive when the quota is not very restrictive. Fourth, for any ϵ, as long as $\epsilon - 1 - \frac{N}{n} > 0$, $\frac{Q^M}{\bar{V}}$ rises as $\frac{N}{n}$ rises. Fifth $\epsilon - 1 - \frac{N}{n} < 0$, the price of a license is always zero. As $\epsilon - 1 - \frac{N}{n}$ approaches zero from above, $P^V(\bar{V}) \to \infty$ and $\bar{V} \to 0$. Thus, the range where $\bar{L}(\cdot) > 0$, i.e., where $V \leq \hat{V}$ shrinks to zero.

How does the price charged by the monopolist, and hence the license price, changes with the level of the quota. Let us denote this by $P^M(V)$. Notice that given a quota at the level V the profit function facing the monopolist denoted $\hat{\pi}(P,V)$, is given by:

$$\hat{\pi}(P,V) = \pi(P) \qquad \text{if} \quad P \geq P^V(V)$$

$$= \tilde{\pi}(P,V) \qquad \text{if} \quad P \leq P^V(V)$$

where: $\tilde{\pi}(P,V) = (P - C)V + (P - C)Q(P)$.

Thus, $\hat{\pi}(P,V)$ is composed of pieces of $\pi(\cdot)$ and $\tilde{\pi}(\cdot)$. Moreover, if $\pi(\cdot)$ and $\tilde{\pi}(\cdot)$ are both concave, so is $\hat{\pi}(\cdot)$. Also if $\pi_P > 0 > \pi_P$ at $P^V(V)$, as depicted in Figure 2(a), then profits are maximized at $P^V(V)$. If $\tilde{\pi}_P > \pi_P \geq 0$, as depicted in Figure 2(b), then profits are maximized at the peak of $\pi(\cdot)$, P^M. If $0 \geq \pi_P > \pi_P$, as depicted in Figure 2(c), then profits are maximized at the peak of $\tilde{\pi}(\cdot)$ at A.

(FIGURE 2 here)

In addition,

$$\tilde{\pi}_P(P,V) = \pi_P(P) + V - Q(P) - (P-C)Q'(P)$$

$$= \pi_P(P) - (P-C)Q'(P), \text{ when evaluated at } P = P^V(V).$$

Hence, $\bar{\pi}_p(\cdot)$ always exceeds $\pi_p(\cdot)$ here which in turn implies that the three cases above are the only ones possible.

(FIGURE 3 here)

Figure 3 helps to illustrate how the price charged by the monopolist and hence the license price changes with the level of the quota. $\bar{\pi}(\cdot)$ is maximized along BB so that BB depicts equation (1). $\pi(\cdot)$ is maximized along CC. AA depicts the demand function. Assuming that $\bar{\pi}(\cdot)$ is concave in the relevant region implies that BB is upward sloping. AA is, of course, downward sloping. Note that AA and BB intersect at output level $\tilde{V}$. Moreover, at a price of $\frac{C\epsilon}{\epsilon-1}$, sales in the home market are Q^M as shown by the point E on AA. Notice that E lies below BB, given our assumptions, since $\bar{\pi}(\cdot)$ increases with P at E.

The dark line in Figure 3 depicts $P^M(V)$ and shows how the price charged changes with the quota. If the quota is set above Q^M, it is not binding and we are in case (b), so that the price charged lies along EC. If the quota lies between Q^M and $\tilde{V}$, $\pi_p(\cdot)$ is negative and $\bar{\pi}_p(\cdot)$ is positive along AA, so we are in case (a). Thus, the profit maximizing price equals $P^V(V)$ and must lie along AA. If the quota is below $\tilde{V}$, then the derivatives of both $\pi(\cdot)$ and $\bar{\pi}(\cdot)$ along AA are negative and we are in case (c), so that the profit maximizing price lies along BB. Therefore, the price charged by the monopolist first rises and then falls as the quota is reduced from the free trade level.

Only when this price falls below AA can $L(\cdot)$, the license price, be positive. Since it is only when $L(\cdot) > 0$ that such a policy can be welfare increasing, it is only when the quota falls below $\hat{V}$ that welfare can rise due to such a policy. Moreover, since welfare falls as the quota falls from Q^M to $\hat{V}$, an even stronger condition is required for such a policy to increase welfare. When V is set below $\bar{V}$, it is apparent from Figure 4 that the sum of consumer surplus and license revenues must fall short of free trade consumer surplus as long as $V \geq \bar{\bar{V}}$. Even at $V = \bar{\bar{V}}$, it is short by GFE, the dead weight loss of such a policy. Thus, only if $P^M(V) < P^F$, can welfare possibly rise.

In our example, welfare can <u>never</u> rise if $e = \epsilon$. This is because as long as $V > 0$, the price that solves (1) satisfies $\frac{(P-C)\epsilon}{P} - 1 > 0 \Rightarrow P > \frac{C\epsilon}{\epsilon-1}$. Since this price equals $P^M(V)$ when $V \leq \hat{V}$, this means that $P^M(V) > \frac{C\epsilon}{\epsilon-1} = P^F$ as long as $V > 0$. Even if V is such that $P^M(V) < P^F$, welfare need not rise above the free trade level. Only if the gain in license revenues outweighs the loss in consumer surplus is such a policy desirable.[12]

In the constant elasticity case, if $e \neq \epsilon$, then the analogue of (1) implies that $P^M(V) > \frac{Ce}{e-1}$ as long as $V > 0$. As shown in Section 3, the free trade price, P^F, is $\frac{C\bar{\epsilon}}{\bar{\epsilon}-1}$ where $\bar{\epsilon} = \theta\epsilon + (1-\theta)e$ and θ is the share of the home market. Thus, P^F lies between $\frac{Ce}{e-1}$ and $\frac{C\epsilon}{\epsilon-1}$. Moreover, as $\frac{Ce}{e-1}$ rise as e falls, $P^M(V)$ <u>must</u> exceed P^F if $e < \epsilon$. Hence, in this case, auction quotas must reduce welfare. If $e > \epsilon$, $P^M(V)$ can lie below P^F and it is possible for welfare to rise when the optimal quota is set. If foreign elasticity of demand, e, is greater than home elasticity of demand, ϵ, then raising price to make the quota bind has a high cost in terms of losing customers in the foreign market. This is especially so if the home market is small relative to the rest of the world. It is possible to construct examples of cases where the optimal policy is a quota below the free trade level of imports.[13]

The results of this section are summarized in Proposition 2.

Proposition 2. If the elasticity of demand is a constant and equal in both markets, then welfare must fall if auction quotas are imposed. If the home market demand is less elastic than that of the rest of the world, i.e. $e > \epsilon$, welfare can rise if the optimal quota is auctioned off. If home market demand is more elastic than the rest of the world, ie. $e < \epsilon$, then welfare must fall.

4. HOME MONOPOLY

So far we have argued that with a foreign monopoly there is reason to expect that auctioning quota licenses will not raise revenue. Here we briefly discuss whether the same result occurs when there is a monopoly at home and competition abroad. The goods are assumed to be differentiated for ease of analysis. The main result is summarized in Proposition 3.

Proposition 3: If goods are substitutes and a quota at or close to the free trade level is imposed then a license has a positive price, while if goods are complements, the license has a zero price. In either case, welfare is adversely effected.

The intuition behind these results is that when goods are substitutes, a quota at the free trade level implemented by auctioning licenses makes the demand facing the home monopolist less elastic for price increases above the free trade level, but does not alter demand for price decreases. This creates an incentive for the home monopolist to raise its price. This in turn shifts the demand for the foreign good out and creates a positive price for licenses. On the other hand, if goods are complements, the quota makes demand facing the home monopolist at the free trade prices less elastic for price decreases, but leaves it unaffected for price increases. This makes it unprofitable to raise or lower prices from the free trade level so that the market for licenses clears when the license price is zero.

The classic paper by Bhagwati (1965) is related to this section in that he was the first to point out the price increase induced by a quota with home monopoly. However, this analysis differs from his since he does not address the effects of auctioning quotas. In addition, both complements and substitutes are considered here with differentiated products produced while he considers only substitutes and a homogeneous product.

Let $D(P,p)$ and $d(P,p)$ be the demand functions for the home and foreign goods, and C be their common marginal cost. Foreign supply is competitive so that $p = C$. Thus, in the absence of a quota the home firm charges P^M which is implicitly defined by the first order condition:

$$(P - C)D_1(P,C) + D(P,C) = 0(4) \tag{4}$$

The level of imports is thus given by $d(P^M,C) = V^F$ in the absence of a quota.

Now consider the effect of imposing a quota at the free trade level and auctioning off licenses in the manner specified. The license price is determined by the market clearing condition in the market for licenses, and so $L(P,C,V)$ is determined by

$$d(P,C + L) = V \tag{5}$$

where V is the level of the quota. Notice that $L_1\ (P,C,V) = -d_1\ /d_2$ is positive if the goods are substitutes, and negative if they are complements. If goods are substitutes, an increase in the home goods' price shifts out demand for the foreign good, thereby raising the price of a license. On the other hand, if they are complements, this would shift demand in and therefore reduce the license price. Also, $L_3(P,C,V) = \frac{1}{d_2} < 0$, so that an increase in the quota always reduces the price of a license.

The demand function facing the home monopolist, when the quota is V, is given by $D(P,C)$ if the quota does not bind and by $\tilde{D}(P,C,V) = D(P,C + L(P,C,V))$ if it does bind. Moreover, the quota binds if $P \geq P^V(C,V)$ when goods are substitutes and if $P \leq P^V(C,V)$ when goods are complements, where $P^V(C,V)$ is defined by (5) with $L(\cdot)$ equal to zero. It is easy to verify that $D(\cdot)$ and $\tilde{D}(\cdot)$ are equal when $P = P^V(C,V)$, and that whether goods are complements or substitutes $\tilde{D}_1(P,C,V) > D_1(P,C)$ as $D_2(\cdot)L_1(\cdot)$ is positive in either case. Thus the demand function facing the home monopolist is given by $\tilde{D}(\cdot)$ if $P \geq P^V(C,V)$ and by $D(\cdot)$ if $P \leq P^V(C,V)$ when goods are substitutes. It is given by $\tilde{D}(\cdot)$ if $P \leq {}^V(C,V)$ and $D(\cdot)$ if $P \geq P^V(C,V)$ when goods are complements.

(FIGURE 4 here)

This is depicted in Figures 4(a) and 4(b) for substitutes and complements respectively. In both cases, the free trade price is $P^V(C,V^F) = P^F$. The demand curve with a quota at the free trade level is depicted by the line ABD. The quota makes demand less elastic for price <u>increases</u> with substitutes and less elastic for price <u>decreases</u> with complements. The corresponding marginal revenue curves to the demand curve ABD are the dashed lines in 4(a) and (b). In 4(a) profits are maximized by reducing output and raising prices to P^* where marginal revenue cuts marginal cost from above. This in turn shifts out foreign demand so that at price C, demand exceeds V so that the price of a license is positive in this case.

Similar arguments and appeals to continuity show that the price of a license is positive for quotas close to V^F. Raising/lowering the quota from V^F shifts $\tilde{D}(\cdot)$ inwards/outwards. In either case, the intersection of the marginal revenue curve corresponding to $\bar{D}(\cdot)$ with marginal cost gives the profit maximizing output. This raises the profit maximizing price away from P^F as long as V is close to V^F. This is all that is needed to shift out $d(\cdot)$ enough for demand to exceed V at a foreign price of C by continuity arguments so that the price of a license is positive.

If goods are complements, and V^F is the quota level, the profit maximizing monopoly price remains at P^F. Hence demand for licenses equals V^F when the price of a license is zero so that the price of a license is zero in equilibrium. If the quota is set close to but below V^F, $\bar{D}(\cdot)$ shifts inwards. The profit maximizing price remains at the intersection of the vertical part of the marginal revenue curve and the marginal cost curve, so that the profit maximizing price equals $P^V(C,V)$ and so the price of a license is again zero. If the quota is set above V^F, $\bar{D}(\cdot)$ shifts outwards and the profit maximizing price remains at P^F which exceeds $P^V(C,V)$ and again the price of a license is zero.

Despite the existence of revenues, welfare tends to fall with such policies because the absence of profit shifting effects with foreign competitive supply[14] just leaves the dead weight loss of lower consumption of the home good. Given the usual assumption of a numeraire good, welfare is the sum of consumer surplus, home profits and license revenues. Thus, if x is the amount sold of the home good, and y is the amount sold of imports, welfare is given by:

$$W = (U(x,y) - Px - (C + L)y) + (Px - Cx) + Ly \quad .$$

The first term is consumer surplus, the second is profits, and the third is license revenues. However, notice that license revenues are just a transfer between consumers who pay more for imports and the government, and that the revenues of the home monopolist, Px, also cancel out in welfare. Thus

$$\Delta W = [U_x(x,y) - C]\Delta x + [U_y - C]\Delta y .$$

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Consider the model of Section 2 with the new timing structure. In the last stage, the firm chooses price P taking as <u>given</u> the value of L and V. Its profits thus depend on how consumer demand is affected given this level of L and V. If consumers assume that L is fixed and that any number of licenses will be available at this price, their demand for the good is given by $Q(P+L)$ even if P is very low. I call this the case with myopic consumers. If, on the other hand, consumers realize that the number of licenses is limited to V, they infer that if the monopolist charges a very low price so that $Q(P+L) > V$, i.e., $P < P^V(V)-L$, then the shadow price of a license will exceed L and equal $\bar{L}$ where $Q(P+\bar{L}) = V$, so that, $\bar{L} = {}^V(V)-L$. This will give the monopolist a total demand of $q(P)+V$ instead of $q(P)+Q(P+L)$. This is the case with non-myopic consumers. Consider the myopic case first.

The firm's profits are given by $\pi(P,L) = r(P) + (P-C)Q(P+L)$. Let $P^M(L) = \arg\max \pi(P,L)$. Note that:

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which lies between -1 and 0, assuming that $\pi_{LL} < 0$ and that demand is not too convex, so that $\pi_{PL} < 0$. $P^M(L)$ is depicted in Figure 5.

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<u>Proposition 4.</u> When firms take L as given, the equilibrium price of a license is zero if $V \geq V^F$. It is positive if $V < V^F$ and increases as V decreases. Thus, for $V < V^F$, a license always has a positive price.

Now consider the case with non-myopic consumers. Here consumers take the license price as given when the product price is high, but realize that a low product price creates a black market for licenses and raises the effective license price. This asymmetry is shown to create a continuum of equilibrium license prices, and a zero license price remains an equilibrium as long as the quota is not too restrictive.

Take the last stage. For a given L and V, $\pi(P,L,V)$ denoted profits, which is a composite function made up of $\pi(P,L)$ if P is high and $\bar{\pi}(P,V)$ if P is low enough.

$$\hat{\pi}(P,L,V) = \pi(P,L) = r(P) + (P-C)Q(P+L) \qquad \text{if} \quad P \geq P^V(V) - L$$

$$= \bar{\pi}(P,V) = r(P) + (P-C)V \qquad \text{if} \quad P \leq P^V(V) - L.$$

Notice that at $P = P^V(V)-L$, $\pi(P,L) = \bar{\pi}(P,V)$ and $\bar{\pi}^P(\cdot) > \pi^P(\cdot)$. Hence, if $\pi(\cdot)$ and $\bar{\pi}(\cdot)$ are concave in P, as is assumed here, $\pi(\cdot)$ is concave in P. Therefore, there are three cases analagous to those discussed in Section 3 and depicted in Figure 2. In case (a), $\bar{\pi}_p(\cdot) > 0 > \pi^P(\cdot)$ at $P = P^V(V) - L$. In this case the maximum of $\hat{\pi}(\cdot)$ occurs at $P^V(V) - L$. In case (b), $\bar{\pi}_p(\cdot) > \pi_p(\cdot) \geq 0$ at $P = P^V(V) - L$ and the peak of $\hat{\pi}(\cdot)$, occurs at the peak of $\pi(\cdot)$, $P^M(L)$. In case (c), $0 \geq \bar{\pi}_p(\cdot) > \pi_p(\cdot)$ at $P = P^V(V) - L$ and the peak of $\bar{\pi}(\cdot)$ occurs at the peak of $\bar{\pi}(\cdot)$, denoted by $\bar{P}^M(V)$.

(FIGURE 6(a), (b), (c) and (d) here.

The question now is how does the profit maximizing level of P set by the monopolist, $P*(L,V)$, change with L and V? First, consider the answer to this when V is set at V^F. Figure 6(a) depicts $P^V(V) - L$, $P^M(L)$ and $\bar{P}^M(V)$ as a function of L in this case. Note that $P^M(L) = P^V(V^F) = P^F$ when L

= 0 and that $\bar{P}^M(V)$ exceeds P^F. Also, as $P^M(L)$ has a slope between 0 and −1, it lies above $P^V(V) - L$ for all $L > 0$. Hence, for all $L > 0$, $P^M(L)$ and $\bar{P}^M(L)$ lie above $P^V(V) - L$ and we are in case (b) so that $P*(L,V)$ equals $P^M(L)$.

As V falls from V^F, $\bar{P}^M(V)$ falls, and $P^V(V)$ rises above P^F so that $\bar{P}^M(V) > P^V(V) > P^F$ if V is close to V^F. This is depicted in 6(b). As V falls further $P^V(V) > \bar{P}^M(V) > P^F$. This is depicted in 6(c). As V falls even more, $P^V(V) > P^F > \bar{P}^M(V)$. This is depicted in 6(d). Define $L*(V) = P^V(V) - P^M(L*(V))$ and $L**(V) = P^V(V) - \bar{P}^M(V)$. Notice that if $P^V(V) > P^M(V) > P^F$, $L**(V) < 0 < L*(V)$ and if $P^V(V) > P^F > \bar{P}^M(V)$, $0 < L**(V) < L*(V)$.

By drawing the analogues of Figure 6(a) we get Figures 6(b) and 6(c) and 6(d) for these three cases as well. By considering the relative positions of $P^V(V) - L$, $P^M(L)$ and $\bar{P}^M(V)$, it is clear that when $\bar{P}^M(V) > P^V(V) > P^F$ as depicted in Figure 6(b):

$$
\begin{aligned}
P*(L,V) &= P^V(V) - L && \text{for} \quad L \le L*(V) \\
&= P^M(L) && \text{for} \quad L \ge L*(V).
\end{aligned}
$$

When $P^V(V) > \bar{P}^M(V) > P^F$ and $P^V(V) > P^F > \bar{P}^M(V)$ as depicted in Figures 6(c) and 6(d), respectively:

$$
\begin{aligned}
P*(L,V) &= \bar{P}^M(V) && \text{for} \quad L \le L**(V) \\
&= P^V(V) - L && \text{for} \quad L**(V) \le L \le L*(V) \\
&= P^M(L) && \text{for} \quad L \ge L*(V).
\end{aligned}
$$
[15]

Having derived $P^*(L,V)$ for varying levels of L and V, it remains to find the equilibrium level of L. Again, this is defined by

$$Q(P^*(L,V) + L) - V = Q(P^V(V)).$$

And so by:

$$P^*(L,V) + L = P^V V)$$

$P^*(L,V) + L$ is depicted in Figures 6(a)-(d). Thus, for $V = V^F$, only $L = 0$ is an equilibrium, as shown in Figures 6(a). For V below V^F but not very small so that $\bar{P}^M(V) > P^V(V) > P^F$, as depicted in Figure 6(b), all values of L between 0 and $L^*(V)$ are equilibria. For V smaller, so that $P^V(V) > \bar{P}^M(V) > P^F$, depicted in Figure 6(c), all values of L between $L^{**}(V)$ and $L^*(V)$ are equilibria, but $L = 0$ is not. For V very small, where $P^V(V) > P^F > \bar{P}^M(V)$, depicted in Figure 6(d) again all L between $L^{**}(V)$ and $L^*(V)$ are equilibria, but $L = 0$ is not. This gives Proposition 5.

Proposition 5. When firms realize that a black market for licenses will exist if price is too low, but take L as given otherwise, zero remains in the support of the equilibrium license prices as long as the quota is not too restrictive. For more restrictive quotas, equilibrium license prices are bounded away from zero. However, there are a continuum of such license prices for any quota below the free trade level.

Thus, the result that auction quotas may not raise revenues unless they are quite restrictive re-emerges even when the timing of moves is altered and consumers are not myopic. However, it is less compelling here as other equilibria with positive license prices also exist.

6. CONCLUSION

This paper points out that proposals to auction quota licenses are unlikely to raise revenues in the presence of foreign monopoly power. In this case, auctioning quotas is not better than giving them away unless the quota is quite restrictive. For this reason, they are also unlikely to raise welfare above the free trade level because of the loss of consumer surplus due to quotas. However, in the presence of home monopoly power, the proposal is likely to raise revenues if goods are substitutes. In this case, auctioning quotas is preferable to giving them away. However, if goods are complements, auction quotas do not raise revenues with a home monopoly and so do not dominate giving away licenses. Although this paper only touches on some simple monopoly examples, Krishna (1988) discusses the case of an oligopoly, where similar results obtain.

Still, much remains to be done to determine the desirability of auction quotas. First, their desirability under uncertainty needs more study. Note that here a license has an option value and its price is positive even when the quota is set at the free trade level. This is discussed in Krishna (1988a). Second, it may be possible to use recent work on computable partial equilibrium models, such as that of Dixit (1987) and Venables and Smith (1986), to help build emperically implementable models to give estimates of the welfare effects of auctioning quota rights in particular markets. Third, while this paper assumes the market for licenses is competitive, it would be desirable to study the determinants of the market structure in the market for licenses. Fourth, it would be worthwhile asking whether the results are sensitive to the way that licenses are sold. I am presently working along these lines.

FOOTNOTES

1. See Krishna (1988), "The Case of the Vanishing Revenues: Auction Quotas with Oligopoly."

2. Business Week, March 16, 1987, p. 64.

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

4. Time, March 16, 1987, p. 59.

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

6. The interested reader should consult Bergsten et al. (1987) and Takacs (1987) for an historical and institutional perspective on work in this area.

7. See Takacs (1987), footnote 7.

8. Auction quota revenues in autos for 1987 are estimated at about 2.2 billion by Bergsten et al. The quota revenues fluctuate quite considerably over the years as demand fluctuates and their level changes making them more or less restrictive.

9. See Krishna (1987) for a survey of this work.

10. There may be domestic competitive supply in which case the monopolist's

demand in what follows should be interpreted as the residual demand curve.

11. This is because when $V = Q^M$, the intersection of HR, the marginal revenue curve corresponding to BE, with marginal cost would occur at a lower output level than the output level at which the kink in demand occurs. As the quota falls, the kink in the demand curve moves back twice as fast as the intersection of the marginal revenue curve with marginal cost. Finally, at the quota level of $\bar{V}$ depicted, the two coincide.

12. It is possible to draw the analogue of Figure 3 with BB very steep and $\bar{V}$ close to Q^M, where auction quotas can raise welfare above its free trade level.

13. Assuming $\varepsilon = 1.1$, $e = 8$, $\frac{N}{n} = 0001$ yields one such example.

14. This is because of our constant marginal cost assumption. If costs were increasing; there would be some producer surplus to shift and this would add a profit shifting element which is ruled out here.

15. One might think another case exists where $\bar{P}^M(V)$ is so much below $P^V(V^F)$ that $L^*(V) > L^{**}(V)$. This is not possible. In this case L is between $L^*(V)$ and $L^{**}(V)$ $P^{\bar{M}}(V) < P^V(V) - L < P^M(L)$ which would imply that at $P^v(V) - L$, $\bar{\Pi}^P(\cdot) > 0$ which is not possible.

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Table 1*

Revenue Available from U.S. Auction Quota
or Tariff-Quotas (million dollars)

Industry	Auction Revenue (IIE)[a]	Auction Revenue (CBO)[b]
steel	1,330	700
textiles and apparrel	3,000	2,400
machine tools	320	100
sugar	300	300
dairy	200	200
TOTAL	5,150	3,700

* From Feenstra (1988), "Autioning U.S. Quotas and Foreign Response." (mimeo)

[a] From Bergsten et al. (1987, Table 4.1), estimates for 1986 or 1987.

[b] From Congressional Budget Office (1987, Table 1), estimates for 1987.

FIGURE 1

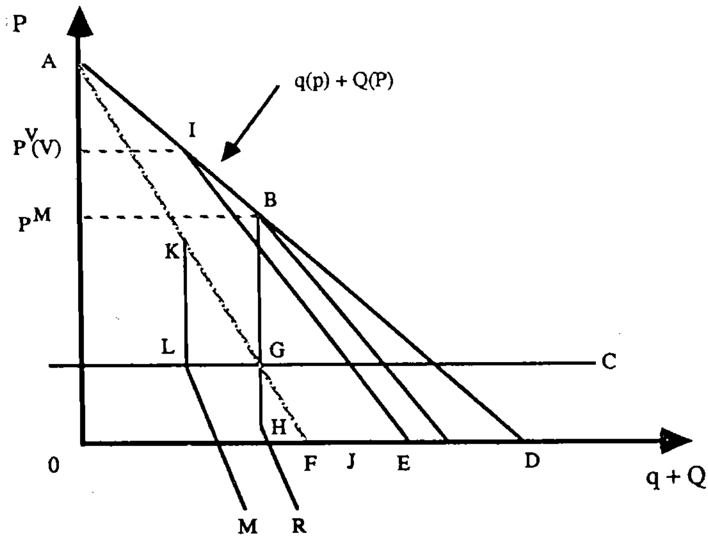


Figure 2a

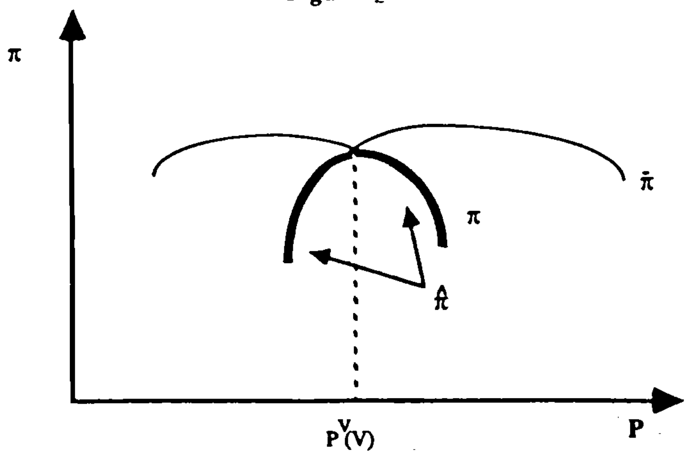


Figure 2b

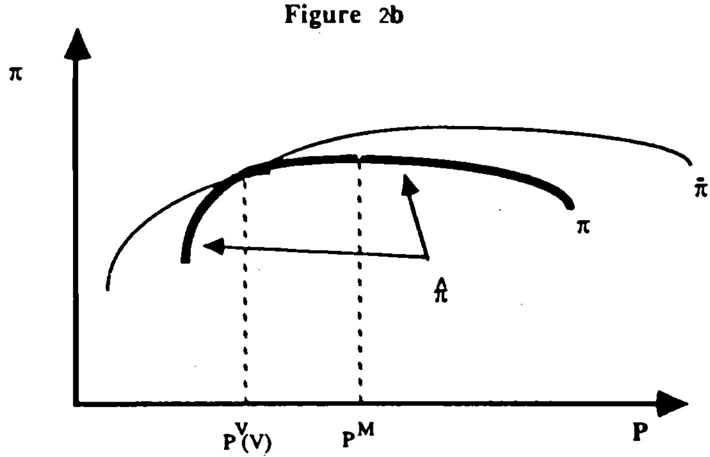


Figure 2c

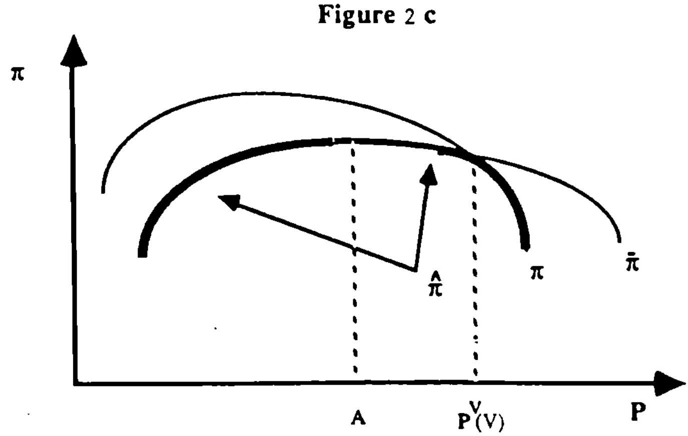


FIGURE 3

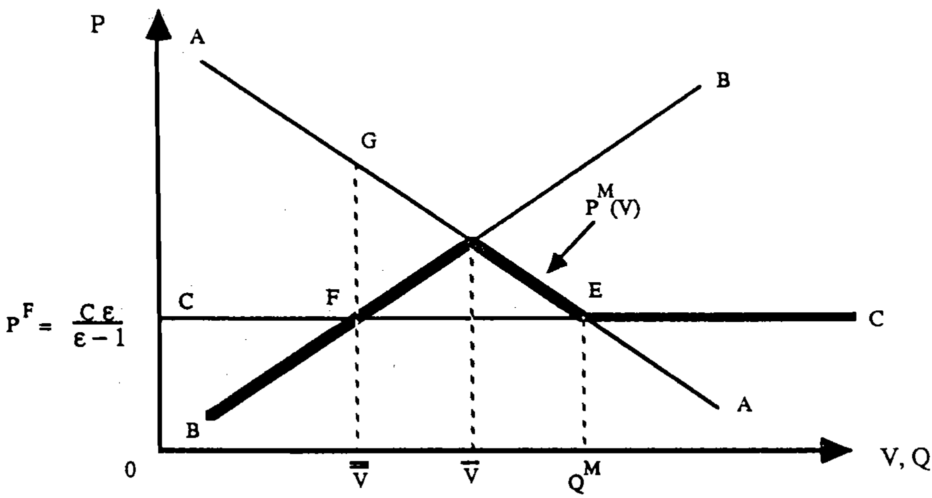


FIGURE 4 a

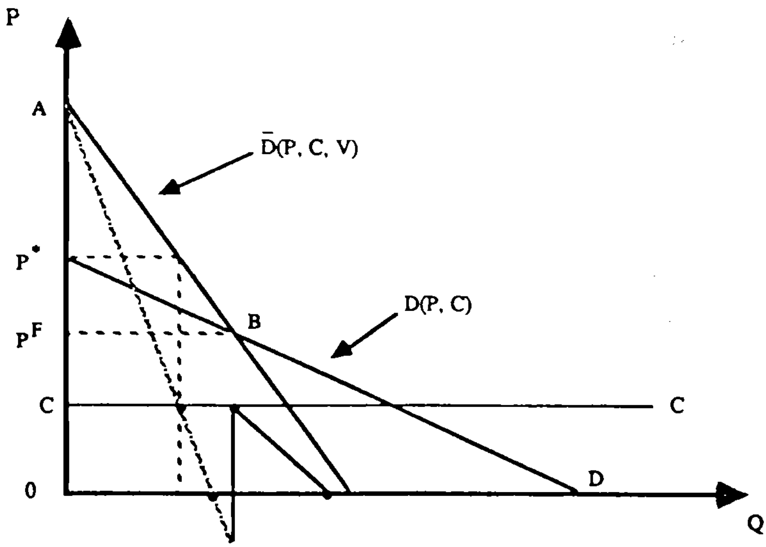


FIGURE 4 b

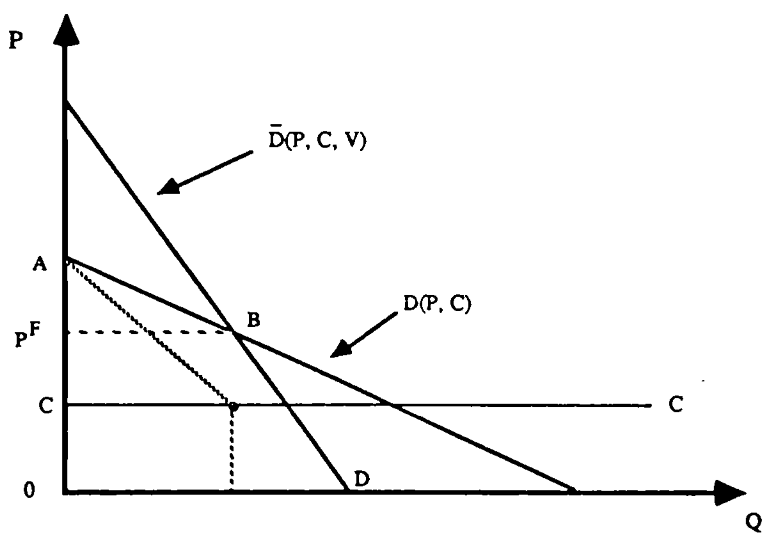


FIGURE 5

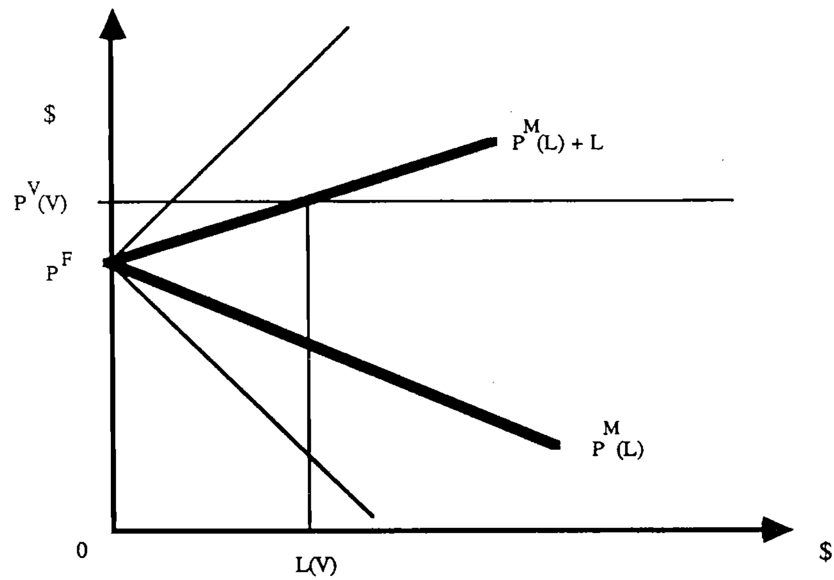
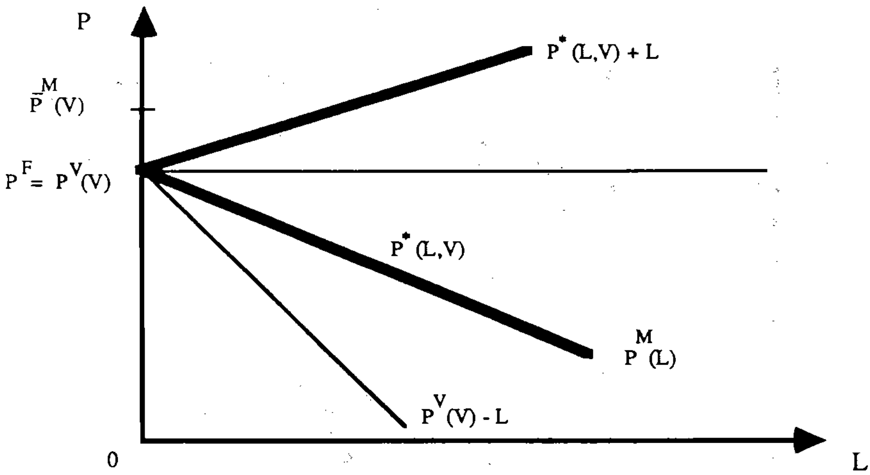


FIGURE 6

(a) $V = V^F$



(b) V slightly less than V^F

$\bar{P}^M(V) > P^V(V) > P^F$

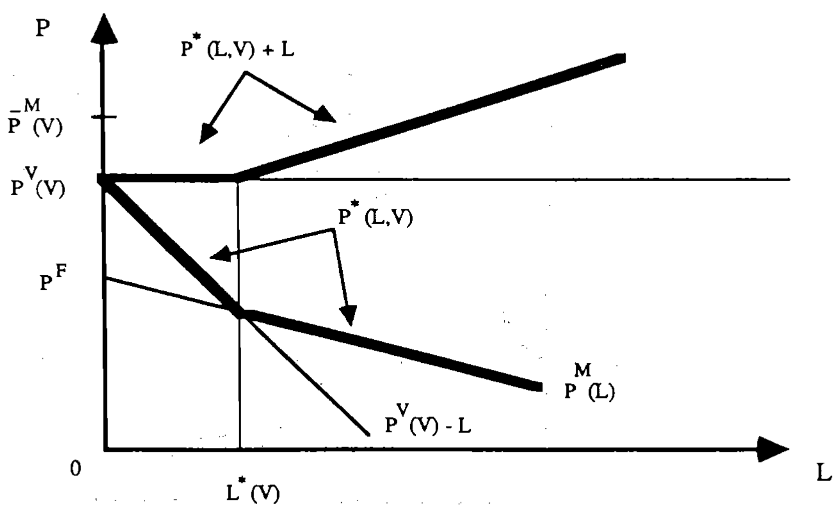
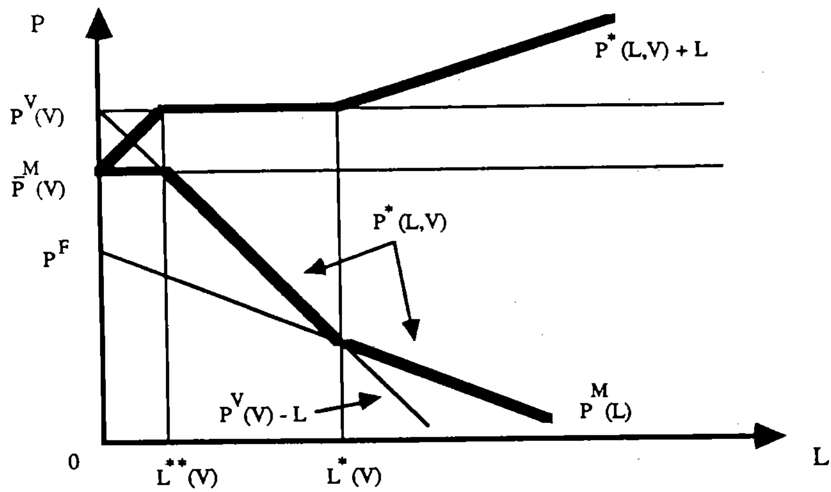


FIGURE 6

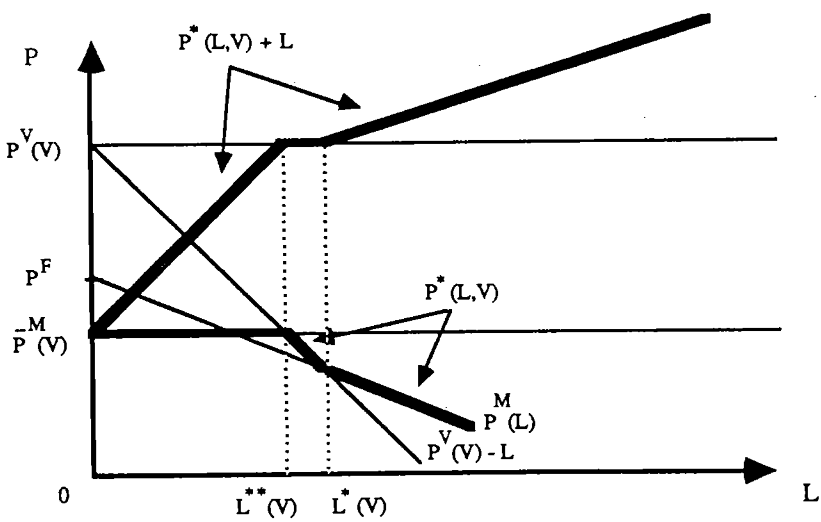
(c) V smaller than V^F

$P^V(V) > \bar{P}^M(V) > P^F$



(d) V much smaller than V^F

$P^V(V) > P^F > \bar{P}^M(V)$



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The question now is how does the profit maximizing level of P set by the monopolist, $P^*(L,V)$, change with L and V? First, consider the answer to this when V is set at V^F. Figure 6(a) depicts $P^V(V) - L$, $P^M(L)$ and $\bar{P}^M(V)$ as a function of L in this case. Note that $P^M(L) = P^V(V^F) = P^F$ when L

= 0 and that $\bar{P}^M(V)$ exceeds P^F. Also, as $P^M(L)$ has a slope between 0 and −1, it lies above $P^V(V) - L$ for all $L > 0$. Hence, for all $L > 0$, $P^M(L)$ and $\bar{P}^M(L)$ lie above $P^V(V) - L$ and we are in case (b) so that $P*(L,V)$ equals $P^M(L)$.

As V falls from V^F, $\bar{P}^M(V)$ falls, and $P^V(V)$ rises above P^F so that $\bar{P}^M(V) > P^V(V) > P^F$ if V is close to V^F. This is depicted in 6(b). As V falls further $P^V(V) > \bar{P}^M(V) > P^F$. This is depicted in 6(c). As V falls even more, $P^V(V) > P^F > \bar{P}^M(V)$. This is depicted in 6(d). Define $L*(V) = P^V(V) - P^M(L*(V))$ and $L**(V) = P^V(V) - \bar{P}^M(V)$. Notice that if $P^V(V) > P^M(V) > P^F$, $L**(V) < 0 < L*(V)$ and if $P^V(V) > P^F > \bar{P}^M(V)$, $0 < L**(V) < L*(V)$.

By drawing the analogues of Figure 6(a) we get Figures 6(b) and 6(c) and 6(d) for these three cases as well. By considering the relative positions of $P^V(V) - L$, $P^M(L)$ and $\bar{P}^M(V)$, it is clear that when $\bar{P}^M(V) > P^V(V) > P^F$ as depicted in Figure 6(b):

$$\begin{aligned} P*(L,V) &= P^V(V) - L && \text{for} \quad L \le L*(V) \\ &= P^M(L) && \text{for} \quad L \ge L*(V). \end{aligned}$$

When $P^V(V) > \bar{P}^M(V) > P^F$ and $P^V(V) > P^F > \bar{P}^M(V)$ as depicted in Figures 6(c) and 6(d), respectively:

$$\begin{aligned} P*(L,V) &= \bar{P}^M(V) && \text{for} \quad L \le L**(V) \\ &= P^V(V) - L && \text{for} \quad L**(V) \le L \le L*(V) \\ &= P^M(L) && \text{for} \quad L \ge L*(V). \end{aligned}$$ [15]

Having derived $P^*(L,V)$ for varying levels of L and V, it remains to find the equilibrium level of L. Again, this is defined by

$$Q(P^*(L,V) + L) - V = Q(P^V(V)).$$

And so by:

$$P^*(L,V) + L = P^V V)$$

$P^*(L,V) + L$ is depicted in Figures 6(a)-(d). Thus, for $V = V^F$, only $L = 0$ is an equilibrium, as shown in Figures 6(a). For V below V^F but not very small so that $\bar{P}^M(V) > P^V(V) > P^F$, as depicted in Figure 6(b), all values of L between 0 and $L^*(V)$ are equilibria. For V smaller, so that $P^V(V) > \bar{P}^M(V) > P^F$, depicted in Figure 6(c), all values of L between $L^{**}(V)$ and $L^*(V)$ are equilibria, but $L = 0$ is not. For V very small, where $P^V(V) > P^F > \bar{P}^M(V)$, depicted in Figure 6(d) again all L between $L^{**}(V)$ and $L^*(V)$ are equilibria, but $L = 0$ is not. This gives Proposition 5.

Proposition 5. When firms realize that a black market for licenses will exist if price is too low, but take L as given otherwise, zero remains in the support of the equilibrium license prices as long as the quota is not too restrictive. For more restrictive quotas, equilibrium license prices are bounded away from zero. However, there are a continuum of such license prices for any quota below the free trade level.

Thus, the result that auction quotas may not raise revenues unless they are quite restrictive re-emerges even when the timing of moves is altered and consumers are not myopic. However, it is less compelling here as other equilibria with positive license prices also exist.

6. CONCLUSION

This paper points out that proposals to auction quota licenses are unlikely to raise revenues in the presence of foreign monopoly power. In this case, auctioning quotas is not better than giving them away unless the quota is quite restrictive. For this reason, they are also unlikely to raise welfare above the free trade level because of the loss of consumer surplus due to quotas. However, in the presence of home monopoly power, the proposal is likely to raise revenues if goods are substitutes. In this case, auctioning quotas is preferable to giving them away. However, if goods are complements, auction quotas do not raise revenues with a home monopoly and so do not dominate giving away licenses. Although this paper only touches on some simple monopoly examples, Krishna (1988) discusses the case of an oligopoly, where similar results obtain.

Still, much remains to be done to determine the desirability of auction quotas. First, their desirability under uncertainty needs more study. Note that here a license has an option value and its price is positive even when the quota is set at the free trade level. This is discussed in Krishna (1988a). Second, it may be possible to use recent work on computable partial equilibrium models, such as that of Dixit (1987) and Venables and Smith (1986), to help build emperically implementable models to give estimates of the welfare effects of auctioning quota rights in particular markets. Third, while this paper assumes the market for licenses is competitive, it would be desirable to study the determinants of the market structure in the market for licenses. Fourth, it would be worthwhile asking whether the results are sensitive to the way that licenses are sold. I am presently working along these lines.

FOOTNOTES

1. See Krishna (1988), "The Case of the Vanishing Revenues: Auction Quotas with Oligopoly."

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

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

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

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

6. The interested reader should consult Bergsten et al. (1987) and Takacs (1987) for an historical and institutional perspective on work in this area.

7. See Takacs (1987), footnote 7.

8. Auction quota revenues in autos for 1987 are estimated at about 2.2 billion by Bergsten et al. The quota revenues fluctuate quite considerably over the years as demand fluctuates and their level changes making them more or less restrictive.

9. See Krishna (1987) for a survey of this work.

10. There may be domestic competitive supply in which case the monopolist's

demand in what follows should be interpreted as the residual demand curve.

11. This is because when $V = Q^M$, the intersection of HR, the marginal revenue curve corresponding to BE, with marginal cost would occur at a lower output level than the output level at which the kink in demand occurs. As the quota falls, the kink in the demand curve moves back twice as fast as the intersection of the marginal revenue curve with marginal cost. Finally, at the quota level of $\bar{V}$ depicted, the two coincide.

12. It is possible to draw the analogue of Figure 3 with BB very steep and $\bar{V}$ close to Q^M, where auction quotas can raise welfare above its free trade level.

13. Assuming $\varepsilon = 1.1$, $e = 8$, $\frac{N}{n} = 0001$ yields one such example.

14. This is because of our constant marginal cost assumption. If costs were increasing, there would be some producer surplus to shift and this would add a profit shifting element which is ruled out here.

15. One might think another case exists where $\bar{P}^M(V)$ is so much below $P^V(V^F)$ that $L^*(V) > L^{**}(V)$. This is not possible. In this case L is between $L^*(V)$ and $L^{**}(V)$ $P^{\bar{M}}(V) < P^V(V) - L < P^M(L)$ which would imply that at $P^v(V) - L$, $\bar{\Pi}^P(\cdot) > 0$ which is not possible.

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Table 1*

Revenue Available from U.S. Auction Quota or Tariff-Quotas (million dollars)

Industry	Auction Revenue (IIE)[a]	Auction Revenue (CBO)[b]
steel	1,330	700
textiles and apparrel	3,000	2,400
machine tools	320	100
sugar	300	300
dairy	200	200
TOTAL	5,150	3,700

* From Feenstra (1988), "Autioning U.S. Quotas and Foreign Response." (mimeo)

[a] From Bergsten et al. (1987, Table 4.1), estimates for 1986 or 1987.

[b] From Congressional Budget Office (1987, Table 1), estimates for 1987.

FIGURE 1

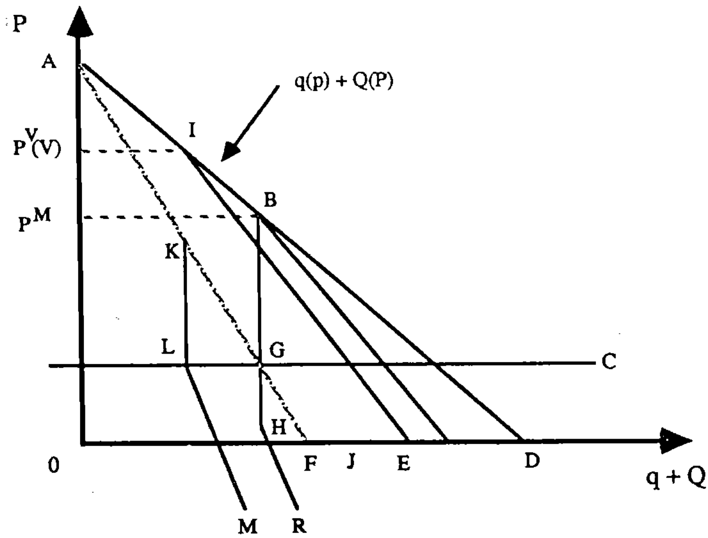


Figure 2a

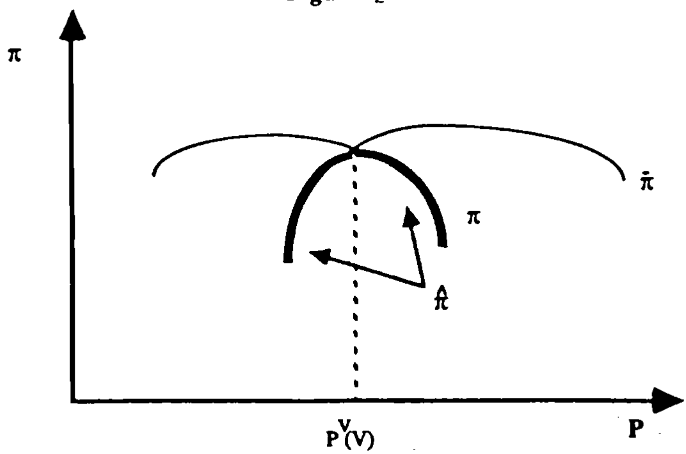


Figure 2b

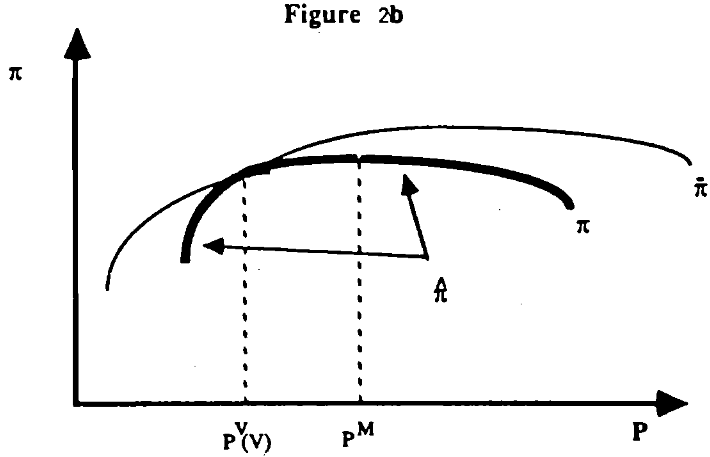


Figure 2 c

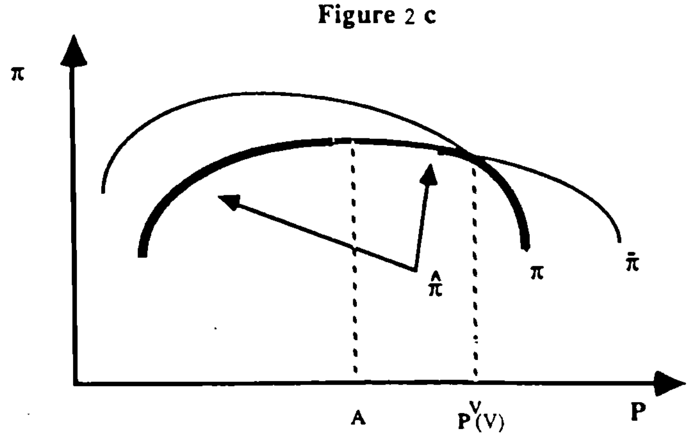


FIGURE 3

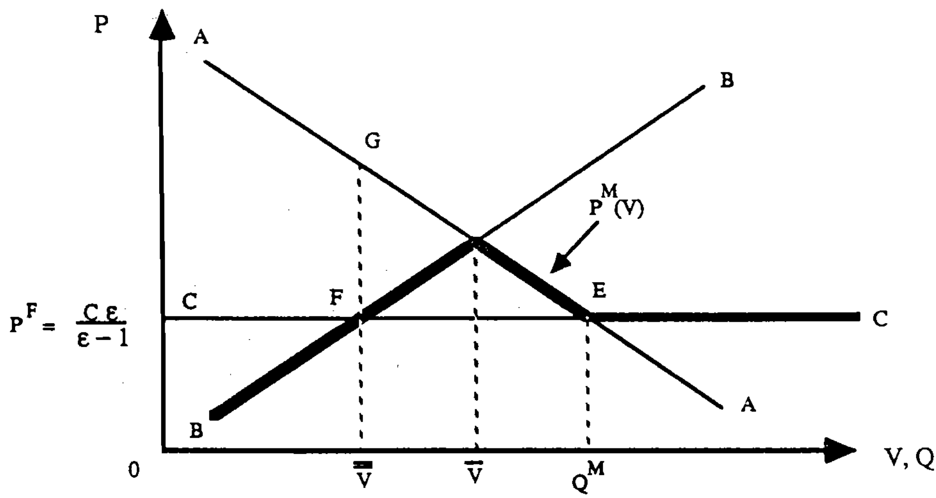

P
A
B
G
$P^M(V)$
C
F
E
C
$P^F = \frac{C\varepsilon}{\varepsilon - 1}$
A
B
0
$\bar{\bar{V}}$
$\bar{V}$
Q^M
V, Q

FIGURE4 a

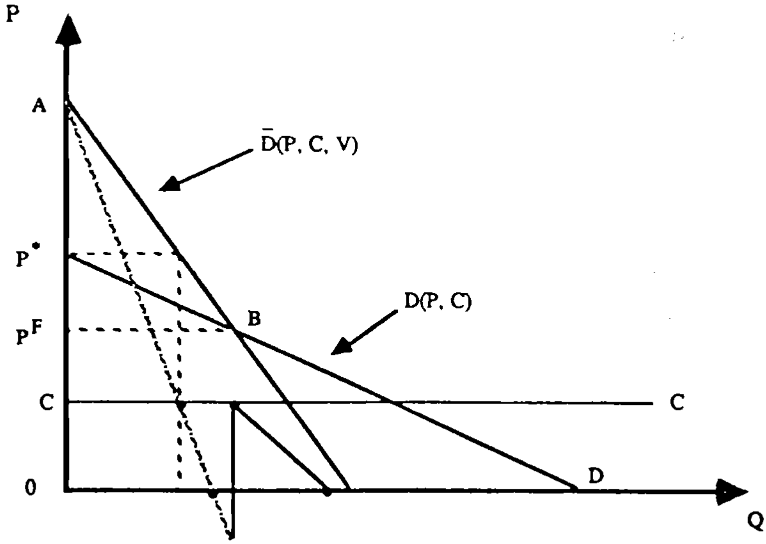


FIGURE4 b

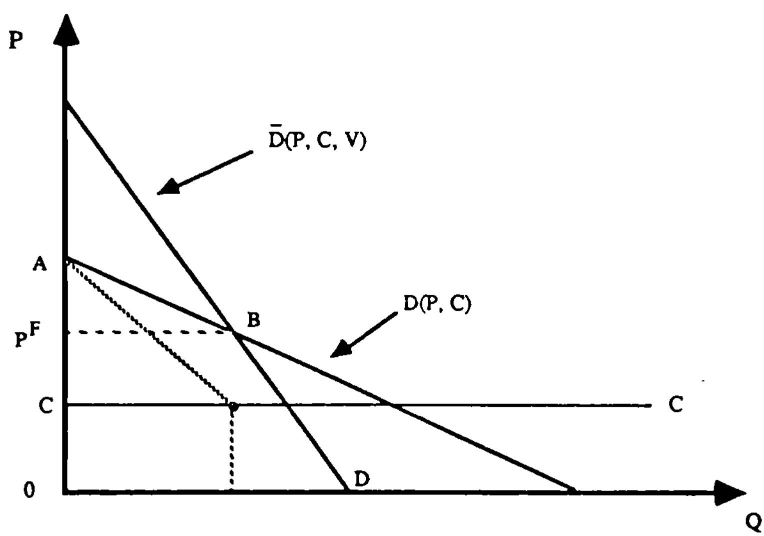


FIGURE 5

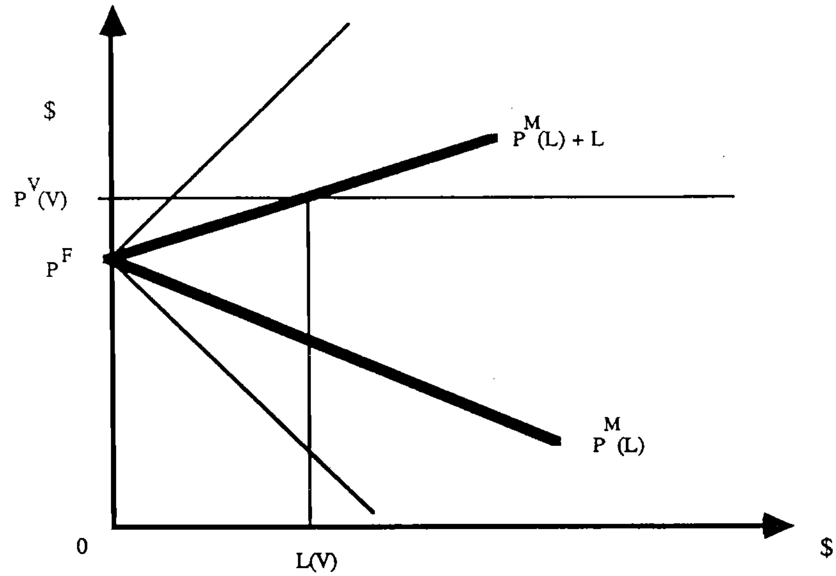
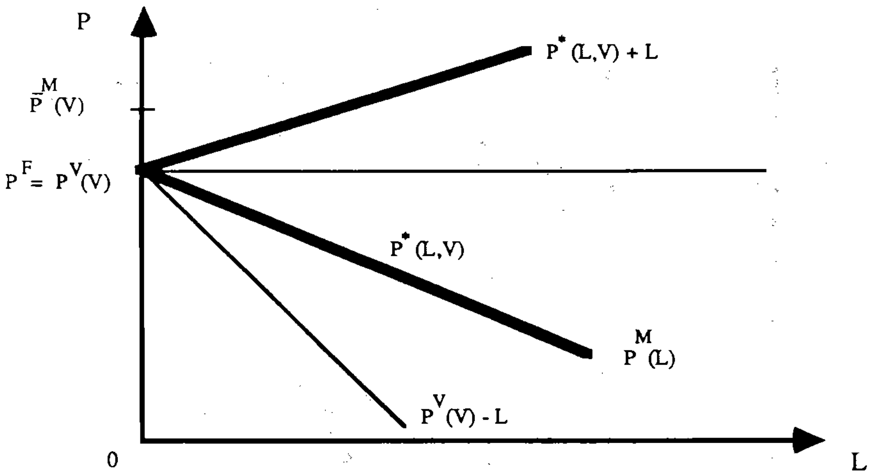


FIGURE 6

(a) $V = V^F$



(b) V slightly less than V^F

$\bar{P}^M(V) > P^V(V) > P^F$

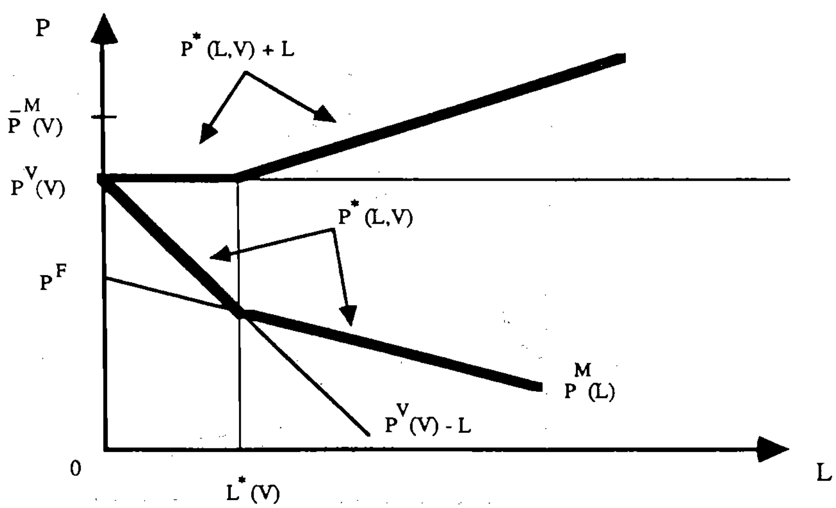
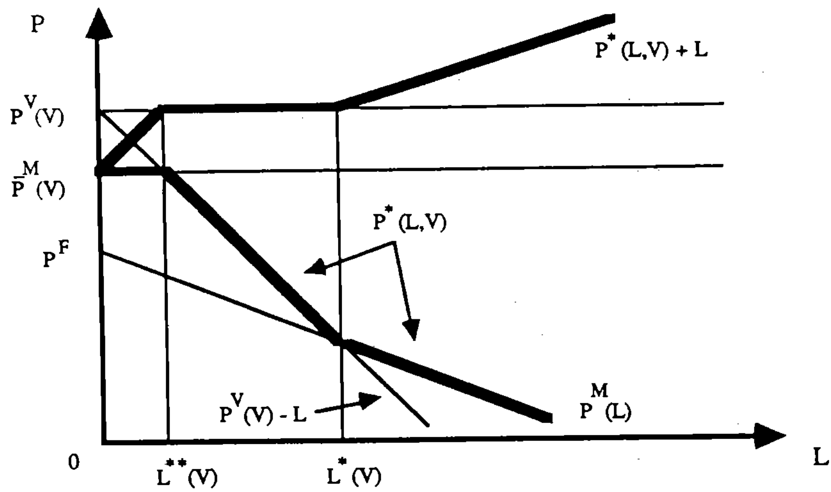


FIGURE 6

(c) V smaller than V^F

$P^V(V) > \bar{P}^M(V) > P^F$



(d) V much smaller than V^F

$P^V(V) > P^F > \bar{P}^M(V)$