Theoretical Implications of Imperfect Competition on Quota License Prices and Auctions

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This article looks at the implications for trade policy of recent work on quota auctions. Recent work has considered a variety of market structures in addition to the standard one of monopoly in the product market. It has also emphasized details of the implementation process, as well as the timing of decisions and dynamic factors. Such considerations are shown to be important, because they can greatly affect the outcome of trade policies.

It is well known that prices of quota licenses should not be interpreted as tariff equivalents when markets are imperfectly competitive (Bhagwati 1965; McCulloch 1973). The early literature on this topic, however, focused mainly on the equivalence issue, with imperfect competition simply modeled in the form of a monopoly. More recent work on trade policy with imperfect competition has taken a more explicitly game-theoretic approach. It has emphasized the importance of market conditions, market structure, and details of the quota implementation. Even within the perfect competition paradigm, new insights have been provided with the use of well-structured microeconomic models that take into account such factors as uncertainty and intertemporal considerations.

There has recently been renewed interest in the study of quantitative restrictions, especially auction quotas, and in various kinds of quota reform. Voluntary export restraints (VERS) have proliferated as a means of sidestepping the General Agreement on Tariffs and Trade, which explicitly forbids quotas. For example, developing countries today face significant quantitative restrictions on yarn, textiles, and apparel under the Multi-Fibre Arrangement (MFA), a system of bilateral, commodity-specific, quantitative restraints. Reform of the MFA is an important component of the ongoing Uruguay Round, and current proposals are to extend the MFA for one or two more years while a phaseout is negotiated.

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VERS are simply quotas that have been negotiated "voluntarily" between the exporting and importing country. Such quotas result in excess demand in the importing country at the world price. This situation creates scarcity rents for the restricted imported good. The allocation of these scarcity rents depends on how the quota is implemented. Usually, implementation is done by means of licenses that confer the right to import (to an importing firm), or the right to export (to an exporting firm), or the right to buy the restricted good (to a consumer in the importing country).

VERS are often justified by the importing country on the grounds that the rents resulting from the quota are appropriated by the exporting country, making the policy more acceptable to them. Import quotas could bestow the windfall gains to the importing country. The basic idea is illustrated in figure 1. The importing country has an excess demand curve (demand less domestic supply) denoted by $D(P)$. The exporting country, which we can think of as the rest of the world, has an excess supply curve (the excess of supply over demand) denoted by $S(P)$. Under free trade, quantity $Q^F$ is imported at price $P^F$. If an import quota is imposed of amount $V$, which is below the free trade level of imports, the rest of the world is willing to supply the amount $V$ at price $P^S(V)$, while domestic consumers are willing to pay $P^D(V)$ for this amount. The difference between the two prices is the value of an import quota license, $L(V)$. The same amount ($V$) could also be imported, with the outcome unchanged, by imposing a specific tariff of $L(V)$. The tariff would raise the supply curve in figure 1 so that it would intersect the demand curve at $V$. This is the argument showing the equivalence of a tariff and an import quota under competition.

Auctioning the import quota licenses generates $L(V)V$ revenue. These rents would accrue to the party that sells the licenses or to the party or parties to whom the licenses are awarded. When a VER is in place, the presumption is that agents in the exporting country obtain the rents: if the licenses are sold, then the quota rent would go to the authority in the exporting country responsible for their sale. By contrast, if the licenses are allocated to exporting firms, the quota rent would go to those firms.

Both in industrial and in developing countries, there has been great interest in auctioning quota licenses. This interest stems from the perceived benefits of such a policy. First, because most existing quotas are allocated to the exporting country, the importing country does not receive the quota rents. Auctioning quotas by the importing country is seen as one way it can retrieve these rents. Many proponents of auctioning quotas in the United States focus on their revenue-raising potential. For example, Tarr (1989, p. 98), using a general equilibrium model, estimates that quota rents accruing to restricted exporters of textiles, automobiles, and steel to the United States were about $14 billion in 1984. Because product markets are imperfectly competitive in the automobile and steel industries, however, estimates based on models of perfect competition may well exaggerate the revenue-raising potential of quota auctions.

The second perceived advantage of auctioning quotas is that if actual license
prices can be used to convert quotas into tariffs, the tariffs can then be phased out in a liberalization process. It is not easy to calculate the tariff equivalents of quotas. A number of countries, including Australia, New Zealand, and Colombia, have actually implemented quota auctions, used the license prices to switch over to tariffs, and then phased out the tariffs. Takacs (1990) provides a detailed account of how license prices from quota auctions are used in trade liberalization. This use of license prices is questionable, however, because market imperfections, the quota implementation procedure, and dynamic elements create nonequivalence between tariffs and quotas.

Sometimes license prices in one exporting country are used to impute unavailable license prices in another exporting country (see Hamilton 1986 and Trela and Whalley 1991 on the MFA). Trela and Whalley compute the Hong Kong supply price by subtracting the license price from the U.S. price. They then compute the production costs of quota-restricted products in other exporting countries by multiplying the unit cost in Hong Kong with the ratio of the exporting country’s relative wage in the textile and apparel industry compared with that of Hong Kong’s. The license price in the exporting country then can be imputed as the difference in this production cost and the U.S. price. This calculation results in large estimates of the rents retained in several exporting countries, with consequent implications for reform of the MFA. These estimates may not be very meaningful, however, if they are different from the actual license prices. Such differences could occur, for example, if countries have different quota implementation procedures, affecting their ability to retain the rents from
export quotas. Krishna, Martin, and Tan (1992) show that this procedure does indeed seem to provide overestimates of the actual license prices.

The analysis of the basic model of auctioning import quota licenses is certainly correct, given its assumptions. But the assumptions themselves may be inappropriate for at least three reasons. The first is the existence of market power. The second is that the basic model illustrated in figure 1 does not address details of the quota implementation procedure. The third is that the model is static and assumes no uncertainty. The limitations of the basic model have important consequences for policy.

This article is organized as follows. Section I discusses the implications of market imperfections in both the product and the license markets. Section II highlights the importance of studying how the quotas are implemented. Section III introduces uncertainty and dynamic elements to the basic competitive model. Section IV contains some concluding remarks.

I. Market Power

In analyzing the effects of a quota and quota license auctions, two distinct but related markets are involved: the market for the product and the market for the licenses. For example, under perfect competition, the size of the quota affects the supply price, \( P_s(V) \), in the product market. The quota also determines the supply in the license market. But demand for the license is based on the price charged for the good in the product market. Demand and supply together determine the value of the license. In each market, there may be market power on the buyer's side, on the seller's side, or on both sides. Much of the existing literature has focused on market power on the seller's side in the product market. But even if there are a large number of perfectly competitive sellers on the supply side of the product market, there may be market power on the buyer's side. For example, in apparel trade under the MFA, there are often claims that large retail stores in the United States exert monopsony power (see Goto 1989, p. 128, and Caves and Rosen 1982, p. 16).

Furthermore, even if the product market is competitive, the license market may not be. If license allocations are determined on the basis of historical market share, concentration in license holdings could be a consequence of history. For example, concentration in license holdings varies quite considerably across apparel categories in Hong Kong. The Herfindahl index of license-holding concentration gives an estimate of the number of firms of equal size in the market. In considering trade between the United States and Hong Kong under the MFA, the index varies from around 70 for cotton dresses and knit shirts of man-made fiber to around 4 or 5 for men's cotton woven shirts and men's wool jackets. An editorial in the Hong Kong trade journal Textile Asia, in March 1989, alleges that "quota price fluctuations do not in fact reflect normal supply and demand but the course of manipulation by quota holders."

If producers are perfectly competitive but there is market power in the license market and on the part of the buyers, then the license price may fall short of the
potential rent. This is termed rent sharing. Krishna, Erzan, and Tan (1991) provide evidence to suggest that rent sharing exists in the MFA, and hence the effects of any proposed reforms to the MFA are likely to be very different from those predicted on the basis of competitive models.

To adequately assess the effects of a quota, both the product and license markets need to be considered. A quota affects the shape of the perceived demand curve facing firms with market power and hence affects the behavior of the firms. The details of the argument vary, depending on the kind of competition facing producers, that is, whether power is in the domestic or foreign market or in both, as well as on demand conditions. For example, if there is imperfect competition in the product market at home or abroad or both, there is no supply curve, because output is chosen to maximize profits, and the choice of output depends on demand conditions. Moreover, because the response of producers in choosing price is very different under a quota than a tariff, the results of a tariff policy with imperfect competition, as developed in Brander and Spencer (1985) and Eaton and Grossman (1986), do not apply.

Domestic Product Market Power

Throughout the discussion of the product market, I assume that license markets are perfectly competitive and that licenses are sold either to competitive retailers with zero marginal costs or to consumers directly. A license entitles its possessor (a retailer or consumer) to buy one unit of the product in question at the price charged by the seller (producer). There are only two countries in the world: Home and Foreign.

If there is no market segmentation, arbitrage enables the license holder to buy at the lower of the prices charged by the seller in the Home and the Foreign market. If the seller attempts to charge a different price in each market, however, consumers will simply buy at the lower of the two prices. Thus, the seller can be restricted to choosing only one price without loss of generality when markets are not segmented.

I assume that the Home government first sets the quota for imports into the Home market. Then the producer sets the price of the product. Finally, the market for licenses clears. This timing structure is consistent with the idea that the market for licenses clears more frequently than the producer sets the product price and that the producer sets the product price more frequently than the government sets the quota.1 Note that because of this timing structure, the price charged by the producer and the quota level set by the Home government are both taken as given when the license market clears. The former affects the demand for licenses, and the latter determines the supply of licenses. Thus the equilibrium license price is determined for the given supply price and quota level. The producer takes the quota as given, but realizes that the choice of price

1. This assumption is not really needed; similar results obtain when the monopolist is able to adjust the product price faster than the rate at which the market for licenses clears (Krishna 1990a).
will affect the value of a license in the license market. The government, being the first mover, realizes that its choice of the quota level will affect the price chosen by the producer and the value of a license.

The model is then solved backward. First, the market for licenses clears, then the producers with market power set the price, taking into account the effect on the license price. Finally, in determining optimal policy, the government chooses the quota, taking into account its effect on the producer's choice of product price and the equilibrium license price.

**Domestic monopoly.** The standard case of Home monopoly and Foreign competitive supply has been widely analyzed (Bhagwati 1965; Shibata 1968). In this case, the supply price from abroad is fixed by the quota level, but the output and price chosen by the domestic producer is affected by the quota because of monopoly power at Home. The license price is positive if, and only if, the supply price from abroad is lower than the demand price. (The demand price is the price at which domestic demand equals the supply from abroad plus domestic production.) The difference between the supply price from abroad and the demand price is the license price.

Under free trade, the domestic monopolist faces the residual demand curve (domestic demand less foreign supply) and chooses price to maximize profits. The domestic monopolist's choice of price then elicits a level of supply from abroad. When the Home and Foreign goods are substitutes, a quota at the free trade level does not affect the Home monopolist's demand curve below the free trade price, because at this price the quota is not binding. The quota causes demand to be less elastic for price increases above the free trade level, however, because raising the price makes the quota bind on the foreign suppliers. In figure 2, AB is the residual demand curve without a quota. If a quota is set that elicits this supply from abroad at price P', the demand curve with a quota is given by CEB, where CD is a steeper curve than AB. This creates an incentive for the Home monopolist to raise the price, which causes a divergence between the demand price and the supply price from abroad and creates a positive price for import licenses. Thus, the license price exceeds the free trade tariff of zero. By continuity arguments, for quotas near the free trade level, the license price will exceed the tariff that leads to the given import level.

Note that with substitute goods and a domestic monopoly, the imposition of any quota can only raise the domestic price. Domestic production could rise or fall. It falls if the quota is close to free trade levels, but can rise if it is more restrictive. Furthermore, the quota need not be more restrictive than free trade to have an effect. A quota at the free trade level will raise the price and reduce domestic production.

If the Home and Foreign goods are complements, a quota at the free trade level makes the Home monopolist's demand curve less elastic for price decreases below the free trade price, but leaves it unaffected for price increases above the free trade price. This makes it unprofitable for the Home monopolist to either raise or lower the price from the free trade level. Therefore, the market for
licenses clears at the license price of zero. If the quota is set below, but close to, the free trade level of imports, the price of the domestic good at which the quota on imports becomes binding—call it $P^+$—exceeds the free trade price. At prices below this level, the quota on imports binds and, because the goods are complements, the quota reduces the demand for the Home monopolist's product. Hence the Home monopolist's demand curve is kinked at $P^+$, being more inelastic for price decreases than for price increases. These considerations tend to cause the Home monopolist to set the price at a point at which the quota is just binding on imports. This in turn means that the license price is zero, although the tariff that gives the same level of imports is positive. In this case, therefore, the tariff tends to exceed the license price (see Krishna 1989b).

**Domestic oligopoly.** Similar results obtain when the domestic firm has a few competitors who are also unrestricted by a quota and who have market power. Consider a market in which differentiated products are sold. There are two symmetric Home firms (Firm 1 and Firm 2) with market power that are not subject to a quota. For ease of exposition, let $P^1$ and $P^2$ denote their prices and let $P^*$ be the price of the competitive Foreign firms who make a homogeneous product and who are restricted by a quota. Assume that all firms have an identical constant marginal cost of production. Because the Foreign firms are competitive, $P^*$ is equal to this marginal cost, and supply from the Foreign firms

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2. Alternatively, they could be two other Foreign firms that are not subject to the quota. An example of such a country-specific quota is the VER on automobiles in 1981 that was aimed at Japan.
is infinitely elastic at this price. The Home firms make products that differ from each other and from the goods produced by the Foreign firms. In the absence of any quotas, each Home firm maximizes its profit by choosing its price, taking its rival's price (and the foreign price) as given.

Now consider the effects of a quota on imports at the free trade level. When imports and domestic goods are substitutes, license demand is based on the demand for imports. If the price of a license is \( L \), demand for a license is given by \( D^*(P_1, P_2, P^r + L) \), where \( D^*(.) \) denotes the demand for imports. The supply of licenses is at most equal to the quota level, \( V \). The equilibrium level of \( L \) is determined by setting the demand for licenses equal to the supply. If the demand at a zero license price exceeds \( V \), the license price is zero; otherwise, it is positive. Thus, the license price is increasing in \( P_1 \) and \( P_2 \), but decreasing in the quota level. Raising the price of import substitutes shifts the demand for licenses outward, thereby raising the license price. Raising the quota level shifts the supply of licenses outward, reducing the license price.

The presence of a quantitative constraint on imports makes the demand facing each Home firm, at the point where the quota just binds, less elastic for price increases, but unaffected for price decreases. The domestic firms recognize that demand for their goods depends on the full price of imports, \( P^r + L(.) \). With a quota, when domestic firms raise their price, the price of licenses is also raised. The domestic firms therefore lose fewer customers to foreign suppliers than they would without a quota. In figure 2, \( AB \) is the demand curve facing a Home firm when its rival Home firm charges the free trade price. The quota transforms the perceived demand curve to \( CEB \). Each Home firm thus has an incentive to raise its price, given the price set by the other firm. If they do so, they raise the equilibrium domestic price and consequently induce an increase in the demand for imports. This increase in demand in turn creates a positive price for a license to import, even when the quota is set at the free trade level. The price-raising incentive is discussed in Bhagwati (1965) for the case of a domestic monopoly and in Helpman and Krugman (1989) for the general case of market power at home.

Selling licenses raises revenue, but it may not lead to an improvement in the Home country's welfare. Because Foreign supply is competitive, the quota system does not shift profits. The gain in revenue comes at the expense of consumer surplus. A quota thus results in a deadweight loss, despite the positive license price and revenue thereby derived. This result is true for quotas both above and below the free trade level.

When imports and Home goods are complements and the quota is set at the free trade level, the price of a license is again implicitly defined as a function of \( P_1, P_2, \) and the quota level. In this case, however, the license price is decreasing in all three arguments. The quota binds only if the Home firms charge a low price. But the binding quota raises the full price of the import and, because the goods are complements, causes the Home firms to lose sales. Thus, demand facing a Home firm is given by a curve like \( AED \) if \( AB \) is the unrestricted demand
curve, and $P'$ is the price where the quota just binds. Hence, there is no incentive for either Home firm to cut its price. The free trade equilibrium remains an equilibrium, and the license price is zero. Quotas close to, but below, the free trade level lead to many possible equilibria, all of which have a license price of zero. Quotas above the free trade level have no effect.

**Foreign Product Market Power**

Market power may take the form of a monopoly or oligopoly in Foreign supply, with Home production, if any, being competitive. The implications for the license price would be different from those under domestic product market power.

*Foreign monopoly.* If there is a single Foreign supplier of the product and the Home and Foreign markets are segmented, it is clearly optimal for the Foreign monopolist to raise the price in response to a quota so that the price of a license becomes zero. A positive license price would indicate that consumers are willing to pay more than the price the monopolist is charging. And raising the price will not reduce sales, because the monopolist is constrained by the quota. In terms of figure 2, the quota makes the demand curve totally inelastic for price decreases so that it is given by $AEQ'$ after the quota, and $AB$ before it. This model with segmented markets is developed diagrammatically in Bergsten and others (1987) and is also mentioned in Shibata (1968) and in Helpman and Krugman (1989).

Now suppose there is costless arbitrage between the Home and Foreign markets so the Foreign monopolist cannot practice price discrimination. One would then expect the Foreign monopolist to limit the price increase in response to a quota, thereby creating a price for the license. Somewhat surprisingly, this is not necessarily so. Quotas set close to the free trade level always have a price of zero.

The intuition behind this result is apparent when we consider the effect of the quota on the Foreign monopolist's demand and profit functions. Let $P'$ denote the price at which the Foreign monopolist's demand from the Home market exactly equals the quota level. If the Foreign monopolist sets prices above $P'$, total demand for the Foreign good is unaffected, because the quota does not bind. If the Foreign monopolist sets prices below $P'$, the quota constrains total demand in the Home market. Thus, in figure 2, the perceived demand curve with a quota is transformed from $AB$ to $AED$. The quota makes demand less elastic for price decreases below $P'$, creating incentives to price at the kink at $P'$. At $P'$, however, by definition the value of a license is zero.

The Foreign monopolist's profits are unaffected by the quota if prices are set above $P'$; because the quota does not bind. At prices below $P'$, however, profits are constrained by the existence of the quota. At prices below $P'$, the Foreign monopolist's profits equal unrestricted profits from both markets minus the loss

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3. $P'$ depends on the quota level. As the quota increases, $P'$ falls.
imposed by the quota in the Home market. If the quota is set at or below free trade, the Foreign monopolist's profit decreases at prices above $P'$. The free trade monopoly price lies below $P'$; and it is assumed that the profit function is concave in price.

Pricing below $P'$ has two effects on profits: the effect on unrestricted profits from both markets and the effect on the loss from the quota imposed by the Home country. If the quota is close to the free trade level, the first effect is close to zero at $P'$ because $P'$ is close to the free trade price, where this effect equals zero. Raising the price to $P'$, however, reduces the loss from the quota. Essentially, by raising the supply price, the monopolist can appropriate the quota rents and, in fact, will choose to do so, because if the quota is not too restrictive, there is little loss in profits. Note that a quota reduces Home welfare if it generates no revenue and restricts consumption, which is already too low because of the presence of monopoly power (Krishna 1990a). If the quota is very restrictive, however, it may be profitable for the monopolist to set the price below $P'$ and allow a positive license price. In either case, the license price does not reflect the equivalent tariff.

How do the sizes of the two markets and their relative elasticities affect the monopolist's incentive to raise the supply price and reduce the value of a license? If demand elasticities in the two markets are the same, the incentive to raise the price in order to appropriate quota rents is weakened as the size of the Foreign market rises. This weakening is reflected in the license price becoming positive relatively fast as the quota falls. The intuition is that raising the supply price in response to a quota becomes increasingly costly in terms of profits foregone in the Foreign market as the size of the Foreign market grows.

If the elasticity of demand is the same in the two markets, welfare can never rise, even if the quota is set optimally. But if Foreign demand is more elastic than Home demand, it is possible for welfare to rise when the optimal quota is set. In this case, raising the price to make the quota bind will cost the monopolist dearly, because the monopolist will lose customers in the Foreign market. Hence the Foreign monopolist will moderate price increases and will not appropriate all the quota rents in the Home market. This effect is strongest if the Home market is small in relation to the Foreign market. Thus, the size of the country imposing and auctioning a quota and its demand elasticity in relation to the rest of the world are likely to be important in determining the effects of such a policy.

Foreign oligopoly. If there are many Foreign firms and competition among them is strong enough, one would expect that the price would not rise in response to a quota and that the price of a license could be positive. Oddly enough, even the pressures of competition may not outweigh the firms' incentive to raise prices to obtain license rents. This can be shown in a simple static oligopoly model of price competition with differentiated products. The assumption of price competition is made both for convenience and because price competition is more intense than quantity competition when goods are substitutes
Suppose there are many Foreign firms facing a global quota in the Home market. Each firm will be discouraged from raising its price in response to the quota, because doing so would reduce its own sales and boost its competitors' sales. Even in this case, licenses have a price of zero, unless the quota is quite restrictive, because the effect of competition among firms does not outweigh each firm's incentive to strategically affect the price of a license.

Consider a model of a Foreign duopoly. Home supply can be incorporated (as long as it is competitive) by reinterpreting Foreign demand as residual demand, given competitive pricing by Home firms. For simplicity, assume that the two Foreign firms (Firm 1 and Firm 2) are identical (that is, impose symmetry). Further assume that Firm 1 and Firm 2 face identical constant marginal costs and produce goods that are substitutes for each other.

In the absence of any quotas, each firm maximizes its profit, taking its rival's price as given. With a global quota, the demand for licenses equals the sum of the demand for the goods produced by the two firms when the prices entering the demand functions include the license prices. The supply equals the quota level. The license price falls as the price charged by a firm rises, because increasing the product price shifts the demand for licenses inward. In addition, it will be assumed that own effects dominate cross effects so that a given increase in the price of both firms reduces demand.

The free trade equilibrium remains the equilibrium when the quota is set at the free trade level. This, of course, implies that the license price is zero in equilibrium. To see why this occurs, suppose the free trade price level for Firm 1 is $P_{1F}$ and the free trade price level for Firm 2 is $P_{2F}$. If Firm 2 sets its price at $P_{2F}$ and Firm 1 sets its price below $P_{1F}$, the quota becomes binding and the price reduction has the additional effect of raising the license price. The full price (including the license price) of both goods will increase by the same amount. The induced increase in the full price restricts the demand for each good and causes the demand curve with a quota to lie inside the unrestricted demand curve for price decreases. Thus Firm 1 has no incentive to set its price below $P_{1F}$. And, because $P_{1F}$ was profit-maximizing in the absence of a quota, Firm 1 has no incentive to raise its price above $P_{1F}$. Similarly, Firm 2 has no incentive to change its price from $P_{2F}$. Hence, the free trade prices constitute a Nash equilibrium after the imposition of a quota at the free trade level.

Now consider the effect of a quota that is very slightly below the free trade level. The quota causes demand to be less elastic for prices below the price at which the quota just binds; the quota does not affect the elasticity of demand at prices above the quota-binding level. The optimal price is the price at which the quota just binds. Therefore, in this case, licenses have no value in equilibrium.

If the quota is quite restrictive, reducing it further will result in the sale of licenses and positive revenue. The resulting improvement in welfare may be

(Eaton and Grossman 1986). I abstract from a Foreign market in this section in order to focus on the rivalry between the Foreign producers in the Home market.
offset by the loss in consumer surplus. Helpman and Krugman (1989), in studying the effects of a VER or quota with a Foreign duopoly, use a linear specification to show that it is never optimal to set a restrictive quota. Krishna (1992) provides an example showing that the license price becomes positive faster as the number of Foreign firms rises and as their products become more substitutable. This makes sense, because both of these effects make the market more competitive. A general result of this example is that welfare declines when a quota is imposed. To increase welfare, the price charged by the Foreign firms would have to fall below the free trade price; consumer surplus losses could then be made up by revenues from quota licenses.

With Foreign market power, auction quotas that do not raise revenue must reduce domestic welfare, because the quotas further restrict consumption without shifting profits.\(^4\) Welfare worsens as the quota is reduced from the free trade level of imports to the level where licenses begin to have a price that is not zero; welfare rises only after the price of licenses becomes positive. Therefore, even optimally set auction quotas are unlikely to improve domestic welfare.

**Product Market Power at Home and Abroad**

It is apparent from the preceding sections that the implications of imperfect competition for license prices depend on whether the market power is domestic or foreign. If there is market power on both sides, some technical problems arise. With two-sided market power, both Home and Foreign firms have incentives to raise their prices. The license price will again fall below that suggested by intuition based on competitive models.

Let us consider a model with one Home firm and one Foreign firm producing substitute goods. The Home firm, by raising its price, can increase the demand for the Foreign product, thereby making the quota bind. When the quota is binding on the Foreign firm, however, the Home firm’s demand becomes less elastic, which makes it in the Home firm’s interest to raise its price. If the quota is binding on the Foreign firm, it is in the Foreign firm’s interest to raise its price, too. Thus, both prices tend to rise, and quotas facilitate collusion.

Because a quota acts like a capacity constraint on the Foreign firm, there is no pure strategy equilibrium in this game. (See Krishna 1989a for a more detailed analysis.) The mixed strategy equilibrium involves the Home and Foreign firms charging prices such that demand for the Foreign firm exceeds the level of the constraint with a non-zero probability. In this event, a license is valuable; therefore, the price of a license is positive, even when the quota is set at the free trade level. As the quota shrinks, however, equilibrium prices change as well, and there is no reason for license prices on average to rise or fall.

When the Foreign and Home goods are complements, the Home firm has no

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\(^4\) This is because of the assumption of Foreign competitive supply with constant marginal cost. In the absence of constant marginal costs, the Home country is likely to benefit from a favorable terms-of-trade effect resulting from the quota.
incentive to make the constraint bind on the Foreign firm by charging a low price. A quantitative constraint on the Foreign firm thus leads to a pure strategy equilibrium, in which prices charged are such that the demand for the Foreign product exactly equals the level of the constraint. The price of a license will be zero, even when the constraint is set below the level of imports under free trade (Krishna 1989b).

**Market Power and Strategic Behavior in License Markets**

So far, I have assumed that quotas are sold directly to competitive retailers or to consumers and that license markets are competitive. When quotas are auctioned, there are usually provisions to prevent monopolization of licenses and to ensure that licenses are fully utilized. But is the assumption of competitive license markets appropriate? If exporters as well as retailers may buy licenses, is there a tendency for monopolization of the license market? What do actual prices paid for licenses mean? These questions are relatively difficult to handle using the standard models in the auction literature. The standard models exogenously specify the valuation or distribution of valuations of agents, whereas the license price is endogenously determined and depends on the allocation of licenses. Thus, significant complications are introduced at a formal level, and the form of the auction becomes crucial. Models of sequential auctions with endogenous valuations developed in Krishna (1990b and 1990c) provide a beginning here.

One might expect that a Foreign monopolist would tend to monopolize the license market, because the monopolist can internalize the effect of his or her own pricing decisions, whereas other buyers of licenses cannot do so. But Krishna (1990b) shows that in a sequential auction this does not occur unless all licenses are sold together as one unit, and retailers do not end up having market power in equilibrium because no retailer becomes large.

The intuition behind the result can be seen from the following example. Assume there are two licenses to be auctioned. There are two bidders: the Foreign monopolist and a competitive Home retailer. The monopolist would gain more than the retailer by obtaining both licenses, because the monopolist also sets the price of the product. Suppose that the Foreign monopolist assigns a value of 10 to having one license and a value of 20 to having both. The competitive Home retailer assigns a value of 9 to having one license and a value of 10 to having both. If both licenses are sold together, the Foreign monopolist will obtain them for a price of 10. However, if they are sold one at a time, this is not so. To solve for the equilibrium outcome of this sequential game, it is necessary to work backward. This is most easily done by means of figure 3, in which a tree depicting possible outcomes is drawn. Each license could go to either the Foreign monopolist or the competitive Home retailer. At every node, the left branch

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5. The details of these procedures for Colombia, Australia, and New Zealand are documented in Takaes (1990).
Figure 3. An Example of a Sequential Auction: The Outcome Tree

Note: In this example two licenses are auctioned sequentially to two bidders: the Foreign monopolist and the competitive Home retailer. The payoffs to the Foreign monopolist, $F$, and the competitive Home retailer, $H$, are shown by the numbers in parentheses as $(F, H)$.

denotes that the license goes to the Foreign monopolist and the right branch that it goes to the competitive Home retailer. It is important to note that this outcome form is different from the usual extensive form depiction of a game. A complete extensive form description of the game is too complicated. The abbreviated outcome tree contains all the relevant information and is more useful.

The end points of the tree give the payoffs associated with each of the four possible outcomes. Arrows denote the allocation at each stage, and prices are given in brackets next to the paths. Consider the situation when the first license has gone to the Foreign monopolist. The Foreign monopolist is willing to pay 10 for the second license whereas for the competitive Home retailer it is worth only 9. Thus the Foreign monopolist would obtain the second license as well, paying a price of 9. If the competitive Home retailer had the first license, again the second license would go to the Foreign monopolist, who would pay only 1 for it. How much is the Foreign monopolist willing to pay for the first license? To calculate this, the two nodes can be replaced by their equilibrium values. These are $(11, 0)$ and $(9, 9)$, respectively. The value to the Foreign monopolist of obtaining the first license is the difference between the values of the two nodes and thus equals 2. Similarly, the value to the competitive Home retailer of obtaining the first license is 9. Thus the competitive Home retailer would get the first license at a price of 2. The outcome of the game, therefore, is that the competitive Home retailer buys the first license at price 2 and the Foreign monopolist buys the second at price 1. The Foreign monopolist's ex ante payoff is therefore $10 - 1 = 9$. The competitive Home retailer's ex ante payoff is $9 - 2$.
These numbers are shown in the vector at the top of the tree. Hence, it is shown that monopolization does not occur if the licenses are sold sequentially.

The monopolist always wins the last license because the monopolist's marginal valuation exceeds that of the retailer. But the first license goes to the retailer because the retailer's willingness to pay for the first license exceeds that of the monopolist. If the retailer wins the first license, the monopolist can win the second one for a low price of 1. If the monopolist wins the first license, the price of the second license will be 9; therefore, the monopolist is better off letting the first license go to the retailer. Thus, even if the first agent's marginal valuation at the last stage lies everywhere above that of the second agent, the first agent does not necessarily obtain all the licenses. In addition, the price paid for the two licenses is different and need not equal the tariff equivalent.

Thus, the monopolist does not win all the licenses if they are auctioned sequentially. In fact, it turns out that the monopolist only wins the last license. The monopolist chooses not to win any earlier licenses, because doing so would raise the price for later licenses. Retailers remain small if we assume that there are a large number of potential retailers. Retailers who already have licenses will internalize the reduction in the value of licenses they already have, and will be outbid by new entrants. This keeps retailers small in equilibrium.

If license auctions are best modeled as auctions with endogenous valuations, we would not expect the implications of standard auction models to apply. Unfortunately, endogenous valuation models are both complex and poorly understood at this time. This being the case, empirical work on such models is still not possible. It is possible, however, to test the predictions of standard models for quota license auctions. If these models do not seem to perform well, the reason might be that valuations are endogenous and not exogenous. Even this has not been attempted so far.

**Monopsony Power and Rent Sharing**

One of the most difficult cases for economists to assess is the case where both buyer(s) and seller(s) have some degree of market power. In this situation, the relative bargaining strength of each party determines how existing rents are distributed. Models based on noncooperative bargaining (Rubinstein 1982) are relevant if there is market power on the part of the license holders together with market power on the part of the importers of the quota-constrained goods. In this case, the two parties have to bargain over the existing potential quota rent. The potential rent per unit is the difference between the demand price for the product in the importing country and the supply price in the exporting country. How the potential rent is split between the license holders and the importers depends on the relative bargaining power of the two sides. The license price is the result of such bargaining and need not equal the potential rent.

Referring again to figure 1, in the competitive model, the license price changes with the quota level, $V$, so that $P^D(V) = P^S(V) + L(V)$ always. In other words, this equality is unaffected by changes in the quota level, and the license price,
\( L(V) \), is always equal to the potential rent, \( [P^D(V) - P^S(V)] \). Now suppose there is competitive supply, but concentration in license holdings as well as market power on the buyer's side. If the potential rent, \( L(V) \), is bargained over and shared in some way between the license holders and the importers, so that of \( L(V) \), the license holders will get a fraction, \( \alpha \), for \( \alpha \in (0, 1) \) of these potential rents. In this case, the license-inclusive import price will lie somewhere between \( P^D(V) \) and \( P^S(V) \). Note that the license price is no longer equal to the potential rent. In addition, the license-inclusive import price can vary with the quota level, as well as the quota utilization ratio and the concentration in license holdings.

In general, there are many reasons why the license price may deviate from the potential rent. Krishna, Erzan, and Tan (1991) argue that bilateral power can lead to sharing the potential rents. To examine the evidence that potential rents are in fact shared, the authors use data on exports of apparel from Hong Kong to the United States under the MFA. If there is no rent sharing, the license-inclusive Hong Kong price, adjusted for tariffs and transportation costs, should equal the U.S. price for the same commodity. Any deviation between the two prices that is not attributable to differences in quality or to data aggregation is taken to indicate rent sharing. The authors find that price differences exist even after accounting for differences in composition and quality. Moreover, these price differences are related to factors such as the quota level, the concentration of license holdings, and the quota utilization rate. Standard competitive models predict that such unexplained price differences should not exist and that any differences that do exist should be small (zero, on average) and uncorrelated with factors such as those mentioned above. This evidence suggests that competitive models may not be adequate for understanding the operation, effects, or proposed reforms of the MFA quotas.

II. THE PROCEDURE FOR IMPLEMENTING A QUOTA

When market imperfections exist, the procedure for implementing a quota becomes especially important, and the simple model outlined above needs to be augmented. The procedure is important for two reasons. The first is that the procedure itself may create market power, enhance existing imperfections, or create new distortions. An obvious example of the creation of market power would be one in which the exporting country allocates the entire quota to one firm. If market power already exists, the procedure for implementing the quota can act as a facilitating practice. For example, in practice, licenses are often allocated to firms on the basis of market share. This practice could enhance the market power of some firms, because the firms would no longer be competing against each other in the quota-constrained market. And the procedure for implementation may itself create new distortions. For example, a procedure that involves much red tape and discretion on the part of a government agency could lead to a waste of resources as well as provide a fertile environment for graft and unproductive rent-seeking practices.
Second, the procedure for implementing a quota affects the behavior of agents, because it can be used to achieve particular policy objectives. For example, a quota implemented by the sale of all licenses may not raise much revenue and may adversely affect welfare in relation to free trade. Alternative procedures for implementing a quota may improve welfare, even in relation to free trade. Clearly, tariffs are better than quota auctions at raising revenue with imperfect competition. Not surprisingly, in all but some very special cases, free trade is at least as good as any quota. One of the special cases arises when some licenses are given away to foreign producers. In this event, a Pareto improvement over free trade can occur. By allowing a lower price to be set abroad than in the importing country, the quota allows price discrimination and higher profits to the exporter than would otherwise be possible. Giving away some of the licenses to the exporter allows the importing country and the exporter to share these gains, and price reductions in the rest of the world enhance their welfare as well.

**Giving Away Some Licenses**

With foreign product market power, if the Home country sells all of the licenses, incentives are created for the Foreign monopolist to raise the supply price to appropriate the quota rents. This incentive can be so strong that the license price becomes zero. Another factor becomes important, however, when the Foreign monopolist has some of the licenses. When the Home and Foreign markets are not segmented, a quota allows the Foreign monopolist to effectively discriminate in the price—but only in one direction: a quota allows a higher price to be charged to consumers in the quota-constrained Home market if the license price is positive.

When the foreign producer is a monopolist and the Home country sells all the licenses, the Foreign monopolist has an incentive to raise the supply price to appropriate the quota rents. If the Home country gives some of the licenses to the Foreign monopolist, there is less for the monopolist to gain by raising the price. By possessing some of the licenses, the Foreign monopolist can keep a portion of the quota rents. The monopolist benefits by pricing low and allowing a positive license price, which may also effectively segment the markets. Of course, doing so is worthwhile only if Home demand is less elastic than Foreign demand. Jones and Takemori (1989) use a general equilibrium model to make a similar point about how tariffs allow market segmentation.

With imperfect competition in the product market, therefore, giving away a portion of the import licenses to the Foreign producer is one way of raising revenue from the auctioning of quota licenses (Krishna 1991). Giving some of the licenses to the Foreign monopolist affects the pricing decision and forces the monopolist to consider not only profits, but also the value of the licenses. Giving

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6. Bhagwati (1965) also emphasizes the importance of the implementation procedure in an auction quota and how it can affect the market structure.
away quota licenses makes it more costly for the Foreign monopolist to raise the product price in order to extract the quota rents from the Home market. Keeping down the Foreign monopolist's price in turn raises the price of the licenses that remain in the hands of the Home country.

First consider a basic case in which the Foreign monopolist gets all the licenses and the quota is close to the free trade level. If Home demand is more elastic than Foreign demand, the Foreign monopolist will want to charge a lower price in the Home market, where the quota is imposed. But the quota permits only a higher price. Thus, the possibility of market segmentation is not valuable and only the incentive for rent appropriation remains. Hence, the price will be set so that the license has zero value. If Home demand is less elastic than Foreign demand, market segmentation is valuable and a license has a positive price even if the quota is set at the free trade level. In this case, markets are effectively segmented by the quota.

Varying the allocation of licenses and the level of the quota changes the relative importance of the incentives for rent appropriation and market segmentation. Allocating fewer licenses to the monopolist reduces the monopolist's gain from market segmentation and increases the monopolist's incentive to appropriate rent by raising the price. This implies a lower license price. Reducing the quota weakly raises the license price because it raises the cost of fully appropriating the quota rents.

The license price does not reflect the implicit tariff. Moreover, it is not clear whether the license price is above or below the implicit tariff. The license price depends on the allocation of the licenses and the level of the quota itself, and on differences in the demand elasticities in the Home and Foreign markets. Thus, the value of a license with a VER where all the licenses are given away differs significantly from the value of a license when all the licenses are auctioned.

The revenue effects are complicated because the revenues are the product of the number of licenses retained and the license price. Giving away licenses raises the license price, but can raise or lower revenues. Moreover, the welfare-maximizing choice of the quota and its allocation must take into account consumer surplus as well as revenue. Krishna (1991) presents the results of simulations in which 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 revenue and consumer surplus. The main results from these simulations are as follows.

In the first example, both the share of licenses retained and the quota level are set optimally. The license sales revenue is given the same weight as consumer surplus. Welfare exceeds that under free trade when Home elasticity is substantially smaller than Foreign elasticity and the Home country is relatively large. In this example, all parties gain from the optimal policy.

In the second example, license revenue is given greater weight in welfare. A quota becomes more desirable for revenue reasons, and the license price under the optimal policy tends to be positive. The results of the simulations also
indicate that it is possible not only for domestic welfare to improve when such policies are set optimally, but also for the Foreign monopolist’s profits and the Foreign country's welfare to rise.

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 (assuming, of course, that the world consists of the Home and Foreign countries only). Quotas can improve world welfare, because they allow price discrimination when the license price is positive. The gain can be distributed between the Home country and the Foreign country through the appropriate allocation of licenses so that all parties benefit.

Even in the case of many Foreign firms, the same policy can yield benefits to the Home country. Giving away some of the licenses affects the Foreign firms' pricing decisions; the Foreign firms charge lower prices when they have licenses, and this increases the value of the licenses (Tan 1990).

Other Aspects of Quota Implementation

Quotas are administered in practice in a variety of ways (see Trela and Whalley 1991). There are several different allocation schemes employed by quota-constrained developing countries under the MFA. Some countries, such as Pakistan, allocate licenses on the basis of the unit value of the order. They do so in hopes of raising foreign exchange earnings by encouraging exports of products having a higher value. This method of allocation could lead to overreporting of unit values. It is also a common practice to allocate licenses on the basis of past performance and to penalize license holders who underutilize their allocations, as is done in Hong Kong and Pakistan. In Hong Kong, a firm that transfers out 50 percent or more of its quota holding will have its quota allocation reduced in the following year. In Pakistan, the allocation of quotas is made against quarterly security deposits that increase each quarter. The purpose of these security deposits seems to be to encourage firms to use up their quota as early in the year as possible. Allocating quotas based on performance can encourage overuse of quotas in order to qualify for quotas in the future. This outcome is reflected in negative prices for quota licenses, such as the prices observed for ramie-cotton sweater panels knitted in Hong Kong in the latter half of 1988.

There is little theoretical, and almost no empirical, work on how these regulations affect the behavior of participants in the quota-constrained market and the related license market, and on the costs and benefits of such practices. There is little guidance to governments with foreign exchange constraints (or other objectives) on how to structure the implementation of quotas. In general, the implementation of quotas is vastly understudied. Its importance is evident from the fact that under the MFA, for example, quotas from certain low-cost countries, such as Bangladesh, were not even close to being filled.
III. Uncertainty and Dynamic Elements

The standard extensions of the basic model have focused on uncertainty. But, in practice, both uncertainty and dynamic considerations can be important, and for a number of reasons. First, uncertainty about demand or supply affects the restrictiveness of the quota and, consequently, its revenue and welfare effects (Dasgupta and Stiglitz 1977; Pelcovits 1979). Second, the price of a license, in the presence of uncertainty and dynamic elements, reflects more than the scarcity value captured in the simple static model. License holders have to be compensated for the opportunity cost of holding the license, and this makes the value of a license depend on factors such as the current state of demand, the remaining availability of licenses, and the time left before the license expires (Krishna and Tan 1992). Thus, interpreting the average license price over a year as the equivalent tariff may not be appropriate. Similarly, a jump in the license price may not indicate price fixing; the license price would increase if demand is unexpectedly high. Third, other aspects of implementation, such as how the quota is allocated and whether or not the licenses may be resold, can have unexpected effects, even in the presence of competition. For example, allocating quotas on a first-come-first-served basis can create a race to obtain the quota. Linking future allocations to utilization can create incentives to use existing licenses, leading to negative license prices. Transferable licenses need not raise more revenue than nontransferable ones under certain conditions (Tan 1992).

An interesting aspect of quotas in the real world is that they are valid for a year and can be used at any time in the year. In some cases, the licenses are also freely traded. The period of time in which it can be used, in combination with uncertainty in demand, gives the quota license an additional option value in the earlier months so that the license price tends to fall over the year. Krishna and Tan (1992) demonstrate the effect of this option value component by means of a simple two-period two-state example having infinitely elastic demand and supply (so that the license price is independent of the number of licenses remaining in the year). Denote by $L_L$ the license price in the low-demand state and $L_H$ the license price in the high-demand state. Then in the final period (period 2), the expected license price is $\pi L_H + (1 - \pi) L_L$, where $\pi$ is the probability of the high-demand state and $(1 - \pi)$ is, correspondingly, the probability of the low-demand state. Let $\delta$ denote the discount rate. If period 1 is a high-demand state, then all the licenses will be used, because $L_H$ exceeds $\delta[\pi L_H + (1 - \pi) L_L]$. If period 1 is a low-demand state, then as long as $\delta$ is not too small (that is, $\delta > L_L/[\pi L_H + (1 - \pi) L_L]$), none of the licenses will be used. The price at which a transaction would occur is $\delta[\pi L_H + (1 - \pi) L_L]$, which is the price of any transaction in this state in the first period. The expected license price in period 1 is $\pi L_H + \delta(1 - \pi)[\pi L_H + (1 - \pi) L_L]$. The ex ante license price expected in period 2 is $(1 - \pi)[\pi L_H + (1 - \pi) L_L]$. Hence, the ex ante license price falls over

7. This is the case, for example, with quota licenses for apparel in Hong Kong.
time. Intuitively, the ex ante license price falls over time because in the first period the license holder has the option of not using his or her license and this option has value.

Krishna and Tan point out that this option value component of the license price is swamped if the arbitrage value of a license is endogenously determined by the demand and supply for licenses. In this case, only the asset value of a license remains, and the price of the license has to rise over the year at a rate of interest that will make people want to hold the license.

It is tempting to argue that increases in license prices over time indicate monopoly power. Prices would also be raised, however, by an unexpectedly high level of demand (accompanied by an increase in the use of licenses). A formal test of the price fixing of licenses requires that the implications of competitive pricing be specified in a dynamic model that has a closed form. In this way, the null hypothesis, that of competition, can be tested against the data.

Uncertainty and temporal aspects interact to produce an interesting and unexpected result in the comparison of transferable and nontransferable licenses. The standard argument is that transferable licenses are more efficient than nontransferable licenses because transferable licenses allow low-cost suppliers to obtain the licenses. The logic is that low-cost suppliers will value them more, and hence bid more for them. An implication of this is that transferable licenses will raise more revenue than nontransferable licenses will (Faini, de Melo, and Takacs 1992).

But this argument may not hold in the presence of uncertainty. Consider an example in which a supplier would value the license differently in two states. This could occur if there is a possibility that the supplier's capacity is exhausted by other orders. Assume that each agent wants at most one license. In state A the valuation of a license is high, say 10. In state B it is low, say 0. If the two states are equally likely, if all agents are identical, if licenses are nontransferable, and if the timing structure is such that licenses have to be obtained before the realization of the state, then each agent would only be willing to pay 5. Assume there are five agents and four licenses. Then the market price of a license would be 5.

If licenses are transferable, then each agent would consider the market price of the license after the state was realized. In our example with four licenses and five agents whose valuations are independently distributed, the market price ex post will be 10 as long as at least four agents have a high realization. For our example, this probability can be verified to be 0.1875. If less than four agents have a high realization, the value will be zero. This, of course, occurs with a probability of 0.8125. Thus, the expected value before the state is known of all of the ex ante identical agents will be 1.875. Note that this is less than 5, the value of a nontransferable license.

It is easy to verify that this result is reversed if there are only two licenses but five agents. The reason is that without transferability, the price of a license is independent of the number of agents and licenses as long as the former exceeds the latter. With transferability, the value placed on a license ex ante depends on
the price ex post. If the quota is very restrictive, the ex post price will be high on average, which causes a high ex ante price. If it is not very restrictive, the ex post price will be low on average, and this causes a low ex ante price. This argument, and an empirical application to the auction of vehicle quota licenses in Singapore can be found in Tan (1992).

IV. Conclusion

The simple models described in this article illustrate why the basic competitive model may be inadequate for analyzing the outcomes of auction quotas in the real world. Even on the theoretical side, however, attention has been focused primarily on the effects of market power on the side of producers. Little attention has been paid to the consequences of market power on the side of buyers in the product market or in the license market, or on the consequences of different rules used in practice to implement quotas. Nor has much attention been paid to uncertainty and dynamic aspects. For policy purposes, it would be useful if such theoretical work were attempted and then supplemented with empirical work to test the validity of these new models and to determine the welfare consequences of such quotas and any proposed reforms. There have been some initial attempts to do so, and their results by and large show that the kinds of considerations reviewed here may well be more than theoretical curiosities.

References

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