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Tariffs and quotas that lower prices and  
raise welfare

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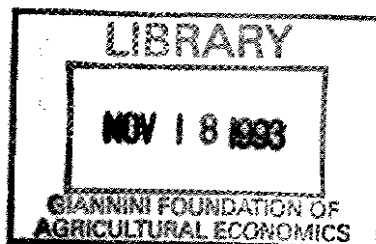
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TARIFFS AND QUOTAS THAT LOWER PRICES  
AND RAISE WELFARE

by

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September, 1993



## **Tariffs and Quotas that Lower Prices and Raise Welfare**

Jeffrey M. Perloff

July 1993

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## Contents

The Spatial Differentiation Model	1
Monopoly	3
Duopoly	4
Demand Curve	6
Bertrand	7
Cartel	10
Effects of Tariffs	11
Price Effects	12
Profit and Consumer Surplus Effects	13
Effects of a Quota	14
Price Effects	16
Profit and Consumer Surplus Effects	17
Conclusions	17
References	19

## **Tariffs and Quotas that Lower Prices and Raise Welfare**

An increase in a tariff or a reduction in a quota may lower prices and raise welfare in markets with spatially differentiated products. These results are illustrated using a standard spatial model with linear disutility or transportation costs (Hotelling 1929, Salop 1979). A domestic and a foreign firm each produce a product at different locations in characteristic space.

A higher tariff or smaller quota causes the foreign firm to sell fewer units. The domestic firm may find it profitable to lower its price to capture the customers who previously purchased from the foreign firm. This reduction in the domestic price may be sufficient for welfare to rise under any market structure bounded between Bertrand and collusion. A reduction in a quota may cause welfare to rise if the firms collude but not if they play Bertrand.

The first section discusses the properties of the basic spatial differentiation model with a tariff. Section two examines the effects of tariffs on prices, profits, and welfare. The corresponding analysis for quotas is presented in the third section. A final section draws conclusions and interprets the results.

### **The Spatial Differentiation Model**

Firms are located along a line segment in characteristic space.<sup>1</sup> Firms cannot choose their location,  $t$ , but can choose their price.

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<sup>1</sup> The relevant line segment is part of a large circle or so far from the end points of the line that end-point considerations can be ignored. The following description of the basic model follows Salop (1979).

Customers are uniformly located along this line segment. For simplicity, each customer buys exactly one unit. The preferred brand of a customer located at  $\hat{f}$  is one at the same point along the line. The utility a consumer gets from the brand located at  $\hat{f}$  is

$$U(\hat{f}, t) = u - c |\hat{f} - t|, \quad (1)$$

where  $u$  is the utility from the consumer's preferred brand,  $|\hat{f} - t|$  is the distance brand  $t$  is from the customer's preferred brand  $\hat{f}$ , and  $c$  is the rate (transportation cost) at which a deviation from the optimal location lowers the consumer's pleasure. That is, this utility function reflects constant marginal disutility as one moves away from  $\hat{f}$  in this metric. As a result, the utility function is symmetric around  $\hat{f}$ . The consumer located at  $\hat{f}$  has a utility of  $u$ ; whereas, the consumer at  $\hat{f} = t + u/c$  has zero utility from that brand.

Each consumer attempts to maximize consumer surplus,  $U(\hat{f}, t) - p$ , which is the difference between the consumer's utility from consuming a brand located at  $t$  and the price. The consumer purchases the best buy: the product with the greatest surplus (the best combination of price and location).

Instead of buying the best-buy brand, however, the consumer may decide to buy the outside good, if it is a better buy in the sense that it gives a higher surplus. If the surplus from the outside good is  $\underline{u}$ , the consumer only buys a unit of the best-buy brand,  $i$ , if its surplus exceeds  $\underline{u}$ :

$$\max_i (U(\hat{f}, t_i) - p_i) \geq \underline{u}, \quad (2)$$

where the expression on the left side of the equation is the surplus from the best-buy brand (maximize the surplus through choice of brand  $i$ ), and that on the right side is the surplus from the outside good.

With equal prices,  $p$ , across brands, the greatest surplus the consumer can get from the best buy is  $u - p$ . The consumer is only willing to buy that brand if its surplus is greater than that from the outside good:  $u - p \geq \underline{u}$ , or, rearranging terms,  $u - \underline{u} \geq p$ . Thus, the consumer has a reservation price,  $v = u - \underline{u}$ , which is the highest price that the consumer is willing to pay for this brand. Alternatively stated, a consumer buys the best-buy brand only if the net surplus from that brand — the surplus from the best-buy brand minus the surplus from the outside good — is positive:

$$\max_i (v - c|\hat{f} - t_i| - p_i) \geq 0. \quad (3)$$

Equation 3 is obtained by subtracting  $\underline{u}$  from both sides of Equation 2, substituting for  $U(\hat{f}, t)$  from Equation 1, and defining  $v \equiv u - \underline{u}$ . As the outside good does not play an important role in the following analysis, we assume that  $\underline{u} = 0$  so that  $u \equiv v$ .

The government may assess a per unit tariff of  $\tau$  on foreign brand sales. Where the government does not intervene (as with a domestic firm) or uses a quota,  $\tau = 0$ .

### *Monopoly*

Initially, suppose there is only one brand. A consumer located  $x \equiv |\hat{f} - t|$  distance from the brand is willing to buy that brand for  $p + \tau$  only if the consumer's net surplus,  $v - cx - (p + \tau)$ , is positive. By rearranging this expression, the maximum distance,  $x_m$ , a consumer can be located from the monopoly brand and still receive nonnegative net surplus (be willing to buy it) is



$$x_m = \frac{v - p - \tau}{c}. \quad (4)$$

This distance,  $x_m(p + \tau)$ , is a function of the price consumers pay,  $p + \tau$ .

The monopoly brand captures all the consumers who are no further than  $x_m$  distance on each side of its location, or all the consumers in a  $2x_m$  segment. The total number of consumers in this range is  $q_m = 2x_m L$ , or, substituting for  $x_m$  from Equation 4,

$$q_m = \frac{2L}{c}(v - p - \tau). \quad (5)$$

That is, the quantity demanded of the monopoly falls by  $-2L/c$  as its price increases by \$1.

If the firm has a constant marginal costs,  $m$ , and no fixed costs, its profit-maximizing, monopoly price is

$$p_m = \frac{v + m - \tau}{2}. \quad (6)$$

Consequently,  $x_m(p_m + \tau) = (v - m - \tau)/(2c)$  and  $q_m = L(v - m - \tau)/c$ .

Given monopoly pricing, consumer surplus for this brand is

$$CS_m = \frac{L(v - p - \tau)^2}{c} = \frac{L(v - m - \tau)^2}{4c}. \quad (7)$$

### *Duopoly*

Now suppose that there are two firms. The domestic firm is located at  $t$  in characteristic space and charges  $p$  per unit of output. The foreign firm is located at  $t^*$  and receives  $p^*$ . The price consumers pay for the foreign good is  $\rho \equiv p^* + \tau$ . For

simplicity, the two firms are assumed to have identical costs: a marginal cost of  $m$  and no fixed cost.

The equilibrium observed depends on how far apart the firms are in characteristic space, the market structure, and government tariffs or quotas. If there are two (or more) firms, there are two possible types of equilibria (Salop 1979). If the brands are far from each other in product space (highly differentiated goods that are not close substitutes), then each firm acts like a monopoly in the sense that no consumer receives positive surplus from both brands, so a small price increase by one firm does not affect the sales of the other. If the firms are located close to each other, some consumers receive positive surplus from both brands, so a small price increase by one firm affects the sales of the other.

Let the distance between the domestic firm and the foreign firm be  $z \equiv |t - t^*|$ , as shown in Figure 1. If both firms set their monopoly prices ( $p_m$  and  $p_m^*$ ) and no consumer can obtain positive net surplus from both firms, then each firm can ignore the other's price. That is, if the firms are at least  $\bar{z} = x_m(p_m) + x_m(p_m^*)$  distance apart, each firm maximizes its profit by charging its monopoly price. Because the firms do not compete for the same consumers, consumer surplus from two brands is twice that from one brand (Equation 7) because there are two local monopolies.

If  $z < \bar{z}$ , a duopolist cannot ignore its rival's price when setting its own. There is a marginal consumer  $x_d$  distance from the domestic firm for whom the net utility from the first brand equals the net utility from the rival brand, or

$$v - cx_d - p = v - c(z - x_d) - p, \quad (8)$$

where  $z - x_d$  is the consumer's distance from the foreign brand. As a result,

$$x_d = \frac{cz + p - p_0}{2c}. \quad (9)$$

In Figure 1 (where  $\tau = 0$  for simplicity), if each firm charges the relatively low price  $p_0$ , the domestic brand located at  $t$  captures the consumers to its right up to a distance  $x_d(p_0)$ . The consumer located  $x_d(p_0)$  distance from the domestic firm is indifferent between buying from either firm. Consumers located slightly further to the right than  $x_d(p_0)$  from the domestic brand could obtain positive surplus if they bought from the domestic firm, but, by buying from the foreign firm, they obtain higher net surplus. Thus, the firms are actively competing for those consumers who could receive a positive net surplus from both firms. The domestic firm sells to all customers located to the left of  $t$  in Figure 1 within the monopoly region distance  $x_m(p_0)$  because those consumers cannot obtain positive net surplus from the foreign brand.

At the higher price  $p_1$  in Figure 1, there is a consumer who could obtain nonnegative (zero) net surplus from both brands. This marginal consumer is  $x_d(p_1) = x_m(p_1)$  distance from either firm. Were the firms to charge an even higher price,  $p_2$ , some consumers located between the brands would buy from neither firm (they have negative net surplus from both brands).

### *Demand Curve*

As a result, the perceived demand curve facing each duopolist is kinked as shown in Figure 2 (where  $\tau = 0$ ,  $p = p^* = p$ ,  $v = 10$ ,  $L = c = 1$ , and  $z = 6$ ). At relatively low prices (such as  $p_0$  in Figure 1), some consumers could obtain positive net surplus from buying either brand. The demand facing the domestic firm is,  $q_d = (x_m + x_d)L$ , or

$$q_d = \frac{L}{2c} (2v + cz + p - 3p). \quad (10)$$

If  $p$  increases by \$1 (holding  $p$  constant), the quantity demanded falls by  $-1.5L/c$ . That is, the demand curve is more elastic in the monopoly region (such as  $p_2$  in Figure 1 or  $p \geq 7.5$  in Figure 2) than in the region where the firms compete for customers (such as  $p_0$  in Figure 1 or  $p < 7.5$  in Figure 2).

If for a given  $p$ ,  $p$  is high enough that no customer receive positive net surplus from both firms ( $x_m(p) + x_m(p) < z$ ), the demand curve facing the domestic firm is the monopoly demand curve (Equation 5). That is, the demand facing the domestic firm is kinked:<sup>2</sup>

$$q_d = \begin{cases} \frac{L}{2c} (2v + cz + p - 3p) & \text{if } x_m(p) + x_m(p) \geq z \\ \frac{2L}{c} (v - p) & \text{otherwise.} \end{cases} \quad (11)$$

In the competitive region, consumer surplus is

$$CS_d = \frac{L}{4c} (2(v-p)^2 + 2(v-p)^2 + 2cz(2v-p-p-cz) + (cz+p-p)). \quad (12)$$

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<sup>2</sup> We ignore the possibility Salop (1979) discusses of supracompetitive prices where one firm's price is so low relative to the other firm's that it can even sell to a consumer located on the other side of its rival.

### *Bertrand*

Suppose the two firms play Nash in prices (Bertrand) and have identical cost functions. To find the equilibrium, we need to examine both parts of the demand curve.

If the equilibrium price is below the kink in the demand curve in the competitive region, we have a standard unconstrained interior solution. Assuming an interior solution, the best-response function for the domestic firm,  $R(p_b)$ , is derived from its first-order condition for profit maximization:  $p_b = R(p_b) = (2v + cz + p_b + 3m)/6$ . Similarly, the best-response function for the foreign firm is  $p_b^* = R^*(p_b) = (2v + cz - p_b - 3\tau + 3m)/6$ . In an interior equilibrium, the Bertrand prices are

$$p_b = \frac{1}{35}(14v + 7cz + 21m + 3\tau), \quad (13)$$

$$p_b^* = \frac{1}{35}(14v + 7cz + 21m - 17\tau), \quad (14)$$

and

$$p_b = \frac{1}{35}(14v + 7cz + 21m + 18\tau). \quad (15)$$

Thus, as  $\tau$  rises  $p_b$  and  $p_b^*$  fall and  $p_b$  rises, as can be shown by differentiating Equations 13 - 15.

If  $\tau = 0$  and the two brand are homogeneous ( $z \approx 0$ ), the Bertrand price is below the monopoly price:  $p_b = (2v + 3m)/5 < (v + m)/2 = p_m$ . As shown in Equations 13 - 15, the smaller  $z$  (the closer the two firms to each other), the lower the Bertrand prices. If  $\tau = 0$ , the Bertrand prices equal  $p_m$  at  $z = (v - m)/(2c) = x_m = \bar{z}/2$  and exceeds  $p_m$  for larger  $z$  (Perloff and Suslow 1993).

This surprising result occurs because Bertrand duopolists face less elastic demands than does a monopoly. One intuition is that as the second brand enters far from the original monopoly, some consumers greatly prefer the new brand to the old one (and vice versa) so that each firm now concentrates on selling to those consumers with relatively inelastic demands. That is, the monopoly kept its price down to sell to some consumers who were close to indifferent between buying and not buying. When the second brand entered, the monopoly gave up on those consumers and sold its product for a relatively high price to those consumers who really like it.

Now suppose that the intersection of the best-response functions  $R(p^*)$  and  $R^*(p)$  is at a vector of prices,  $(\hat{p}^*, \hat{p})$  above the kink in the demand curve. An example is point A in Figure 3.<sup>3</sup> In the figure, the "kink constraint" line is the combinations of  $(p^*, p)$  such that the demand curve is at the kink.<sup>4</sup> For price combinations above the kink constraint line, some consumers located between the two firms buy from neither (as with  $p_2$  in Figure 2). If the domestic firm believes that the foreign firm will set its price at  $\hat{p}^*$ , it has an incentive to lower  $p$  to capture the unserved consumers between the two firms.<sup>5</sup>

The true best-response functions are  $r(p^*)$  and  $r^*(p)$ , as shown in Figure 3. The domestic firm's best-response function is  $R(p^*)$  for  $p^*$  below the kink constraint. For higher  $p^*$ , the domestic firm lowers its price following the kink constraint until its price

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<sup>3</sup> If  $v = 10$ ,  $L = c = 1$ ,  $m = 2$ ,  $z = 6$ , and  $\tau = 3.4$ , one obtains a figure similar to Figure 3.

<sup>4</sup> That is, the kink constraint line is defined by  $x_m(p) + x_m(p^*) = z$ , or  $2v - cz - \tau - p - p^* = 0$ .

<sup>5</sup> At the kink in the demand curve, the derivative of profit with respect to  $p$ ,  $2(v - 2p + m)L/c$ , is strictly negative because  $\hat{p} > p_m = (v + m)/c$ .

equals  $p_m$  (at point C in Figure 3). For any higher  $p^*$ , it charges  $p_m$ . The foreign firm's best-response function,  $r^*(p)$  is similar. There may be many Nash equilibria along the kink constraint, such as those located between points B and C in Figure 3.<sup>6</sup>

### *Cartel*

If the firms collude, on the lower part of the demand curve ( $X \geq z$ ) the cartel prices are

$$p_c = \frac{v + m}{2} + \frac{cz}{4} = p_m + \frac{cz}{4}, \quad (16)$$

$$p_c^* = p_m + \frac{cz}{4} - \frac{\tau}{2}, \quad (17)$$

and

$$p_c = p_m + \frac{cz}{4} + \frac{\tau}{2}. \quad (18)$$

Thus, the domestic price is independent of  $\tau$ ,  $p_c^*$  falls by half as much as  $\tau$  rises, and  $p$  increases by half as much as  $\tau$  rises.

In this competitive region, so long as the products are differentiated ( $z > 0$ ), the domestic cartel price is *above* the monopoly price,  $(v + m)/2$ , by  $cz/4$  and  $p_c$  is above by  $cz/4 + \tau/2$ . The intuition is that the cartel firms do not fight over the customers between them. As discussed above, they respond to the better matching between consumers and brands by raising prices.

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<sup>6</sup> Most articles that use this type of model ignore the multiplicity of Nash equilibria. Given identical firms, they arbitrarily assume that the equilibrium is the mid-point of this segment of Nash equilibrium points along the kink-constraint.

By the same reasoning as before, if the cartel does not set prices  $p_c$  and  $p_c^*$  at the interior solutions, it sets it at the kink in the demand curve. Along the kink,

$$p_c = v - \frac{cZ}{2} - \frac{\tau}{4}, \quad (19)$$

$$p_c^* = v - \frac{cZ}{2} - \frac{3\tau}{4}, \quad (20)$$

and

$$p_c = v - \frac{cZ}{2} + \frac{\tau}{4}. \quad (21)$$

As  $\tau$  increases,  $p_c$  and  $p_c^*$  fall and  $p_c$  rises. For higher enough  $\tau$ , the domestic cartel price equals the monopoly price, so that  $p_c$  does not vary as  $\tau$  increases further. Thus, if the firms collude, an increase in  $\tau$  *always* decreases the domestic price or has no effect.

### Effects of Tariffs

Thus, the effect of a tariff on prices, consumer surplus, and profits depends on the region of the demand curve where firms are operating and the market structure. There are three possible regions: 1) the unconstrained duopoly region ("competitive" lower portion of the demand curve), 2) the constrained duopoly region (at the kink on the demand curve), and 3) the monopoly region (upper portion of the demand curve).



*Price Effects*

The comparative statics effects of  $\tau$  on prices under both market structures are summarized in Table 1 for the general case.<sup>7</sup> The effects are also illustrated in Figure 4 for  $v = 10$ ,  $c = L = 1$ ,  $m = 2$ , and  $z = 6$ .

In this example, if the firms play Bertrand, the unconstrained duopoly competitive region is  $\tau < 2$ , the constrained competitive region (at the kink on the demand curve) is  $2 \leq \tau < 4$ , and the monopoly region is  $\tau \geq 4$  as labelled in Figure 4. If the firms collude, the constrained competitive region is  $\tau < 4$ , and the monopoly region is  $\tau \geq 4$ .<sup>8</sup>

The Bertrand prices may rise or fall. In the unconstrained duopoly region ( $\tau < 2$ ), where firms compete for the same consumers, the Bertrand price of the domestic firm,  $p_b$ , and the after-tariff price that consumers pay,  $p_b \equiv p_b^* + \tau$ , are increasing in  $\tau$ .

In the constrained duopoly region ( $2 \leq \tau < 4$ ), there are many possible Nash equilibrium prices as shown in Figure 3. The lowest Nash price that the domestic firm may charge is  $\underline{p}_b$  and the highest price is  $\bar{p}_b$ . These two lines in Figure 4 bound the possible domestic price (a shaded region). Thus, as  $\tau$  rises in the constrained region, the domestic price may rise, stay constant, or fall. As  $\tau$  approaches 4, however, the price must fall.

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<sup>7</sup> The term "probably" in the table is used loosely and is based on Figure 4, which is discussed below.

<sup>8</sup> The cartel firms are in the unconstrained region for  $\tau$  less than  $\tau = 2(v - m) - 3cz$ . In this example where  $z = 6$  (which is relatively large), this expression implies a negative  $\tau$ . Thus, there is no unconstrained region in this example.

Similarly, the prices charged by the foreign firm are bounded between  $p_b$  and  $\bar{p}_b$ . As  $\tau$  rises above 2,  $p_b$  may rise, stay constant, or fall. As  $\tau$  approaches 4, however, the price must rise.

In the monopoly region,  $\tau \geq 4$ , an increase in the tariff has no effect on the domestic firm's (monopoly) price. An increase in the tariff causes the after-tariff price of the foreign product,  $p_b$ , to rise. In this example with a relatively large  $z$ , the domestic monopoly price is substantially less than the Bertrand price if the government does not intervene at all.

If the firms collude, an increase in  $\tau$  causes  $p_b$  to fall if  $\tau \leq 4$  and to remain constant in the monopoly region. An increase in  $\tau$  always causes the after-tariff price of the foreign product to rise. For  $\tau \geq 4$ , the domestic price is the same whether the firms play Bertrand or collude because the domestic firm sets the monopoly price in either case.

### *Profit and Consumer Surplus Effects*

The effects of an increase in  $\tau$  on the profits of the domestic firm and on consumer surplus are shown in Figure 5 for the same numerical example as above. If the firms play Bertrand, domestic profits rise with  $\tau$  in the unconstrained region; may rise or fall in the constrained region; and are constant in the monopoly region. Domestic profits are higher in the monopoly region than if there were no tariff.

If the firms play Bertrand, as  $\tau$  increases, consumer surplus,  $CS_b$ , falls in the unconstrained region; may rise or fall in the constrained region (though it must eventually rise as  $\tau$  approaches 4); and then falls in the monopoly region. In this example, though  $CS_b$  may rise locally, the global optimum occurs at  $\tau = 0$ .

An alternative welfare measure,  $W_b$ , is consumer surplus plus tariff revenues. This measure rises in the unconstrained region, may rise or fall in the beginning of the constrained region but must eventually rise, and falls in the monopoly region. The global optimum, for this example, is at  $\tau = 4$ . At  $\tau = 0$ ,  $W_b = 25.56$ ; whereas, at  $\tau = 4$ , it rises nearly 41 percent to 36.

If the firms collude, the profits associated with sales by the domestic firm increase with  $\tau$ . If, however, the firms split profits so each receives  $(\pi_c + \pi_c^*)/2$ , its profits fall with  $\tau$  as shown in Figure 5. Consumer surplus,  $CS_c$ , rises in the constrained region (up to  $\tau = 4$ ) and falls in the monopoly region as shown in Figure 5. Consumer surplus plus tariff revenues follows the same pattern. The alternative welfare measure,  $W_c$ , rises until  $\tau = 4$ , and then falls. At  $\tau = 0$ ,  $W_c = 18$ ; whereas, at  $\tau = 4$ , it doubles to 36.

Thus, tariffs may have surprising effects, as shown in this example. The domestic price may fall with the tariff, even though the after-tariff price on the foreign brand rises. The domestic firm always gains or is unaffected by the tariff. Consumers may gain from the tariff even ignoring the tariff revenues. Using the consumer surplus plus tariff revenues measure of welfare, any modest tariff raises welfare.

### Effects of a Quota

A quota on the foreign firm causes it to restrict sales by raising its price and only selling to consumers located close to it in characteristic space. If the two firms are located so far apart that each sets a monopoly price, the quota has no effect on the domestic firm. If a binding quota,  $\bar{q}$ , is applied to the foreign firm, it sets its quantity (as given by its monopoly demand curve, Equation 5) equal to the quota, so that

$$p_m^* = v - \frac{c}{2L} \bar{q}. \quad (22)$$

Thus,  $p_m^*$  rises as  $\bar{q}$  falls. This price is independent of costs,  $m$ , and depends only on tastes and the quota.

If the brands are close enough together that the firms compete for some customers, as the quota restricts the foreign firm's sales, the domestic firm can lower its price and capture some of the foreign firm's former customers. If the firms play Bertrand and are operating in the unconstrained region,

$$p_b^* = \frac{1}{3} \left( 2v + cz + p - \frac{2c}{L} \bar{q} \right). \quad (23)$$

Substituting Equation 23 into the domestic firm's best-response function,

$$p_b = \frac{1}{17} \left( 8v + 9m + 4cz - \frac{2c}{L} \bar{q} \right). \quad (24)$$

Substituting Equation 24 into 22,

$$p_b^* = \frac{1}{17} \left( 14v + 3m + 7cz - \frac{12c}{L} \bar{q} \right). \quad (25)$$

Thus if the firms compete for customers, as the quota falls, both prices rise.

At the kink, the foreign price,  $p_b^*$  is the same as in Equation 22, and

$$p_b = v - cz + \frac{c}{2L} \bar{q}. \quad (26)$$

The domestic firm sets its monopoly price when  $\bar{q} \leq L(2cz - v + m)/c$ .

If the firms collude, in the interior,  $p_c = (v + m)/2 + cz/4$  (as before). If the quota is binding and the firms are at the kink in the demand curve, prices are determined as in Equations 24 - 26.

### *Price Effects*

The effects of a quota on price are shown for the general case in Table 2. Figure 6 shows the effect of a quota on price for the same example as above ( $v = 10$ ,  $m = 2$ ,  $c = L = 1$ , and  $z = 6$ ). If the quota is so large ( $\bar{q} > 6.6$ ) that it does not bind, there is no effect on price, as shown on the right side of the figure. In the unconstrained duopoly region where the quota binds ( $5.14 < \bar{q} \leq 6.6$ ),  $p_b^*$  rises as the quota falls. For lower quotas where the domestic firm is operating along the kink ( $4 < \bar{q} \leq 5.14$ ),  $p_b$  falls as the quota falls.<sup>9</sup> For even lower quotas where the firms are in the monopoly region ( $\bar{q} \leq 4$ ), the domestic firm sets its monopoly price.<sup>10</sup> In this example, the monopoly price is below the Bertrand price the domestic firm would have charged in the absence of a quota.

With a cartel, the lower the quota, the higher the foreign price. Lowering the quota reduces the domestic cartel price until it reaches the monopoly level (where it no longer changes as the quota falls).

Thus, tight quotas lower the domestic price below the unregulated Bertrand or collusive price. Quotas raise the foreign price above the unregulated Bertrand or collusive prices.

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<sup>9</sup> In general, the upper bound on the kink region is  $\bar{q} = 2L(7cz - 3v + m)/(7c)$ .

<sup>10</sup> In general, the domestic firm sets its monopoly pricing for  $\bar{q} \leq L(2cz - v - + m)/c$ .

### *Profit and Consumer Surplus Effects*

If the firms play Bertrand, as the quota falls, the domestic firm's profits ( $\pi_b$ ) rise until they reach the monopoly level. As the quota falls, consumer surplus,  $CS_b$ , falls in the unconstrained region, rises in the constrained region, and then falls again in the monopoly region ( $\bar{q} < 4$ ). Though consumer surplus rises as the quota tightens in the constrained region, consumer surplus is always lower than at the unregulated Bertrand equilibrium.

If the firms collude, as the quota falls, the profits attributable to the domestic firm ( $\pi_c$ ) rise, but its share of the combined profits (e. g.,  $(\pi_c + \pi_c^*)/2$ ) falls. Consumer surplus rises as the quota falls until  $\bar{q} < 4$ . Thus, in the duopoly region (where some consumers receive positive net surplus from both brands), tightening the quota causes consumer surplus to rise if the firms collude. The globally optimal quota is at the edge of the monopoly region, which is  $\bar{q} = 4$  in this example where  $CS_c = 20$  (compared to 18 when the quota does not bind).

### **Conclusions**

Tariffs and quotas can lower prices and raise domestic welfare when products are spatially differentiated. Moderate to large tariffs and quotas are likely to *reduce* the price of the domestic brand, though they usually raise the price consumers pay for the foreign brand regardless of market structure. A moderate tariff increases welfare regardless of market structure. A moderate quota increases welfare if the firms are colluding.

These unusual results were illustrated in a plausible example with moderate product differentiation. With very little product differentiation (nearly homogeneous

products) or so much differentiation that the firms do not compete, the usual results hold.

The reason for the unusual welfare effects is that the tariffs and quotas move us from one second-best equilibrium to another, and the new second-best equilibrium may dominate the original one. Even when the government does not intervene, the spatial equilibrium is a second-best because price is above marginal cost. In contrast, in the usual analysis with homogeneous products and a competitive industry, tariffs and quotas move us from a first-best equilibrium to an inferior, second-best equilibrium.

Thus, it does not follow from these results that tariffs and quotas are optimal policies. Dealing directly with pricing distortions in spatially differentiated markets is superior. Nonetheless, using tariffs or quotas may be more politically feasible than directly regulation prices of firms.

### References

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Table 1: Comparative Statics Results from an Increase in  $\tau$ 

	Unconstrained Duopoly Region	Constrained Duopoly Region	Monopoly Region
$p_b$	$\frac{3}{35} > 0$	? (probably $< 0$ )	0
$p_b^*$	$-\frac{17}{35} < 0$	? (probably $< 0$ )	$-\frac{1}{2} < 0$
$p_b$	$\frac{18}{35} > 0$	? (probably $> 0$ )	$\frac{1}{2} > 0$
$p_c$	0	$-\frac{1}{4} < 0$	0
$p_c^*$	$-\frac{1}{2} < 0$	$-\frac{3}{4} < 0$	$-\frac{1}{2} < 0$
$p_c$	$\frac{1}{2} > 0$	$\frac{1}{4} > 0$	$\frac{1}{2} > 0$

Table 2: Comparative Statics Results from a Decrease in  $\bar{q}$ 

	Unconstrained Duopoly Region	Constrained Duopoly Region	Monopoly Region
$p_b$	$\frac{\partial^2 c}{\partial 17L} > 0$	$\frac{\partial^2 c}{\partial 2L} < 0$	0
$p_b^*$	$\frac{\partial^2 c}{\partial L} > 0$	$\frac{\partial^2 c}{\partial 2L} > 0$	$\frac{\partial^2 c}{\partial 2L} > 0$
$p_c$	0	$\frac{\partial^2 c}{\partial 2L} < 0$	0
$p_c^*$	$\frac{\partial^2 c}{\partial 2L} > 0$	$\frac{\partial^2 c}{\partial 2L} > 0$	$\frac{\partial^2 c}{\partial 2L} > 0$