Input Tariffs as a Way to Deal with Dumping

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The General Agreement on Tariffs and Trade (GATT) has significantly reduced the use of tariffs as barriers to international trade in today's marketplace. The existence of antidumping legislation, however, provides American industry with a method of procuring protection when the pressures of international competition become oppressive. Many American companies have taken advantage of the legislation and claimed injury at the hands of unfair competition from abroad, often winning the imposition of punitive duties on competing imports as compensation for previous underpricing.

The international trade literature has produced many models of dumping, providing thorough analyses of the effects of dumping and antidumping laws on both the foreign and domestic markets.[1] This article uses an analytical model developed in Skeath (1993) to explore in detail an intriguing antidumping case, initiated in mid-1990, involving flat-panel display screens for laptop computers. The vertical relationships between laptop screen and laptop computer producers make the results of the analysis applicable to a wide variety of international industries with vertically integrated or vertically related firms.[2] The analysis is used to show the consequences of antidumping duties for both intermediate and final good producers in the laptop computer industry. In particular, examination of the behavior of consumers and producers in response to an input tariff offers insight into the rationale behind the recent request on the part of the protected industry for repeal of the tariff.

A Specific Case of Dumping and Input Tariffs

The relatively recent, and divisive, case in question involved producers of display screens for laptop computers. Following a complaint filed by a group of American producers of flat-panel computer display screens calling themselves the Advanced Display Manufacturers of America (ADMA), in August of 1991 the United States Department of Commerce and the International Trade Commission imposed a 63 percent tariff on imports of Japanese active matrix liquid crystal displays. While the ADMA had hoped for substantial duties on three other types of flat-panel displays as well, they claimed the ITC's final decision as a victory and as an essential element in guaranteeing the survival of the American display screen industry.[3]

Antidumping regulations were originally designed to protect American manufacturers such as the display producers from foreign manufacturers practicing predatory pricing (that is, selling their goods in the U.S. market at a price below the average cost of production) or price discrimination (pricing abroad at a level below their domestic price); such practices are often referred to as "unfair trade practices." Under the antidumping laws, duties can be levied on imports if the dumping is found to cause injury to an American industry. Rulings follow a two-step process: The Commerce Department's International Trade Administration must first find that dumping has occurred and then the International Trade Commission (ITC) must determine that injury has also occurred. If both investigations find evidence of dumping, punitive duty levels are determined based on manufacturing cost levels.

The duties imposed on active matrix liquid crystal displays in August 1991 followed preliminary and final rulings by both the Commerce Department and the ITC that described Japanese firms as pricing below fair value. The final official dumping margin for the active matrix display was calculated at 62.67 percent, despite preliminary findings that put the margin well below 10 percent. As noted above, the American display manufacturers considered the final tariff decision to be an important victory as well as a crucial ingredient in guaranteeing the long-term viability of their industry.

The computer manufacturing industry, however, felt differently about the punitive duties. Members of that industry had consistently and vociferously argued that the American display screen industry did not produce screens of high enough quality or in great enough quantity to meet their needs; thus, the imposition of dumping duties promised merely to increase the price of their products that required the taxed screens as inputs. After the imposition of the tariff, an IBM spokesperson was quoted noting that the decision was, "in effect, an eviction notice from the U.S. government to the fastest growing part of the U.S. computer industry."[4] Within a few months, Japanese screen manufacturers were suspending exports of the taxed displays to the United States and moving their computer production and assembly facilities out of the United States back to Japan.[5] Apple Computer was considering moving its portable computer production plants to Singapore or Ireland, and both Compaq and IBM were threatening similar moves of their laptop production facilities to off-shore locations.[6]

The reactions of the major computer manufacturers in response to the imposition of tariffs implied that the antidumping duties would do more to hurt the computer industry than they would do to help screen producers to compete with their Japanese rivals. Although the ADMA claimed that the duties would enhance the viability of the U.S. laptop screen industry, other sources claimed that a lack of investment in the newest technologies was responsible for the U.S. screen producers lagging behind their Japa-

[1] The standard treatment of dumping as price discrimination on the part of a foreign monopolist can be found in most international economics texts. This analysis presents dumping as profit-maximizing behavior by the foreign firm but shows its potentially welfare-decreasing effects on the domestic market. More recent theory can be found in Ethier (1982), Das and Mohanty (1984) and Dixit (1988). Brander and Krugman (1983) connect the existence of intra-industry trade to the phenomenon of "reciprocal dumping"; see also Helpman and Krugman (1989). On the subject of the role of antidumping laws in affecting the behavior of domestic and foreign firms, see Webb (1987,1992) and Herander and Schwartz (1984).

[2] The effects of trade policy in vertically related markets have been examined by Rodrik and Yoon (1989) as well as by Spencer and Jones (1991, 1992). These papers do not incorporate quality differentiation as does Skeath (1993).

[3] The tariff on active matrix liquid crystal displays was set at 62.67 percent. A second group of flat-panel displays known as electroluminescent screens had a 7.02 percent duty imposed upon them. No duties were levied on the other two types of displays in question, passive matrix liquid crystal displays and displays that use a gas-plasma technology. Early Commerce Department investigations had suggested that the dumping margin was considerably smaller than was finally decided. See Farnsworth (1991), Fisher (1991), Lachica (1991a, 1991b), Pollack (1991a, 1991b), and Zachary (1991).

[4] Spokesman Michael Dutton, for International Business Machines Corporation, quoted in *The New York Times*, 8/16/91 (Pollack 1991b).

[5] The tariff applied to unassembled screens only and not to fully assembled computers. Thus, Japanese computer manufacturers who shipped complete machines to the United States could avoid paying the tariff. Japanese firms using imported screens to assemble machines in the United States were unable to avoid the tariff and were forced to move their facilities out of the United States. Presumably it was too costly for Japanese firms to move their screen production facilities into the United States.

[6] See Sanger (1991a, 1991b) and *The Wall Street Journal* (1991a, 1991b).

nese counterparts in quality.[7] In effect, these arguments implied that dumping was not to blame for the American manufacturers' inability to capture a significant share of the market. In addition, many were concerned that the economic cost of job losses associated with the movement of computer production locations abroad would significantly outweigh any benefits that would be reaped by the display producers. Even without such movement, the economic impact of projected price increases for laptop and notebook computers served to make computer manufacturers and consumers wary of the benefits of the duties.

A model for analyzing the effect of the display screen tariff must incorporate the industry's vertical relationship with the computer industry and the presence of product differentiation based on quality.

Similar concerns have been raised in relation to other antidumping duties that have been imposed on products used primarily as inputs into other manufactured goods. Duties on imported ball bearings, for instance, were recommended by the Commerce Department in 1989. These tariffs were as high as 212 percent on some types of ball bearings; their effect was to significantly increase production costs for a number of American manufacturers.[8] Another recent tariff imposed on Canadian soft-wood products is said to threaten the U.S. housing and construction industry.

The most recent development in the display screen duty case was the Commerce Department's revoking of the punitive tariffs, at the request of "the sole remaining U.S. maker of the screens."[9] The request, made in November 1992, was quickly granted; it was announced in January 1993 that the Commerce Department planned to revoke antidumping duties on the Japanese screens.[10] Reports suggest that new ties to laptop producers influenced the display screen firm in its decision to request removal of the tariffs, although no direct evidence was presented from the firm itself regarding its rationale.

The case of the ADMA and active matrix liquid crystal displays illustrates the political-economic intricacies that can surround the creation of trade policy. It also highlights the fact that policies designed to benefit certain firms or industries may have other, just as significant, effects on other firms in other industries. Moreover, the model presented below will show that antidumping policies do not always have the anticipated effect even on the industries that they are designed to protect.

The Theoretical Model

An appropriate model for analyzing the effect of the display screen tariff must incorporate the most salient features of the industry's organization, notably its vertical relationship with the computer manufacturing industry and the presence of product differentiation, even among otherwise identical types of displays, based on quality. Further, it must allow for the imposition of trade (or domestic) policies that might affect the equilibrium outcome in the industry. The model presented in Skeath (1993) incorporates each of these characteristics;[11] the equilibria obtained from the model shed light on the manner in which actions of the display or computer producers may affect the welfare of the other producer. In addition, analysis of the equilibrium outcomes that arise following the imposition of (antidumping) tariffs indicates why the display manufac-

[7] Richard Flasck, quoted in *The Wall Street Journal*, 2/11/91, had been a U.S. display manufacturer. He noted that "[t]he Japanese have invested billions into displays, while the U.S. hasn't made the investment. About the only thing [duties] will do is prevent the U.S. population from enjoying products using these displays." See Zachary (1991).

[8] See Johnson (1992). Companies most affected by the ball bearing tariff include General Electric, Hewlett Packard and IBM.

[9] See Nomani (1993). The sole U.S. producer of active matrix displays at the time of the request was Optical Imaging Systems, Inc., owned largely by Guardian Industries Corp. Other firms are mentioned as being in the process of creating prototype screens but not at the stage of producing for the general market. Bradsher (1992) reports OIS as the firm responsible for requesting the reversal of the tariffs, while Nomani identifies Guardian. Both make reference to business connections with Apple Computer as significant in the change of heart of the screen producers.

[10] The official announcement of an end to the screen duty came on June 21, 1993. See Andrews (1993).

[11] The model described below and presented originally in Skeath (1993) draws on earlier work by Spencer and Jones (1991, 1992) and Rodrik and Yoon (1989) in its treatment of vertical relations and international trade. The demand side of the model has its roots in work by Chang and Kim (1989, 1991) and Chang and Chen (1992), while the industrial organization is similar to the model in Ronnen (1991).

turers may have had good reason to request that the duties be withdrawn.

The model of quality-differentiated intermediate goods begins with two countries (home and foreign), two firms producing final goods (F and F*), and two intermediate good firms (I and I*), foreign variables being indicated with a superscript *. Standard simplifying assumptions in the literature are that the quality of a critical input determines the quality of the final good it is used to produce and that a unit-for-unit correspondence exists between input and final good. Such assumptions may reasonably be argued to accurately describe the laptop computer industry, in which similarly priced machines with identical features (speed, memory size, and the like) are often distinguished by the quality of their display screens and in which each machine requires only a single display, regardless of its quality. Thus, this model assumes that one unit of intermediate good is required for the production of one unit of final good. In addition, it is quite realistic to assume that the foreign (that is, Japanese) screen firm produces the high-quality input (see Hart 1993). In the model described here, firm I* produces an input that can be used by either final good firm to produce a high-quality product; use of firm I's input results in the production of a low-quality final product.

Firm I*, the high-quality input producer, provides its input, at its marginal cost of c_H, to either final good firm.[12] Firm I, the low-quality input producer, incurs marginal costs of production of c_L and sells its input on the domestic market at a price of p_L ($\geq c_L$). The foreign firm always purchases its input from I*; the home firm can choose to purchase its input from either intermediate good firm. Under these assumptions, the foreign (here, Japanese) firm F* always provides a high-quality good to the market but the home (American) firm F may provide a good of either high or low quality. Costs for the final good firms are determined solely by the cost of the intermediate input.[13] Thus, the final market equilibrium outcome depends crucially on which input is purchased by firm F and on the price paid for that input.

The demand side of the model consists of a set of consumers located along the interval [0,1] who gain utility from consuming a single unit of the final good according to the quality of that unit; each consumer maximizes utility. Consumers have different tastes for quality depending on their location on the interval and are identified according to their position along that interval, or according to their type, T, $0 < T < 1$. A consumer located at position T (also referred to as a consumer of type T) who purchases one unit of the final good of quality q_H (high-quality) or q_L (low-quality), at price P_H or P_L, gets utility of $U_H(T) = q_H \cdot T - P_H$ if she purchases the high-quality good and utility of $U_L(T) = q_L \cdot T - P_L$ if she purchases the low-quality good. Given that the consumers get zero utility if they make no purchase, it follows that a consumer will purchase a specific quality good if and only if her utility from the purchase of that good is greater than her utility from the purchase of the other quality good.[14] The marginal consumer who is indifferent between the purchase of a high-quality good and no good at all is the consumer who is located at $T_H = P_H/q_H$, where T_H solves $U_H(T_H) = 0$. The marginal consumer who is indifferent between purchasing the low-quality good and no good at all is similarly defined to be located at $T_L = P_L/q_L$, where T_L solves $U_L(T_L) = 0$. Consumers to the left of T_H, those located at $T < T_H$, are not willing to purchase the high-quality good because they receive negative utility from such a purchase while those to the right of T_H, those located at $T > T_H$, are willing to buy the high-quality good because it provides them with a positive amount of utility. The same is true for consumers to the left and right of T_L. The marginal consumer indifferent between a high-quality and a low-quality good, consumer T_z, has $U_H(T_z) = U_L(T_z)$. A consumer located to the left of T_z, one with $T < T_z$, receives greater utility from purchasing the low-quality good than from purchasing the high-quality good while a consumer located to the right of T_z, one with $T > T_z$, receives greater utility from purchasing the high-quality good.

The parameters T_L and T_H, which show the locations of the marginal consumers of low- and

[12] Provision of the input at marginal cost to the foreign firm may be justified by assuming that a vertical relationship exists between the two firms. In the case of vertically integrated firms, firm F* would always be able to obtain the input from I* at cost. To explain provision of the input at marginal cost to the domestic firm, however, the original model assumes the existence of numerous competing producers of the input in the foreign country. The existence of competition for the input producer in the foreign country is based in fact; there are significantly larger numbers of flat-panel display producers in Japan than there are in the United States. See Hart (1993).

[13] Since the quality of the input determines the quality of the final product, it is safe to assume that any cost variations in production of the final good come solely from variations in the price paid for the input.

[14] Clearly, consumers only purchase a good if it provides strictly positive utility as well. In the event of a tie, if the utility level received from purchasing the high-quality good is the same as the utility level received from purchasing the low-quality good ($U_H(T) = U_L(T)$), consumer T is assumed to purchase the high-quality good.

high-quality goods, also identify the quality-deflated prices that are offered for a unit of a good of low or high quality. In order to simplify the analytics of the model, all equilibrium values are expressed in such quality-deflated terms. Thus, $\gamma_H = c_H/q_H$ is the quality-deflated marginal cost of producing the high-quality input, $\gamma_L = c_L/q_L$ is the quality-deflated marginal cost of producing the low-quality input, and $\rho_L = p_L/q_L$ is the quality-deflated price charged by firm I for the low-quality input. The relative quality level of output is defined as $k = q_H/q_L$.

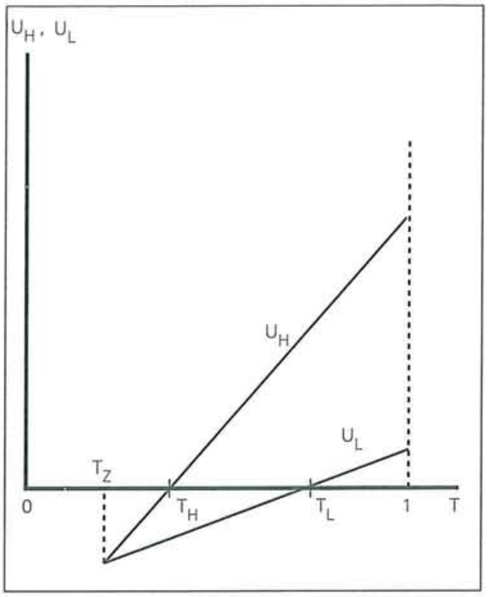
The final market equilibrium is attained in two stages. In Stage 1, input producers set their prices. Because it is assumed that firm I* prices at marginal cost, the only real decision made in Stage 1 is that of firm I in setting p_L. In Stage 2, the final good producers purchase inputs and compete in a non-cooperative price-setting game; only the domestic firm, F, has a choice of inputs in Stage 2. In the second stage, then, firms F and F* set prices P_L and P_H which determine the quality-deflated values T_L, T_H, and T_z which, in turn, determine the pattern of consumption in the market. Solving for the final equilibrium is achieved via backward induction, first finding all of the possible Stage 2 pricing outcomes and then determining the price that will be set by firm I in Stage 1.

Three outcomes are possible in Stage 2. Consumers might purchase only the high-quality good, or they might purchase some of each quality, or they might purchase only the low-quality good, depending on the relative sizes of T_L, T_H, and T_z. Figures 1, 2, and 3 show the three possible ways in which T_L, T_H, and T_z might be related to each other.[15] In each figure, the locations of consumers (T) are shown on the horizontal axis and utility levels (U) are shown on the vertical axis. The lines illustrated are $U_H(T) = q_H \cdot T - P_H$ and $U_L(T) = q_L \cdot T - P_L$, plotting the utility associated with purchasing the high- and low-quality goods for each consumer (that is, each value of T) along the horizontal axis. The slope of each line is determined by the quality level of the good whose utility is measured by the line; thus, the U_H line is more steeply sloped than the U_L line because $q_H > q_L$.

In Figure 1, $T_H < T_L$, which guarantees that $T_z < T_H < T_L < 1$. In this case, all consumers located at $T > T_H$ find that the high-quality good provides them with more utility than the low-quality good while all consumers located at $T < T_H$ find that they receive negative utility if they purchase either quality good. Accordingly, all consumers between T_H and 1 purchase the high-quality good but no consumers choose to purchase the low-quality good. In Figure 2, $T_L < T_H < T_z < 1$. Thus, consumers located at $T < T_L$ choose to purchase neither good because they would receive negative utility from a purchase, consumers located between T_L and T_z purchase the low-quality good because it offers them higher utility than does the high-quality good, and consumers between T_z and 1 purchase the high-quality good because it offers them the highest utility level. In Figure 3, $T_L < T_H < 1 < T_z$. In this case, consumers located between 0 and T_L buy neither good while consumers located between T_L and 1 purchase the low-quality good because it offers greater utility than the high-quality good. No consumers purchase the high-quality good. Market shares (that is, the number of consumers buying each quality, or the number of units sold) for

Figure 1

Market Share Determination
$T_Z < T_H < T_L < 1$

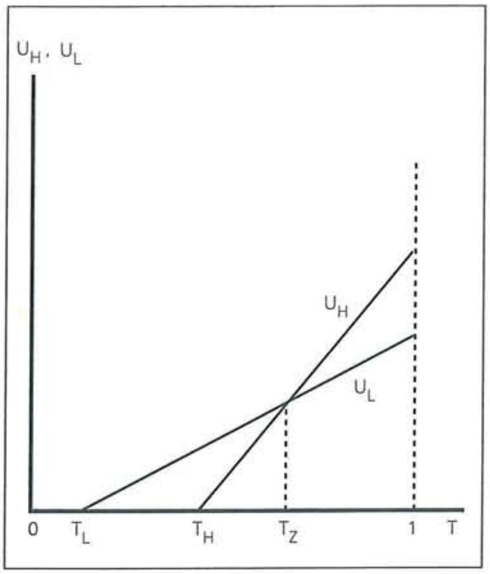


Consumers from 0 to T_H purchase neither good.
Consumers from T_H to 1 purchase the high-quality good.

[15] These figures are essentially equivalent to ones presented by Chang and Kim (1989, 1991) because the demand side of the model is based on their work.

Figure 2

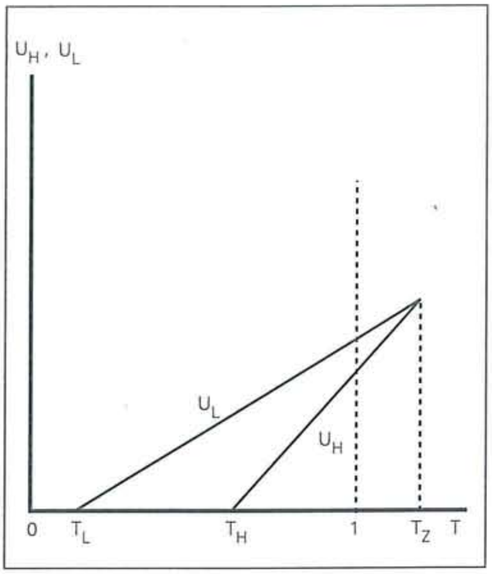
Market Share Determination
$T_L < T_H < T_Z < 1$



Consumers between 0 and T_L purchase neither good.
Consumers between T_L and T_Z purchase the low-quality good.
Consumers between T_Z and $_1$ purchase the high-quality good.

Figure 3

Market Share Determination
$T_L < T_H < 1 < T_Z$



Consumers between 0 and T_L purchase neither good.
Consumers between T_L and 1 purchase the low-quality good.

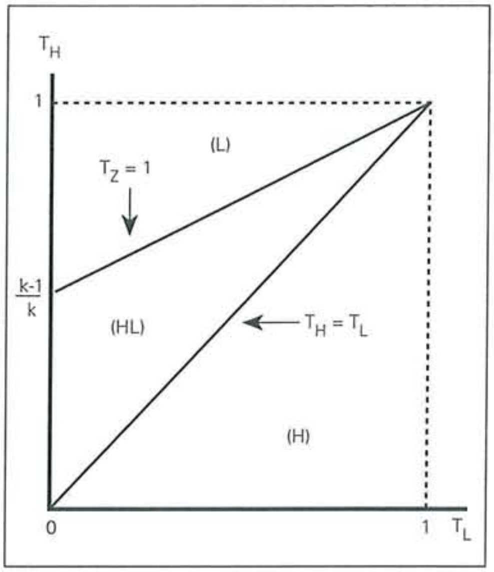
the low-quality producer are 0, $T_z - T_L$, and $1 - T_L$, in Figures 1, 2, and 3, respectively, and market shares for the high-quality producer are $1 - T_H$, $1 - T_z$, and 0, respectively.

The market share results can be summarized by noting their dependence on the size of T_H relative to T_L and on the size of T_z relative to 1. When $T_H < T_L$, only high-quality goods are demanded. When $T_H > T_L$, both qualities or only low quality may be demanded, depending on whether $T_z < 1$ or not. If $T_H > T_L$ and $T_z < 1$, both qualities are demanded, while if $T_H > T_L$ and $T_z > 1$, only low quality is demanded. These three possibilities are shown together in a single diagram in Figure 4. This figure shows the (T_L, T_H) space divided into three distinct areas by the lines $T_H = T_L$ and $T_z = 1$. The area labeled (H) includes all T_L and T_H combinations for which only high quality is demanded (including those T_L and T_H combinations on the $T_H = T_L$ line). In area (H), both firms F and F* produce and sell high quality; they compete in an identical product duopoly. Area (HL) includes combinations of T_L and T_H for which both qualities are demanded. In this area, F produces and sells low-quality goods while F* produces and sells high-quality goods. Area (L) includes those remaining combinations of T_L and T_H for which only low quality is demanded (which includes the T_H and T_L combinations on the $T_z = 1$ line). In area (L), F produces and sells low quality but F* sells nothing because it can only produce the high-quality good for which there is no demand. Market share outcomes in areas (H), (HL), and (L) correspond exactly to the share outcomes derived from Figures 1, 2, and 3, respectively.

Once market share outcomes are known, firms F and F* can determine their optimal prices, each firm's best response to the price of the other firm. Firms determine their optimal prices by considering the market area in which different price combinations lie and by considering the profits that they could earn in each case. Profits in area (H) are zero for each firm because they both produce high-quality goods in this

Figure 4

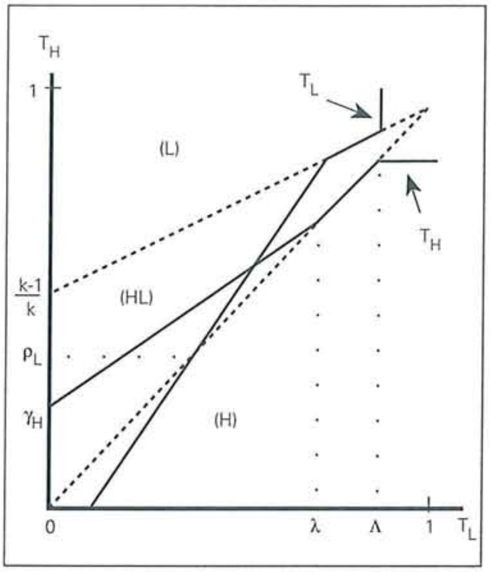
Equilibrium Market Regimes



In area H, $T_H < T_L$ and $T_Z < 1$.
In area HL, $T_H > T_L$ and $T_Z < 1$.
In area L, $T_H > T_L$ and $T_Z > 1$.

Figure 5

Price Reaction Functions



area; firms choose price in this model (rather than quantity), so the equilibrium when they both produce the high-quality product entails each setting price at marginal cost ($P_H = c_H$ or $T_H = \gamma_H$).[16] In the other areas shown in Figure 4, profits are determined as the product of the number of units sold (market share) multiplied by per unit profit (price minus cost). Knowing its profit potential, each firm chooses price to maximize profits given the price chosen by the other firm.

The profit-maximizing prices set by each firm in Stage 2 can be illustrated using best-response functions (reaction functions) for each firm. The reaction functions, which are upward-sloping but not continuously differentiable, as in Ronnen (1992), show each final good firm's best price response to its rival's choice of price. In other words, if the foreign firm decides on a price of T_H, the domestic firm's best response function shows the price, T_L, that maximizes firm F's profits in response to T_H. The reaction functions are illustrated in Figure 5, which uses the same axes as those in Figure 4.[17] As is clear from an inspection of the two reaction functions in Figure 5, there is a single intersection of the two functions. Thus, a unique, quality-deflated price equilibrium can be determined for any given values of the model's parameters, k, γ_H, and ρ_L.[18]

An important feature of the reaction functions, $T_L(T_H, \rho_L)$ and $T_H(T_L, \gamma_H)$, is their non-differentiabil-

[16] This equilibrium is the (unique) Bertrand pricing equilibrium for the game described by this model. Zero profits in this context means that no profits are earned beyond a normal rate of return.

[17] The T_H reaction function depends on k and γ_H while the T_L reaction function depends on k and ρ_L. Full equations for the reaction functions can be found in Skeath (1993). In the discussion that follows, note that k and γ_H are fixed but that ρ_L is endogenous, since it is chosen in Stage 1 by firm I.

[18] The equilibrium must entail T_L and T_H being less than one in order to guarantee that the firms can sell their products to the consumers in the domestic market. As long as $k \geq 1$, $\gamma_H < 1$, and $\rho_L < 1$, both T_H and T_L will be strictly less than one in equilibrium. These parameter restrictions are assumed to hold.

ity. The kinks in the reaction functions are caused by the interrelationships of T_L and T_H in determining which products are purchased in equilibrium. Consumers decide whether to purchase the low- or high-quality product based on the relative positions of T_L, T_H, and T_z as discussed above. It follows that the location of the kinks is closely related to the location of the areas (H), (HL), and (L) in Figure 4. More generally, this means that the manner in which a firm responds to a given choice of T by its rival is different when that T is high than when it is low.

Consider the foreign firm's reaction function, $T_H(T_L, \gamma_H)$, in Figure 5. For relatively low values of T_L, F* maximizes profit by choosing some $T_H > T_L$ in the (HL) area. As T_L rises, however, F* finds it optimal to raise T_H by less than the increase in T_L in order to maintain its customer base and to continue maximizing profits. (Because F* responds to increases in T_L with smaller increases in T_H, the slope of its reaction function in the (HL) area is less steep than the line $T_H = T_L$.) Once T_L reaches the critical value, λ, F*'s optimal T_H puts its reaction function onto the $T_H = T_L$ line and into the (H) area in which consumers purchase only the high-quality product.[19] The foreign firm can exactly match any increase in T_L beyond λ with an increase in T_H without moving away from the (H) area, without losing customers; thus, the T_H reaction function lies along the $T_H = T_L$ line for T_L above λ. Finally, once T_L is so large that it lies beyond a second critical point, Λ, the foreign firm has no need to change its T_H at all in response to increasingly higher values of T_L. For $T_L > \Lambda$, F* has no need to worry about its customer base as no consumers could be encouraged to purchase low quality at such a high price. This fact allows the T_H reaction function to be horizontal for large T_L values.

A similar explanation can be provided for the shape of the T_L reaction function. For low values of T_H, the domestic firm's profit-maximizing choice of T_L lies above T_H so that the T_L reaction function is in area (H). In this area, the domestic firm actually prefers to produce the high-quality good, so that its choice of T_L is not truly relevant until it is high enough that the reaction function enters the (HL) area.[20] Once T_H exceeds ρ_L, as shown in Figure 5, the T_L reaction function lies in area (HL). As T_H rises beyond this point, the domestic firm's optimal T_L rises more slowly than T_H, again as a way of preserving the size of the consumer group purchasing the low-quality good. Eventually, T_H becomes large enough that F's optimal T_L hits the $T_z = 1$ line and the (L) area. For higher values of T_H, it is optimal for the domestic firm to change T_L in such a way that the reaction function moves along the $T_z = 1$ line and stays just inside the (L) area. Once T_H becomes so large that consumers would no longer consider switching from low to high quality, there is no more need to change T_L at all in response to changes in T_H. The T_L reaction function becomes vertical in response to very high T_H values.

The price equilibrium in Stage 2 of this model is found by identifying the T_H and T_L values at the intersection of the two reaction functions. The specific position of each reaction function is determined by the costs incurred by each firm during production; the T_H reaction function position is determined by the value of γ_H and the T_L reaction function position is determined by the value of ρ_L. In this model, γ_H is fixed but ρ_L can be changed by firm I. Thus, firm I can control the ultimate pricing outcome by changing its ρ_L and moving the T_L reaction function left (for low ρ_L) or right (for high ρ_L).

For the equilibrium to occur in the (HL) area in Figure 5, ρ_L must be below the critical value λ. Equilibria in this area provide firm F with strictly positive profits because F's market share $(T_z - T_L)$ and unit profit $(T_L - \rho_L)$ are both positive. When $\rho_L < \lambda$, then, the domestic input producer is able to sell its low-quality input to the domestic final good producer and remain in business. If ρ_L is higher than λ, the reaction functions intersect in the (H) area (either on or to the right of $T_H = T_L$), and no consumers purchase the low-quality good. In this case, firm I cannot stay in business because it cannot sell any of its product. It follows that if an equilibrium is to exist in which firm F purchases its input from I, then it must be the case that the reaction functions intersect in area (HL) and that $\rho_L < \lambda$.

Given these specifications of the equilibrium in Stage 2 of the game, it is possible to determine the action to be taken by firm I in Stage 1. Firm I desires to maximize its profits, subject to the constraint that those profits are non-negative and subject to the

[19] The critical value, λ, can be determined using the reaction function equations. Here, $\lambda = (2k - 1)^{-1} [k (1 + \gamma_H) - 1]$. This is the critical value for the T_H reaction function at which the function changes slope the first time. The second critical value, at which the T_H reaction function changes slope the second time, is denoted below as Λ; the actual value of Λ is $\frac{1}{2}(1 + \gamma_H)$.

[20] Technically, if the T_L reaction function lies within the (H) area, any T_L that satisfies $T_L \geq T_H$ may be chosen by the domestic firm. That is, in response to low values of T_H, if the optimal T_L would be at least as large as T_H, then it does not matter what actual T_L is chosen as long as it is some $T_L \geq T_H$, because the low-quality product will not be produced in equilibrium.

further constraint imposed on those profits by the Stage 2 equilibria. As shown above, firm I must charge $\rho_L < \lambda$ if it is to sell any of its product to firm F. Taking these constraints into account, the profit-maximizing, quality-deflated price for firm I is $\rho_L = \frac{1}{2}\gamma_L + \frac{1}{2}\lambda$. Firm I's profit-maximizing price will be below λ, and thus will guarantee an equilibrium in Stage 2 in area (HL), if (and only if) $\gamma_L < \lambda$. For values of $\gamma_L > \lambda$, the Stage 2 equilibrium occurs in area (H) and consists of a duopoly for firms F and F* in the high-quality good.

Effects of Dumping Duties

The theoretical model described above shows that the domestic low-quality input producer is unable to participate in the market when its quality-deflated marginal cost exceeds the critical value, λ. In such circumstances the input producer might be concerned that its foreign rival(s) were setting a price below the "fair (cost-based) value" of their own input in order to drive the domestic producer (whose prices were determined by cost) out of the market. Such a scenario is similar to the situation that occurred with the ADMA in 1990; their inability to penetrate the display screen market led them to believe that their rivals were dumping screens on the U.S. market. The ADMA argued to the Commerce Department and the ITC that punitive duties should be assessed on the foreign (Japanese) screens in order to level the playing field in the display screen industry. In the model being used here, such duties can be modeled as an increase in the selling price of the high-quality input in the domestic market; in other words, duties imposed to protest foreign dumping of the high-quality input raise the price of that input for the domestic final good firm.

The purpose of antidumping duties imposed by the domestic government is to encourage the use of domestic inputs by domestic final good manufacturers. Firm I has little benefit to gain unless it is in the position of being outside of the market before antidumping policy takes effect. In other words, one would expect such policy to be used only when the (no policy) market equilibrium consists of a high-quality duopoly between the domestic and foreign firms; one would expect such policy to be used only if the original equilibrium occurred in the (H) area in Figure 5. Unfortunately, the model described above can be used to show that the imposition of antidumping tariffs on the high-quality input cannot help the domestic input producer to sell its product to firm F if it was unable to do so in the absence of the duties. This result helps considerably in understanding the rationale for the U.S. firm's recent request to rescind the display screen tariffs.

To see that the display screen duty can do little to help domestic producers of the input in the model above, consider the effect of a (quality-deflated) tariff imposed on the high-quality input, t_I. Such a tariff serves to increase firm F's costs of producing the high-quality final good by increasing the cost of the critical input to $\gamma_H + t_I$. The tariff does nothing to alter F*'s costs of producing the high-quality good. Firm F is then at a cost disadvantage, relative to F*, if it desires to continue producing a high-quality product. Further, the imposition of such a tariff does nothing to alter the profits that would be earned by firm F when it chooses to produce a low-quality product, because the equilibrium cost and market share structures for both firms (F and F*) in such a case are identical to those in the absence of the tariff.

The ADMA argued that punitive duties should be assessed on the foreign screens in order to level the playing field in the display screen industry.

If the equilibrium is in area (H) in the absence of any antidumping duties, then firms F and F* both produce high-quality goods and earn zero profits. After the tariff, production of the low-quality final good is still not sensible for firm F because the reaction functions illustrated do not shift under a tariff on the high-quality input.[21] That is, the equilibrium cannot be moved from the (H) area into the (HL)

[21] The reaction functions do not shift under an input tariff because they illustrate behavior in an equilibrium in which F produces the low-quality good and F* produces the high-quality good. Neither firm's cost changes in such an equilibrium in the presence of an input tariff. The reaction functions would shift under a tariff on the final good, however. Such a tariff effectively raises the costs of the foreign final good firm and changes the position of the T_H reaction function. A subsidy provided to the domestic input producer would also change the equilibrium illustrated in Figure 4 by shifting the T_L reaction function. See Skeath (1993) for a more comprehensive analysis of these alternative policies.

area with only a simple input tariff. There *are* additional consequences of the tariff, however. With the tariff in place, firm F cannot earn even zero profits by producing the high-quality final good. The domestic firm is at a cost disadvantage relative to the foreign firm after the tariff so that if F* were to price at its marginal cost of γ_H, firm F would not be able to match that price without realizing a loss on each unit sold. In the presence of the antidumping duty, then, firm F is forced to withdraw from the market.[22] Without firm F in the market, the domestic input producer is left without a buyer for its product and must also withdraw.

Conclusion

The model described above provides significant insight into the actions of the various firms involved in the ADMA antidumping case. In any market where the producer of a low-quality input faces relatively high production costs, that producer may perceive the pricing behavior of a lower-cost foreign rival to constitute "unfair" competition. A request for punitive duties would then be a reasonable one for the "damaged" firm to make. Of course, as in the model and in the ADMA case, firms in other industries may be hurt by the imposition of such duties; the damage done to an interdependent industry may then be reflected onto the protected industry itself.

This type of scenario plays itself out in the model of quality-differentiated vertical trade presented here, and it apparently occurred in the case of the U.S. display screen industry as well. A producer of a low-quality input finds itself unable to encourage domestic demand for its product even when protected by a tariff on the rival, higher-quality input. The reasoning is seen clearly in the theoretical model; antidumping duties do not improve the profitability of the domestic final good producers when they use the domestic input in production. If the low-quality input was an unprofitable choice before the tariff, then it remains so after the tariff. Further, other related industries can be badly hurt by such duties. Despite the ADMA's original statements to the contrary, direct protection cannot, in a case such as this, guarantee the viability of an industry producing a low-quality input. In light of the model's results, it is not so surprising that the low-quality producer itself was the one to request an end to the protection on display screens, particularly if it was influenced by a business association with one of the laptop computer (final good) manufacturers.

The inability of the antidumping duty to adequately "protect" the viability of the display screen industry follows from the vertical relationship between that industry and the laptop industry itself. Other policy options available to governments, however, might be more useful in guaranteeing the survival of such an input industry. In particular, given the arguments of the laptop producers that the domestic input producers could provide neither the quality nor the quantity necessary to supply their needs, efforts to secure the future of the display screen industry might be directed at these specific aspects of the industry.

[22] In the case of the ADMA and American laptop producers, the final good producers chose to move their production facilities abroad in order to avoid the input cost increase without withdrawing completely from the market.

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