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COMPETITION IN QUALITY-DIFFERENTIATED PRODUCTS AND OPTIMAL TRADE POLICY

Winston W. CHANG and Jae-Cheol KIM*

Abstract. This paper examines a model of export rivalry between a developed and a newly industrializing country by highlighting two important trade problems: competition in product quality and the NIC's dependence on imported intermediate inputs. Assuming that a DC producer is the leader in setting prices, the paper analyzes the optimal strategies of the NIC producers and the two countries' optimal trade policies. It is shown that the optimal policy of the DC is non-interference and that of the NIC is to impose a tariff on imported intermediate inputs and/or a tax on its exports to counter the foreign monopoly power. The optimal rates are shown to depend on the cost and quality parameters.

I. INTRODUCTION

Recent literature on international trade with imperfect competition has shown many different results on optimal trade policy. These results appear to depend on assumptions concerning the behavior of firms (Cournot or Bertrand competition, for example), market structure (segmentation or integration), and industry structure (fixed number of firms or free entry). In a Cournot-duopoly model with a domestic and a foreign firm competing in the third market, Brander and Spencer (1985) showed that an export subsidy raises both the home firm's profits and its national welfare.[1] However, as Eaton and Grossman (1986) have pointed out, if the firms engage in Bertrand competition, the optimal policy should instead be an export tax. Another example of differing policy implications is in the case of consistent conjectures. In a duopoly model with quadratic costs and linear demands, Csaplar and Tower (1988) showed that the optimal policy, instead of being free trade as originally claimed by Eaton and Grossman (1986), should be an *ad valorem* export tax. Eaton and Grossman (1988) have added that if the specific tariff or subsidy is the instrument, then the optimal policy is free trade.

The structures of market and industry are also crucial in determining the optimal trade policy. For example, in a two-country Cournot oligopoly model with integrated markets, Markusen and Venables (1988) have shown that a specific import tariff raises a country's welfare when there is no entry, but has no effect on its welfare if there is free entry. However, in the case of segregated markets, a

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[1] Dixit (1984) considered a more general case in which there is domestic consumption of the products and showed that an export subsidy is optimal only when the number of domestic firms is not too large.

specific import tariff raises home welfare regardless of whether or not there is free entry.[2] They have also shown that a policy is more effective when markets are segregated than when they are integrated, and if the transport costs are small, it is more potent when there is a fixed number of firms than when there is free entry.

In this paper, we examine a model of trade with imperfect competition by considering the type of competition often encountered between a developed (DC) and a newly industrializing country (NIC). It is often the case that the latter's products are actually inferior or perceived to be inferior in quality by the consumers in the world markets. Moreover, the NIC often relies on the supply of sophisticated parts or intermediate inputs from the DC in order to produce its final good for exports. This has been pointed out in a cover story of the *Business Week*.[3] The present paper considers this aspect of imperfect competition by analyzing how the producers in both countries compete in the world markets and also by examining the optimal trade policies of the two countries.

To highlight this trade problem, we set up a simple model in which there is one traded intermediate input and two final goods which are quality-differentiated.[4] The NIC imports the intermediate input from the DC to produce its low quality product for export. Each country consists of a single producer competing in the world market. Assume that the DC and the NIC play two-stage games. In the first stage, both countries play a Nash game in policy parameters; in the second, the two producers play a Stackelberg game in light of the announced policies of their governments. The DC producer is assumed to be the leader in price setting and the NIC producer the follower. With the cost and quality parameters explicitly introduced, the paper derives the conditions for the existence of three product regimes: the high-quality, low-quality, and mixed regime (both qualities exist). After analyzing the optimal pricing behavior of the producers, the paper examines the optimal trade policies of the two countries. It will be shown that the optimal policy of the DC is non-intervention, because the DC producer is not only a monopoly in the production of intermediate input but also a leader in the pricing of the final product. On the other hand, the optimal policy of the NIC is in general a tariff on its imports of intermediate input or on its export of final product. The optimal rate will be shown to depend on the cost and quality parameters. In particular, it will be sown that as the NIC producer experiences a more disadvantageous situation in cost or quality competition, its government should accordingly reduce its optimal tariff rate. Finally, it will be shown that the optimal

[2] See also Venables (1985) and Horstmann and Markusen (1986) for the effect of entry on policy implications.

[3] See Helm (1985).

[4] In Chang and Kim (1987), a model of competition between a DC and a NIC was examined in which the latter has the option of producing two products: one with a medium quality requiring the use of imported intermediate inputs, and the other with a low quality requiring only domestically produced inputs. The DC produces the high quality product for a particular group of consumers while the NIC's products are demanded by another group of heterogeneous consumers. For the treatment of the theory of trade in middle products, see Either (1982), Sanyal and Jones (1982) and Helpman (1985).

product regime desired by the NIC producer may not be the same as the one chosen by its government.

Section II of the paper describes the model and analyzes the pattern of demand. Section III examines the leader-follower equilibrium. The optimal trade policies of the two countries are analyzed in Section IV. Finally, some concluding remarks are made in Section V.

II. THE MODEL

A. Consumers' Preference and Production Technology

Consider two competing countries, Country 1 (the DC) and Country 2 (the NIC) in their exports of quality-differentiated products to the common foreign markets, Country 3. Country 1 is technologically more advanced than Country 2 and produces a high quality final good and its intermediate input. Country 2 produces only a low quality product whose production requires the use of the intermediate input produced in Country 1. For simplicity, assume that each unit of the final products requires one unit of an intermediate input. Concerning the behavior of the firms, assume that Producer 1 is the price setter for its intermediate and final products. Given Producer 1's price choice, Producer 2 then determines the price of its final product. In other words, Producer 1 and Producer 2 play a Stackelberg game in which the former is the leader and the latter is the follower. For simplicity, assume that there is no domestic demand in the exporting countries and no domestic production in Country 3.

Without loss of generality, let the service rate of the low quality product to be equal to one and that of the high quality product to be k (>1) to ease notational complexity. A discriminating consumer in Country 3 is assumed to purchase only one unit of either of the final products. Even if the low quality product is cheaper in terms of the unit service cost, a consumer with strong preference for the service may still want to purchase the high quality product. Each consumer is differentiated by a real number t measuring his preference for the quality. These consumers are uniformly distributed with density one on the closed interval $[0, T]$ where $T>0$. Let P_j be the unit price of a product of quality j ($j=H, L$) paid by the consumers in Country 3. The two different utilities of the two products that a type t consumer obtains are[5]

$$U_H(t)=tk-P_H \qquad (1)$$
$$U_L(t)=t-P_L\,.$$

The reservation utility when a consumer is not buying the product is assumed to be zero.

Let us define t_H (t_L) the type of consumers who are indifferent between buying

[5] A more general utility function should include income as an argument. Here we stress the heterogeneity of consumers' tastes on quality and choose to neglect the income difference. The present form of the utility function has been used before by Wilson (1980) and Kim (1985).

and not buying the high (low) quality product, and t_M be the types of consumers who are indifferent between buying the high and low quality products. Using (1), we have

$$t_H=\frac{P_H}{k}, \quad t_L=P_L \quad \text{and} \quad t_M=\frac{P_H-P_L}{k-1}. \tag{2}$$

Assume that all products are produced at constant marginal and average costs. Below, we define the additional notation:

$\tilde{C}_L$: the unit production cost (tax and tariff inclusive) of the low quality product.

C_L: the unit production cost (tax and tariff inclusive) of the low quality product if the intermediate input *were* priced at foreign producer's cost.

C_H: the unit production cost (tax and tariff inclusive) of the high quality product.

τ_1 (τ_2): the rate of specific export tax (import tariff) on the intermediate input imposed by Country 1 (Country 2).

τ_H (τ_L): the rate of specific export tax on the high (low) quality product imposed by Country 1 (Country 2).

v: Producer 1's unit profit of producing the intermediate input.

From the definitions of C_L and v, we have[6]

$$\tilde{C}_L=C_L+v. \tag{3}$$

Since one unit of the intermediate input is required in the production of one unit of the low quality product, the effect of τ_2 and τ_L on the production and pricing structure of this product will be the same. Specifically, $\partial C_L/\partial\tau_2=\partial C_L/\partial\tau_L=1$; therefore, there is no need to distinguish the two types of tariff rates. Let $\tau=\tau_2+\tau_L$ and treat it as the choice variable of Country 2. The effect of a change in τ on $\tilde{C}_L$ is not yet clear because Producer 1 adjusts v in response to the change as we will discuss in Section III. Finally, note that $\partial C_L/\partial\tau_1=\partial C_H/\partial\tau_H=1$.

B. Pattern of Demand

Depending on the prices P_H and P_L, different patterns of consumption among consumers in Country 3 are observed. The H (L) regime refers to the case where the consumers purchase only the high (low) quality product while the M regime refers to the mixture case where both qualities are purchased. We will characterize each regime in terms of t_H, t_L, t_M and T. Let Z_H and Z_L be the amounts of the high and low quality products purchased by the consumers, respectively.

Consider first the case where $t_L<t_H$. It readily implies that $t_L<t_H<t_M$. If $t_M\geq T\geq t_L$, then, as shown in Fig. 1(a), only the L regime is observed so that $Z_H=0$ and $Z_L=T-t_L$. On the other hand, if $t_L<t_H$ but $T>t_M$, then consumers with

[6] Let C_H^0 (C_L^0) be the unit production cost of the high (low) quality product net of the cost of the intermediate input and its export tax, m be the unit cost of the intermediate input and q_1 (q_2) be the unit export (import) price of the intermediate input received (paid) by Producer 1 (2). Then, $C_H\equiv C_H^0+m+\tau_H$ and $C_L\equiv C_L^0+m+\tau_1+\tau_2+\tau_L=C_L^0+q_1-v+\tau_1+\tau_2+\tau_L=C_L^0+q_2+\tau_L-v\equiv\tilde{C}_L-v$.

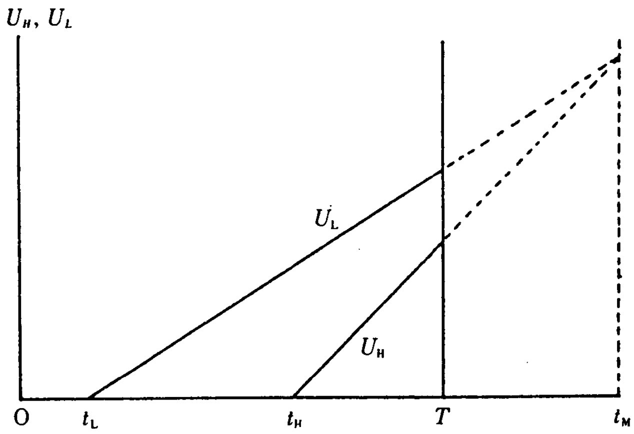

Fig. 1(a).

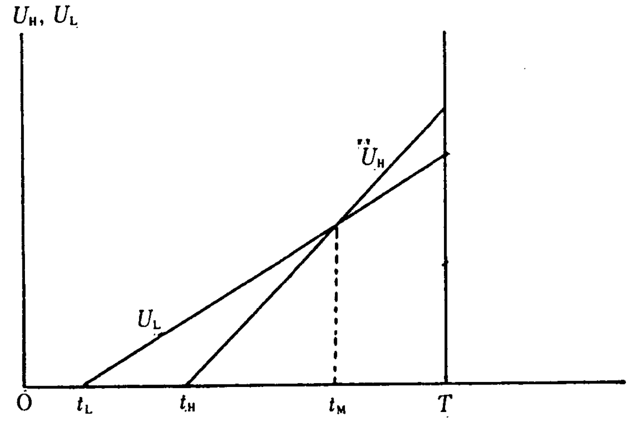

Fig. 1(b).

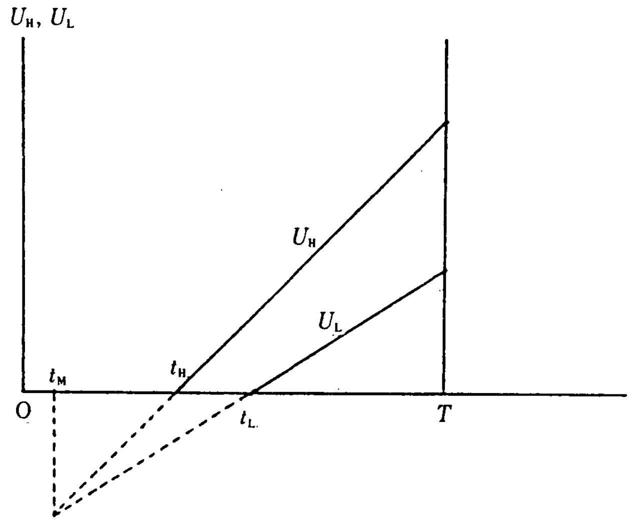

Fig. 1(c).

TABLE 1.

	L	M	H	No Purchase
	$t_L < t_H$ $t_L \leq T \leq t_M$	$t_L < t_H$ $t_M < T$	$t_H \leq t_L$ $t_H < T$	$T \leq t_L$ $T \leq t_H$
Z_H	0	$T - t_M$	$T - t_H$	0
Z_L	$T - t_L$	$t_M - t_L$	0	0

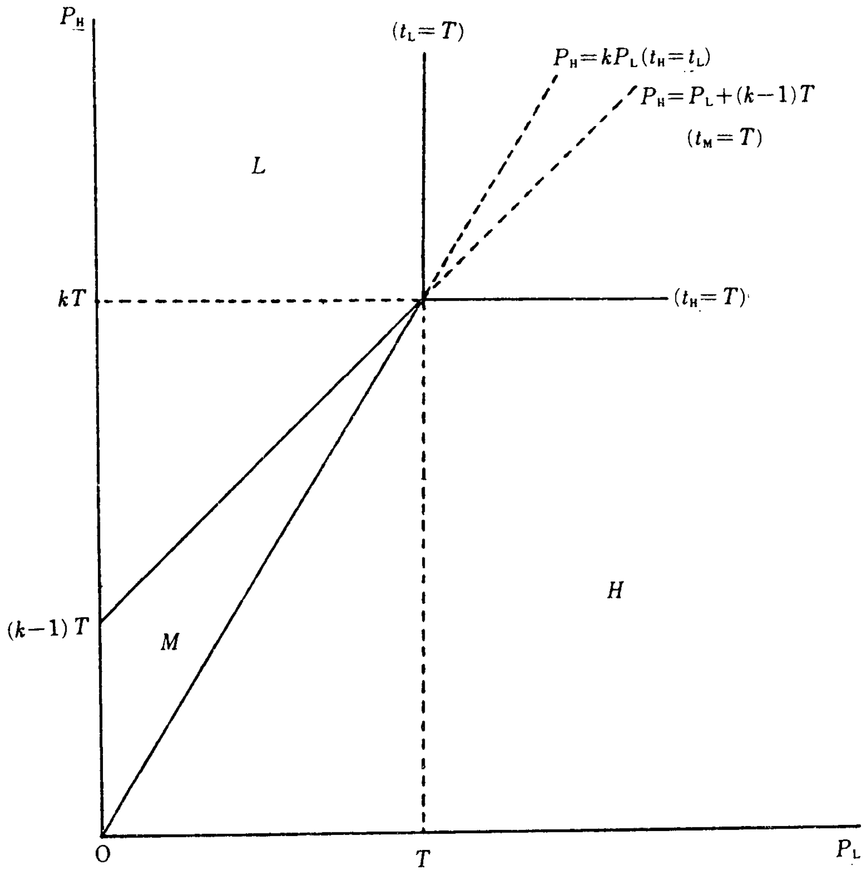

Fig. 2.

relatively high t's (between t_M and T) will purchase the high quality product while others (between t_L and t_M) buy the low quality product as shown in Fig. 1(b). As a result, the M regime is realized. In this case, $Z_H = T - t_M$ and $Z_L = t_M - t_L$. Consider next the case where $t_L \geq t_H$. We have $U_H \geq U_L$ for all $t \geq t_M$ as shown in Fig. 1(c); therefore, if $t_H < T$, only the H regime is realized. In this case, $Z_H = T - t_H$ and $Z_L = 0$. On the other hand, if $t_H \geq T$ and $t_L \geq T$, no consumers will buy either product. The above consideration exhausts all possibilities. The results are summarized in Table 1.

It is useful to characterize the demand patterns in the price plane. By analyzing the various regions for $U_H \gtreqless U_L$ and $U_j \gtreqless 0$ $(j=H, L)$, and using (2), we obtain Fig. 2 which further characterizes the demand patterns. If (P_L, P_H) lies in the north-east region of the point (T, kT), no products are demanded. For a good to be in demand, the price vector must be in one of the three regimes, H, M and L. If P_H is above the line $P_H = P_L + (k-1)T$, only the low quality product will be demanded. On the other hand, if $P_H < kP_L$, only the high quality product will be demanded. Finally, if the price vector lies in the triangle formed by the P_H axis and the two boundary lines $P_H = P_L + (k-1)T$ and $P_H = kP_L$, both qualities will be in demand. The two upward sloping boundaries must be excluded from the M regime—the upper one belongs to the L regime and the lower one to the H regime.

III. THE LEADER-FOLLOWER EQUILIBRIUM

In this section, we analyze the optimal behavior of Producer 1 and Producer 2 to establish a leader-follower equilibrium given tariff rates τ_1, τ_H and τ.

A. The Optimal Behavior of Producer 2

Given the price strategy of Producer 1, Producer 2 as a follower chooses (i) the demand regime and (ii) the price of the low quality product. We first consider the best reply in each demand regime and then combine these local best replied to find the global best reply. Let us define π_i^j to be the profits of Producer i in the j regime $(i = 1, 2$ and $j = H, L)$.

Consider first the M regime. The profits of Producer 2 are $\pi_2^M = (P_L - \tilde{C}_L)(t_M - t_L)$ which, upon substitution from (2) and (3), can be written as

$$\pi_2^M \equiv \pi_2^M(P_L : P_H, v) = \frac{(P_L - v - C_L)(P_H - kP_L)}{k-1} \tag{4}$$

π_2^M is strictly concave in P_L given P_H and v. Producer 2's best reply is obtained from $\partial \pi_2^M / \partial P_L = 0$:

$$P_L \equiv P_L(P_H, v) = \frac{P_H + k\tilde{C}_L}{2k}. \tag{5}$$

This is the line CD in Fig. 3.

In the L regime, Producer 2's profits are $\pi_2^L = (P_L - \tilde{C}_L)(T - t_L)$. We can similarly obtain the best reply from $\partial \pi_2^L / \partial \mathrm{P}_L = 0$:

$$P_L \equiv P_L(P_H, v) = \frac{T + \tilde{C}_L}{2}. \tag{6}$$

This is the vertical line AB in Fig. 3. In this regime, no high quality is produced and Producer 2 is the monopolist in the export market. Finally, in the H regime, no low quality is produced; therefore, any P_L is the best reply.

The global best reply $P_L = P_L(P_H : v)$ with a given v is shown in Fig. 3 by the

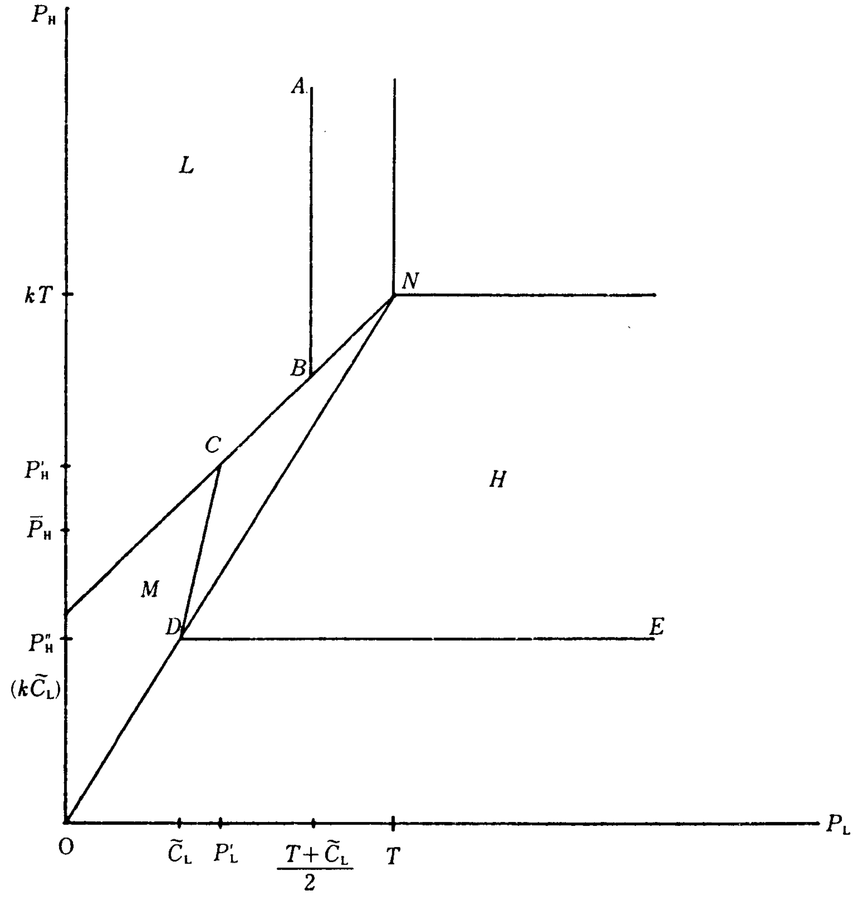

Fig. 3.

line $ABCDE$ and the shaded area, given the assumption that $T > \tilde{C}_L$.[7] The choice of P_L can now be globally illustrated. Suppose that with a given v, Producer 1 sets $P_H = \bar{P}_H$ as shown in Fig. 3. As long as it is in the region of L regime, profits will increase with P_L whenever $P_L < (T + \tilde{C}_L)/2$, but remain to be negative whenever $P_L < \tilde{C}_L$. This range of P_L therefore will not be chosen by Producer 2. As P_L is further increased and is now in the region of the M regime, profits will further increase with P_L until the best reply line CD is reached. Beyond that line profits decline and shrink to zero at the boundary of the M and H regime. Thus, given $P_H = \bar{P}_H$, P_L is chosen from the CD line at $P_L = (\bar{P}_H + k\tilde{C}_L)/2k$. If instead P_H is set by Producer 1 to be below point D (i.e., $P_H < P''_H = k\tilde{C}_L$), Producer 2 will incur losses if the low quality product is produced. The best reply therefore is to choose any P_L in the region below the line segment ODE that ensures the realization of the H regime. On the other hand, if P_H is set above point B, the optimal P_L is chosen from the line segment $AB\,(P_L = (T + \tilde{C}_L)/2)$, and only the L regime is realized. Finally, if P_H is set between points B and C, Producer 2's best reply is to choose a corresponding P_L from the line segment BC and the L regime is again

[7] If $T \leq \tilde{C}_L$, the low quality product is not viable. For it to be in demand, $U_L > 0$. Thus $t > P_L$ and $T > P_L$. If $T \leq \tilde{C}_L$, then $\tilde{C}_L > P_L$ and the producer must incur losses.

realized.[8]

B. The Optimal Behavior of Producer 1

We now examine the optimal behavior of Producer 1 given Producer 2's best reply described above. Let S_H and S_L be the utilities of a type T consumer if he *were* able to purchase the high and low quality products at their respective (tariff-inclusive) production costs. Thus S_H and S_L are the (potentially) maximum consumer surpluses of the two products if producers behaved in the perfectly competitive manner:

$$S_H \equiv kT - C_H, \quad S_L \equiv T - C_L. \tag{7}$$

In the H regime, $\pi_1^H = (P_H - C_H)(T - t_H)$. The usual monopolistic price and profits are

$$\hat{P}_H^H = \frac{kT + C_H}{2} = C_H + \frac{S_H}{2} \tag{8}$$

$$\hat{\pi}_1^H = \frac{S_H^2}{4k},$$

where ˆ denotes the optimized value while the superscript H represents the H regime. The same convention will be used for other regimes.

In the M regime, the profits of Producer 1 are

$$\pi_1^M \equiv \pi_1^M(P_H, v) = (P_H - C_H)(T - t_M) + v(t_M + t_L) \tag{9}$$

$$= (P_H - C_H)\left(T - \frac{P_H - P_L}{k-1}\right) + v\frac{P_H - kP_L}{k-1},$$

where $P_L = (P_H + k\tilde{C}_L)/2k$. The range of P_H in this regime must be between points C and D as shown in Fig. 3; namely, $P_H' > P_H > P_H''$, where $P_H' = k[\tilde{C}_L + 2(k-1)T]/(2k-1)$ and $P_H'' = k\tilde{C}_L$. Using P_H' and P_H'', π_1^M in (9) can be rewritten as

$$\pi_1^M = \frac{-(2k-1)(P_H - C_H)(P_H - P_H') + vk(P_H - P_H'')}{2k(k-1)}. \tag{9'}$$

π_1^M is a function of P_H and v since P_H' and P_H'' contain $\tilde{C}_L$ which is a function of v by (3). Differentiating π_1^M with respect to P_H and v gives

$$\partial\pi_1^M/\partial P_H = \frac{-2(2k-1)(P_H - P_H') - (2k-1)S_H + kS_L}{2k(k-1)} \tag{10}$$

$$\partial\pi_1^M/\partial v = \frac{2(P_H - P_H'') + S_H - kS_L}{2(k-1)}.$$

It can be shown that π_1^M is strictly concave in P_H and v. In view of (10), we can characterize Producer 1's optimal behavior in terms of S_H and S_L.

[8] It can be shown that point C lies below point B as long as $\tilde{C}_L < T$. In this case where $\tilde{C}_L = T$, all the three points B, C, and D move to the point N and there will be no low quality product.

Case 1: $S_H/S_L \leq k/(2k-1)$. In this case, $\partial \pi_1^M/\partial P_H > 0$ for any given $v \geq 0$ since $P_H < P'_H$. This implies that given v, $\pi_1^M < \lim \pi_1^M = \pi_1^L(P'_H, v)$ where the limit is taken as P_H approaches P'_H. The last equality follows from the fact that π_1 is continuous across the regimes; therefore, Producer 1 will not choose a P_H for the realization of the M regime. Since $\pi_1^L = v(T-P_L)$, we see that for any given v, π_1^L is maximized when P_H is set to force P_L to the lowest possible value in the L regime. As shown in Fig. 3, this P_H is $\hat{P}_H^L = P'_H$. Thus Producer 1's profits can now be written as

$$\pi_1^L(P'_H, v) = v(T-P'_L) \tag{11}$$

where $P'_L = \{k\tilde{C}_L + (k-1)T\}/(2k-1)$. The resulting optimal $\hat{v}$ can be found by solving $d\pi_1^L/dv = 0$:

$$\hat{v}^L = S_L/2\,. \tag{12}$$

The optimal profits $\hat{\pi}_1^L$, therefore, are

$$\hat{\pi}_1^L = \frac{kS_L^2}{4(2k-1)}\,. \tag{13}$$

Moreover, using the inequalities, $S_H/S_L \leq k/(2k-1)$ and $2k-1>1$, we find that $\hat{\pi}_1^L > \hat{\pi}_1^H = S_H^2/4k$. Therefore, we can conclude that Producer 1 chooses the L regime by setting $\hat{P}_H^L = P'_H$ where P'_H is evaluated at $v = S_L/2$.

Case 2: $S_H/S_L \geq k$. Given P_H, we have $\partial \hat{\pi}_1^M/\partial v > 0$. It follows that Producer 1 will keep on raising v whenever M is observed. This will lead to $P_L = \tilde{C}_L$ (i.e., $\pi_2^M = 0$). The limiting value of v which causes a switch from the M regime to the H regime can be solved from the two equations $P_L = \tilde{C}_L$ and $P_H = kP_L$, the latter being the lower boundary line of the M regime as shown in Fig. 2. The solution is $(P_H - kC_L)/k$. Therefore, given P_H, $\pi_1^M \leq \lim \pi_1^M = \pi_1^H(P_H, (P_H - kC_L)/k) \leq \hat{\pi}_1^H$ where the limit is taken as v approaches $(P_H - kC_L)/k$. Moreover, it is easy to show that $\hat{\pi}_1^H > \hat{\pi}_1^L$. As a result, the H regime is realized with profits $\hat{\pi}_1^H$. In this case, $\hat{v}^H$ must be set to insure $\hat{P}_H^H \leq k\tilde{C}_L = P''_H$, where $\hat{P}_H^H$ is given in (8). This implies that $\hat{v}^H$ must be set no less than $(\hat{P}_H^H - kC_L)/k$ to prevent Producer 2 from importing the intermediate input.

Case 3: $k/(2k-1) < S_H/S_L < k$. In this case, there exist interior solutions for v and P_H in the M regime. Solving $\partial \pi_1^M/\partial P_H = \partial \pi_1^M/\partial v = 0$ yields

$$\hat{v}^M = S_L/2 \tag{14}$$

$$\hat{P}_H^M = C_H + \frac{S_H}{2}\,.$$

As can be verified from Table 2, the optimal profits $(\hat{\pi}_1^M)$ are greater than both $\hat{\pi}_1^M$ and $\hat{\pi}_1^L$. Thus the M regime is chosen in this case.[9] Table 2 also summarizes

[9] Note that $\hat{\pi}_1^M$ is always greater than $\hat{\pi}_1^L$ and $\hat{\pi}_1^H$. This, however, does not mean that the M regime is always better than the other two regimes for Producer 1. When the conditions for Case 3, $k/(2k-1) < S_H/S_L < k$, do not hold, $\hat{\pi}_1^H$ is simply not realizable.

TABLE 2.

	$\frac{S_H}{S_L} \leqq \frac{k}{2k-1}$	$\frac{k}{2k-1} < \frac{S_H}{S_L} < k$	$k \leqq \frac{S_H}{S_L}$
	L	M	H
$\hat{v}$	$\hat{v}^L = S_L/2$	$\hat{v}^M = S_L/2$	$\hat{v}^H \geqq S_L - S_H/2k$
$\hat{P}_H$	$\hat{P}^L_H = C_H + S_H - kS_L/2(2k-1)$	$\hat{P}^M_H = C_H + S_H/2$	$\hat{P}^H_H = C_H + S_H/2$
$\hat{P}_L$	$\hat{P}^L_L = C_L + S_L/2 + (k-1)S_L/2(2k-1)$	$\hat{P}^M_L = C_L + S_L/2 + (kS_L - S_H)/4k$	—
$\hat{Z}_H$	$\hat{Z}^L_H = 0$	$\hat{Z}^M_H = \frac{(2k-1)S_H - kS_L}{4k(k-1)}$	$\hat{Z}^H_H = \frac{S_H}{2k}$
$\hat{Z}_L$	$\hat{Z}^L_L = \frac{kS_L}{2(2k-1)}$	$\hat{Z}^M_L = \frac{kS_L - S_H}{4(k-1)}$	$\hat{Z}^H_L = 0$
$\hat{\pi}_1$	$\hat{\pi}^L_1 = \frac{kS_L^2}{4(2k-1)}$	$\hat{\pi}^M_1 = \frac{S_H^2}{4k} + \frac{(kS_L - S_H)^2}{8k(k-1)}$	$\hat{\pi}^H_1 = \frac{S_H^2}{4k}$
$\hat{\pi}_2$	$\hat{\pi}^L_2 = \frac{k(k-1)S_L^2}{4(2k-1)^2}$	$\hat{\pi}^M_2 = \frac{(kS_L - S_H)^2}{16k(k-1)}$	$\hat{\pi}^H_2 = 0$

other results of the leader-follower equilibrium.

The preceding three cases completely characterize Producer 1's preferred choice of regimes. Our results reveal that the choice depends crucially upon k (the relative service or valuation rate of the two products) as well as S_H and S_L (the maximum potential consumers' surpluses of the two products generated in a competitive environment). When the relative maximum surplus of the high to low quality products, S_H/S_L, is no less than the relative valuation ratio k, the high quality product dominates the low one and the H regime emerges. However, the reversed inequality, $S_H/S_L < k$, does not necessarily result in a reversal to the L regime. The realization of the latter can only occur when the relative maximum surplus is sufficiently low ($S_H/S_L \leq k/(2k-1)$); otherwise it is optimal for Producer 1 to choose the M regime. These conditions can be interpreted from a different perspective. For example, the conditions for the realization of the H regime, $S_H/S_L > k$, is equivalent to $C_H/C_L < k$. If the *direct* cost ratio of the high to low quality products is less than the respective valuation ratio, the high quality product has a comparative advantage and Producer 1 will choose the H regime. On the other hand, if C_H is sufficiently high relative to C_L ($C_H \geq [kC_L + 2(k-1)kT]/$

$(2k-1))$, the low quality product will dominate the market and the L regime is chosen.

IV. THE OPTIMAL TARIFF POLICY

In this section, we examine the optimal tariff policies of both countries. Assume that both countries behave in the Nash way, knowing the optimal behavior of each producer. Since there is no domestic demand for the products, the social welfare of a country is the sum of producer's profits and tariff revenue.

A. Country 1

The social welfare function of Country 1 is given by

$$W_1 = \pi_1 + \tau_H Z_H + \tau_1 Z_L \tag{15}$$

where Z_H and Z_L in each regime are given in Table 2. Consider first the M regime. We note that $\partial\pi_1^M/\partial\tau_H = -Z_H^M$ and $\partial\pi_1^M/\partial\tau_1 = -Z_L^M$, which are direct consequences of the envelope theorem. Now, using the above results, we obtain

$$\frac{\partial W_1^M}{\partial\tau_H} = \tau_H\frac{\partial Z_H}{\partial\tau_H} + \tau_1\frac{\partial Z_L}{\partial\tau_H} \tag{16}$$

$$\frac{\partial W_1^M}{\partial\tau_1} = \tau_H\frac{\partial Z_H}{\partial\tau_1} + \tau_1\frac{\partial Z_L}{\partial\tau_1},$$

where $\partial Z_H^M/\partial\tau_H = -(2k-1)/4k(k-1)$, $\partial Z_L^M/\partial\tau_H = \partial Z_H^M/\partial\tau_1 = 1/4(k-1)$ and $\partial Z_L^M/\partial\tau_1 = -k/4(k-1)$. Note also that W_1^M is strictly concave in τ_H and τ_1. For the other two regimes, we utilize $\partial\pi_1^H/\partial\tau_H = -Z_H^H$ and $\partial\pi_1^L/\partial\tau_1 = -Z_L^L$ to obtain

$$\frac{\partial W_1^H}{\partial\tau_H} = \tau_H\frac{\partial Z_H}{\partial\tau_H} \tag{17}$$

$$\frac{\partial W_1^L}{\partial\tau_1} = \tau_1\frac{\partial Z_L}{\partial\tau_1}$$

where $\partial Z_H^H/\partial\tau_H = -1/2k$ and $\partial Z_L^L/\partial\tau_1 = -k/2(2k-1)$. W_1^H is strictly concave in τ_H and W_1^L is strictly concave in τ_1.

Now, suppose that for a given τ, the M regime is realized at $\tau_1 = \tau_H = 0$. Since W_1^M is strictly concave in τ_1 and τ_H, (16) implies that $\partial W_1^M/\partial\tau_H = \partial W_1^M/\partial\tau_1 = 0$ yields the optimal tariff policy $\tau_1 = \tau_H = 0$. Furthermore, W_1 is continuous across regimes. In view of (17), it is maximized at $\tau_1 = 0$ in the L regime and at $\tau_H = 0$ in the H regime. We can therefore conclude that $\tau_1 = \tau_H = 0$ is globally optimal. Similarly, we can argue for the cases where the H or the L regime is realized at $\tau_1 = \tau_H = 0$ and conclude that no intervention policy is the best for Country 1.[10]

[10] Depending on the regime, either one of τ_1 and τ_H is indeterminate. We simply assume that zero tariff is chosen by Country 1 in such cases.

B. Country 2

Knowing that Country 1 will not intervene, Country 2 determines the optimal tariff policy to maximize its social welfare. The social welfare function of Country 2 is given by

(18) $$W_2 = \pi_2 + \tau Z_L$$

Where Z_L in each regime is given in Table 2. It can be verified that $\partial\hat{\pi}_2^L/\partial\tau = -k(k-1)S_L/2(2k-1)^2 = -(k-1)\hat{Z}_L^L/(2k-1)$ and $\partial\hat{\pi}_2^M/\partial\tau = (S_H - kS_L)/8(k-1) = -\hat{Z}_L^M/2$. Using these results, we obtain

(19) $$\frac{\partial W_2^L}{\partial\tau} = \frac{k[kS_L^* - (3k-1)\tau]}{2(2k-1)^2}$$
$$\frac{\partial W_2^M}{\partial\tau} = \frac{kS_L^* - S_H^* - 3k\tau}{8(k-1)},$$

where S_H^* and S_L^* as the (potentially) maximum consumer benefits of the two goods if producers behaved in the perfectly competitive manner under free trade. Since $\tau_1 = \tau_H = 0$, we have $S_H^* = S_H$ and $S_L^* = S_L + \tau$.[11] Note that W_2 is continuous across the regimes. Moreover, W_2^M and W_2^L are strictly concave in τ. Let τ' be the value of τ such that $S_H/S_L = k/(2k-1)$. We have $\tau' = S_L^* - (2k-1)S_H^*/k$. Similarly, let τ'' be the value of τ such that $S_H/S_L = k$. This implies $\tau'' = S_L^* - S_H^*/k$. Thus τ' and τ'' establish the ranges of τ for the realization of the three regimes: If $\tau < \tau'$ for L, $\tau' < \tau < \tau''$ for M and $\tau'' \leq \tau$ for H.

In order to characterize the optimal policy of Country 2, it is useful to evaluate (19) at $\tau = \tau'$ and τ''. At $\tau = \tau'$,

(20) $$\frac{\partial W_2^L}{\partial\tau} = \frac{(3k-1)S_H^* - kS_L^*}{2(2k-1)}$$
$$\frac{\partial W_2^M}{\partial\tau} = \frac{(3k-2)S_H^* - kS_L^*}{4(k-1)};$$

and at $\tau = \tau''$, we have

(21) $$\frac{\partial W_2^M}{\partial\tau} = \frac{S_H^* - kS_L^*}{4(k-1)}.$$

The above three partial derivatives become zero when $S_H^*/S_L^* = k/(3k-1)$, $k/(3k-2)$ and k, respectively.

Case 1: $S_H^*/S_L^* \geq k$. Recall that W_2 is continuous across the regimes[12] and is strictly concave in τ. It increases with τ for $\tau < \tau''$ since $\partial W_2^L/\partial\tau > 0$ at $\tau = \tau'$ and $\partial W_2^M/\partial\tau \geq 0$ at $\tau = \tau''$. Thus W_2 reaches its maximum value of zero in the H regime

[11] Using (7) and referring to the notation defined in footnote 6, we have $S_H^* \equiv kT - (C_H^0 + m) = S_H + \tau_H$ and $S_L^* \equiv T - (C_L^0 + m) = S_L + \tau_1 + \tau$.

[12] This can be verified by using Table 2 and noting that $W_2^L = W_2^M$ at $\tau = \tau'$, since $\hat{\pi}_2^L = \hat{\pi}_2^M$ and $\hat{Z}_L^L = \hat{Z}_L^M$ at $\tau = \tau'$.

($\tau \geq \tau''$). The H regime, therefore, is the best one. Since $\tau'' < 0$ in this case, Country 2 must impose (in this case, merely post) a nonnegative tariff ($\tau \geq 0$) or a subsidy not exceeding τ'' ($0 > \tau > \tau''$) to insure the realization of this regime.

Case 2: $k/(3k-2) \leq S_H^*/S_L^* \leq k$. In this case, W_2 increases with τ for $\tau \leq \tau'$ and reaches its maximum at $\tau = (kS_L^* - S_H^*)/3k > 0$ where $\tau' < \tau < \tau''$. As a result,

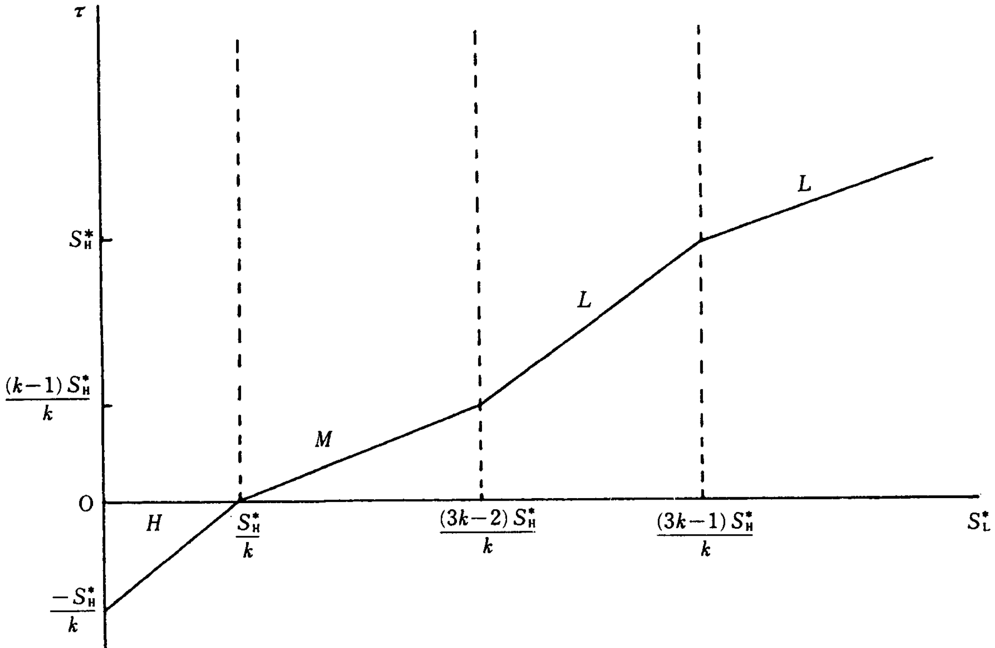

Fig. 4(a).

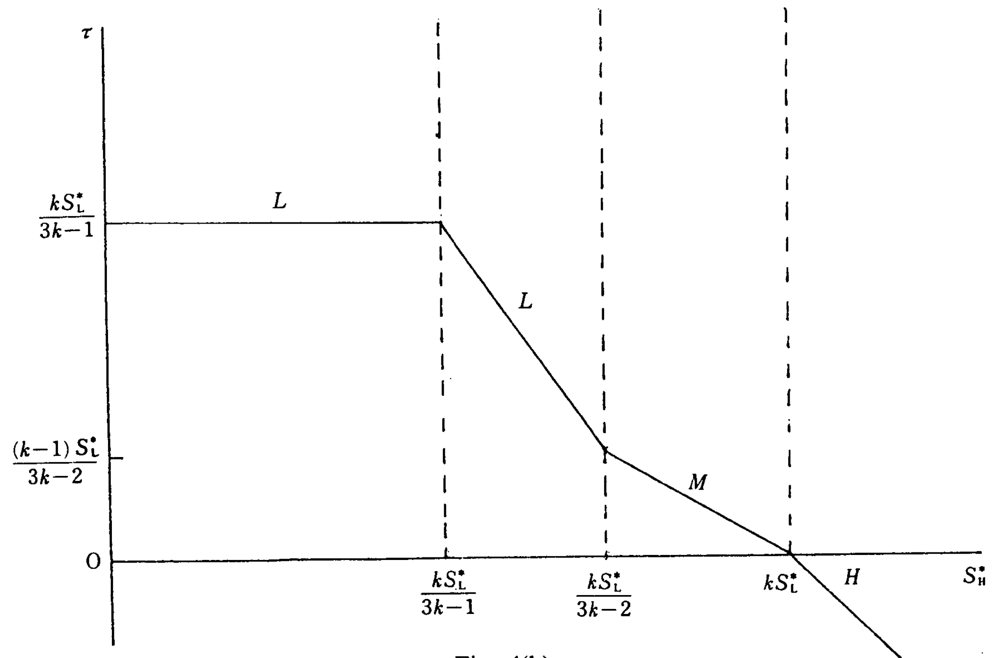

Fig. 4(b).

Country 2 must impose an import tariff on the intermediate input or an export tax on the low quality product to realize the M regime.

Case 3: $k/(3k-1)<S_H^*/S_L^*<k/(3k-2)$. In this case, $\partial W_2^L/\partial\tau>0$ and $\partial W_2^M/\partial\tau<0$ at $\tau=\tau'$. Therefore, W_2 reaches its maximum at $\tau=\tau'=[kS_L^*-(2k-1)S_H^*]/k>0$. The L regime is realized and Country 2 imposes a positive tariff to capture some rents from the foreign firm.

Case 4: $S_H^*/S_L^*<k/(3k-1)$. In this case, $\partial W_2^L/\partial\tau<0$ and $\partial W_2^M/\partial\tau<0$ at $\tau=\tau'$. Therefore, W_2 is maximized in the L regime at $\tau=kS_L^*/(3k-1)$. The tariff is again positive.

Note that the best reply of Country 2 in general calls for positive tariffs. Moreover, as shown in Figs. 4(a) and 4(b), τ is an increasing function of S_L^* and a nonincreasing function of S_H^*. This implies that as Producer 2 becomes less competitive in the export market, Country 2 must accordingly reduce its tariff rate.

Note also that the pattern of production and trade may be altered as a result of Country 2's strategic tariff policy. For example, if $k/(3k-2)<S_H^*/S_L^*<k/(2k-1)$, Producer 2 will choose the L regime under free trade, but Country 2's government will select the M regime.

V. CONCLUDING REMARKS

In this paper, we have constructed a model to highlight the important trade problems: competition in product quality and dependence on imported intermediate inputs. Our two-country model can be applied to competition between an advanced and a newly developing country. We have analyzed the optimal responses of the producers and the strategic tariff policies of the two rival countries. The optimal policy of the advanced country is non-intervention,[13] because of the monopolistic domination over the intermediate input. However, a tariff must be generally used by the NIC to counter the monopoly power of the DC. Such a rent extraction by an import tariff on the intermediate input or equivalently an export tax on final product is in line with the recent results dealing with optimal trade and industrial policy, even though the framework of analysis is quite different. Our producers' Stackelberg game chooses price rather than quantity competition, and is therefore a Bertrand duopoly.

We have shown that the optimal tariff rate is determined by the cost and quality parameters of both producers. It should vary inversely with domestic firm's degree of disadvantage against the foreign firm. Such degree of disadvantage is reflected through the following factors: the service (valuation) rates of the two products, their maximum consumers' surpluses, and their direct production costs. Moreover, we have shown that the producers' choice of regime is also determined

[13] There are a few future research areas where non-intervention of the DC government may have to be modified. Among them are situations where NIC and DC compete in DC markets, where prices are set in the Nash way, where the governments of both countries jointly maximize social welfare, and where the final products are strategically complements.

by these factors. However, given a cost and quality structure, the choice of regimes preferred by the government and the producers may be different.

Since subsidy is not optimal for the NIC in our present model, it seems somewhat inconsistent with the real world phenomenon. Many exporting firms in the NICs are in fact often subsidized. This may be the result of pursuing different objectives such as promotion of exports to reduce domestic unemployment, to gain foreign exchanges, or to support an infant industry.

The service rate of the low quality product was normalized to be one for the sake of simplicity. However, it is easy to generalize the model by explicitly recognizing the two absolute service rates. Let X_j $(j=H, L)$ be the service rate of the quality j product. The utility functions become $U_j = tX_j - P_j$ $(j=H, L)$. Analysis can be readily carried through with only some minor changes. Among them, S_j must be redefined as $TX_j - C_j$ $(j=H, L)$. By regarding k as X_H/X_L, the new profit and welfare functions are the old ones divided by X_L. The introduction of X_H and X_L allows the model to handle the effect of changing service rates on the pattern of trade. This may be due to a change in consumers' tastes or due to quality improvements which are usually tied to changes in the costs of production.

The present model can be further adapted to analyze changes in the patterns of trade over time. Assume that Country 1 has been exporting its products to Country 3 for a long period of time. As a result, consumers in Country 3 have enough information about the quality of the product through the past consumption experience. Suppose that Country 2 attempts to start entering the market with the product whose quality is virtually identical to that of Country 1. (namely, $X_H = X_L$ or $k=1$). Also suppose that $C_H > C_L$. The results in this paper show that Country 1's market would be taken over by Country 2 if the consumers knew that there was no quality difference. However, it is reasonable to assume that the consumers who have insufficient information about the new product perceive it to be lower in quality one or a "lemon". Let X_L^0 be the initial subjective quality measure of Country 2's product perceived by the consumers where $X_L^0 < X_L$. If $S_H^*/S_L^* < X_H/X_L^0$, Country 2 will start exporting. However, if $S_H^*/S_L^* > X_H/X_L^0$, it cannot export its product, and efforts will have to be made to change the consumers' perception of its product, possibly through advertising. As consumers can obtain more and more information about the new product quality through consumption or through Country 2's advertisement, the market share of Country 2's product is expected to increase. Eventually, it is possible that Country 1 is forced to produce only the intermediate input and the final product market is taken over by Country 2.

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