A Signaling Model of Quality and Export: with application to dumping*

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Abstract

Extending the literature on quality and trade and supported by the empirical evidence obtained from China, this paper demonstrates that in a developing country, a firm's export to developed countries has a potential signaling effect on domestic consumers' perception of its product quality. The model analyzes the signaling and imitating strategies of different types of firms in their decisions to export, and characterizes the conditions for the separating, pooling, and hybrid equilibria. Next, the analysis shows that the strategic exporting of low-quality producers under informational asymmetry can result in dumping. Moreover, the model shows that the implementation of antidumping measures of foreign countries can lead to a Pareto improvement for the firms and consumers of the home country under some circumstances.

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"*There is considerable evidence that quality variation is greater in underdeveloped than developed areas. .... Any comparison of the heterogeneity of quality in the street market (in India) and the canned qualities of the American supermarket suggests that quality variation is a greater problem in the East than in the West.*" Akerlof (1970, p.496)

1. Introduction

As illustrated in the above quotation, great variations in product quality are often widely observed in developing countries.[1] Motivated by this observation, the current paper provides an analysis of quality and trade under asymmetric information. The purposes of this paper are of two folds. First, by extending the original contributions of Bagwell and Staiger (1989), Bagwell (1991), and Shy (2000), we show that exporting to developed countries can potentially serve as a signaling mechanisms for high-quality producers in developing countries. Second, we provide a new model of dumping from a perspective of signaling/imitating.

The model considers two types of firms (A and B) in a developing economy. Type A firms produce high-quality goods, while Type B firms produce low-quality goods. Every firm faces a home market and a potential foreign market. In the home market of the developing country, a firm's type and its product quality are the firm's private information. However, there is generally much less asymmetric information about the quality of goods in the foreign market of developed countries, because of much better quality control, much stricter government regulations on product quality and information disclosure, and a much more developed legal system of consumer protection in developed countries.[2] Thus, if firms export, the quality of their products will to a large extent be revealed to foreign consumers. Consequently, a Type A firm would obtain a higher profit (or incur a smaller loss) than a Type B firm in the foreign market.

In line with Linder (1961), a number of recent studies demonstrate that individuals'

[1] See, for example, Rashid (1988) and Suri (1988) for some case studies in some developing countries and some countries in historical times.

[2] For example, in China, a developing country, food poison or even fake medicine that cause death or serious injury are a major concern (e.g. "China deaths blamed on rat poison," cnn.com, September 16, 2002; "Four killed after using spurious drug," *China Daily*, May 16, 2006). In the USA, in contrast, many pharmaceutical companies or even tobacco companies are sued and penalized for not providing enough information to consumers.

demand for quality increase with their incomes so that consumers' preference for high-quality goods is much stronger in developed countries than developing countries.[3] This literature implies that a firm's profit or loss in the foreign market significantly depends on its type (because the demand for low-quality goods is very low in developed countries). Then, the analysis shows that a firm's act of exporting can potentially serve as a signal to domestic consumers that it produces high-quality goods. For example, a Type A firm may want to distinguish itself from Type B firms by exporting, which may result in a separating equilibrium in which a firm exports if and only if it is of Type A. In such a case, a firm's type is revealed to domestic consumers, and consequently a Type A firm will obtain a higher profit and a Type B firm will obtain a lower profit in the domestic market. Also, a Type B firm may try to hide its type by imitating Type A firms through exporting, provided that its loss in the foreign market is small enough. If both types of firms export, then there will be a pooling equilibrium. In this case, domestic consumers cannot discern firms' types, and consequently Type B firms benefit at the expense of Type A firms in the domestic market. Further, the analysis reveals a hybrid equilibrium, in which Type A firms always export, while Type B firms randomize their decision whether to export or not. Under such a scenario, when Type B firms export, there will be a pooling equilibrium; when Type B firms do not export, there will be a separating equilibrium.

Next, based on the framework presented in the first part of this paper, we provide a new model of dumping. Its basic argument is as follows. Because consumers' preference for low-quality goods is weaker when their incomes are higher, the price elasticity with respect to product quality is much higher in developed countries than in developing countries. Thus, a firm that produces low-quality goods (i.e. a Type B firm), if it exports, will likely charge a price in the foreign market of the developed countries that is lower than its domestic price, which implies that a firm may engage in "dumping" (by the definition normally used in the existing literature). This can happen in a pooling equilibrium or a hybrid equilibrium of the model.

[3]For example, see Flam and Helpman (1987), Copeland and Kotwal (1996), Murphy and Shleifer (1997), Schott (2004), Fan (2005), Hummels and Klenow (2005), and Hallak (2006).

Moreover, since the revenues from exporting low-quality goods are low, a Type B firm is likely to suffer a loss in the foreign market. Therefore, the model implies that informational asymmetry between producers and consumers in a developing country is a possible source of dumping. If there were no informational asymmetry, a Type B firm would not export and hence "dumping" would not take place. However, when asymmetric information exists between firms and domestic consumers, a Type B firm will choose to export if its increased profit in the domestic market (resulting from the counter-signaling effect of exporting) is greater than the loss in the foreign market. Meanwhile, since low-quality products face a low demand in the foreign market, a Type B firm likely charges a foreign price that is lower that its domestic price, which results in "dumping". Thus, this paper provides a new model of dumping, which complements the existing literature. Moreover, we conduct an analysis of trade policy. The model shows that if antidumping policies of foreign countries are implemented in strict accordance with the definition of the WTO (as stated in economics textbooks) rather than politically motivated and manipulated, then they may have both positive and negative impacts on the welfare of the home country, depending on the parameter configurations of the model. In particular, it demonstrates that the implementation of antidumping measures of foreign countries can lead to a Pareto improvement for the firms and consumers of the home country under some circumstances.

In the remainder of this paper, Section 2 discusses the theoretical antecedents and presents some empirical evidence that motivates this theoretical analysis. Section 3 sets up the basic analytical framework. Section 4 investigates the signaling and imitating strategies of different types of firms and characterizes the conditions for the separating, pooling and hybrid equilibria under asymmetric information. Section 5 presents a new model of dumping and analyzes the new implications of antidumping policy. Section 6 summarizes the paper. Most of the mathematical proofs are provided in the Appendix.

2. Theoretical Antecedents and Empirical Motivation

2.1. Theoretical Antecedents

This paper is based on the received literature on quality and trade under asymmetric information. The pioneering studies of this literature are Bagwell and Staiger (1989) and Bagwell (1991), who examine the cases wherein a firm's product quality is imperfect information for foreign consumers. More recently, Shy (2000), to whom our paper is particularly closely related, extends Bagwell and Staiger (1989) and Bagwell (1991) from a one-country setting to a two-country setting. Shy (2000) examines a model in which a firm operates for two periods. In the first period, its product quality to known to neither domestic nor foreign consumers; in the second period, its product quality is revealed to all consumers. Also, Shy (2000) assumes that if a firm exports, it incurs a fixed cost of export and receives export subsidies from the government. Moreover, Shy (2000) assumes that the amount of export subsidies are proportional to a firm's value of overseas sales, which implies that the export subsidies that the firm receives increase with its product quality since a higher quality product yields a higher value of overseas sales (in the second period). Then, Shy (2000) shows that under some parameter configurations, a firm will produce high-quality goods if and only if it exports, which implies that export serves as a signal of high quality products to both domestic and foreign consumers. Shy (2000) also shows that the signaling effect of export does not exist if there is no export subsidy or if the export subsidy is determined by the quantity (rather than the value) of overseas sales.

The current paper extends Shy (2000) mainly in the underlying reasons for why export can serve as a signal of product quality. In Shy (2000), the underlying reason is that firms receive export subsidy and the export subsidy increases with a firm's export revenue. In contrast, export subsidy plays no role in our model. Instead, in our paper, the underlying reason for the signaling effect of export is that richer countries have more demand for high-quality products than poor countries and that a firm's product quality is much better revealed in developed countries than developing countries. In particular, the current paper is in line with the insight of Linder (1961) and incorporates some unique features of developing

countries, which have been abstracted from consideration in the received literature. As illustrated by the evidence presented in the next subsection and the literature listed in Footnote 3, the argument provided in the current paper has significant empirical relevance. Moreover, the new model of dumping provided in the second part of the paper, which highlights the strategic exporting (and often dumping) behavior of *low-quality* producers, further illustrates the difference between the first part of the current paper and Shy (2000).

2.2. Empirical Motivation

This subsection provides empirical support for our proposition that in a developing country, a firm's decision to export to the developed countries has a signalling effect on domestic consumers' perception of its products' quality. The evidence is obtained by observing an unusual characteristic of commercial advertising in China. Since the late 1980s, advertising has been popular in China, and has become the major channel for Chinese firms to convey valuable information, particularly about their product quality, to Chinese consumers.[4] Comparing advertisements in China with those in western countries, we observe that Chinese firms often, and unusually, stress that their products are exported to developed countries. Some examples are given below.

> (1) An air conditioner producer (Chuan Lan) claimed: "*We proudly announce that our air conditioners are exported to 22 countries in North America, Europe, and East Asia!*" (3/14/1994, Jin Ji Daily).
>
> (2) A rubber tire manufacturer (Hua Xiang) stated that their tires had obtained DOT standard certificate in the US and ECE standard certificate in Western Europe, and that their products were exported to many advanced countries (1/1/94, Jin Ji Daily).
>
> (3) A leather company (Lu Yu) claimed: "*Our company has established trading*

[4] In fact, since there were few well recognized national brands in the central planned economy in pre-reform China, Chinese firms might even have had more incentives than their western counterparts in utilizing advertisements to promote their products.

companies in Japan, the USA, France, Italy and Australia." (10/6/97, Jin Ji Daily)

(4) A cashmere sweater manufacturer (Er Duo Si) proudly declared: "*Our sweaters are warming the whole world*!" (12/7/97, Jin Ji Daily).

We have systematically surveyed the daily advertisements in the three most widely circulated national newspapers in China - People's Daily, Jin Ji Daily and Wen Hui Morning Post - between 1991 and 2000. We concentrated on the manufacturing industries, which were the main sources of China's exports. We divided the manufacturing industries into 18 sectors, based on the 2 digit international standard industrial classification (ISIC) code. We went through the classified sections of the three newspapers (of everyday for those 10 years), and recorded the total number of advertisements and the number of advertisements mentioning the exports of products to advanced countries for each sector. Then, we summarized the results to a monthly brief, yearly brief and finally to Table 1.

Table 1 is about here

As evidenced in Table 1, the proportion of the advertisements that refer to exporting to rich countries is high. For example, in the People's Daily, Jin Ji Daily and Wen Hui Morning Post, 32.0%, 28.5%, and 44.4% respectively of the advertisements for rubber products claimed export to rich countries. The percentage of firms claiming exports to rich countries varied across sectors, and might be proportional to the percentage of firms exporting in that sector.[5] In sum, the summary statistics support the view that it is a quite commonly used strategy as well as a source of great pride for firms to provide information on their exports if they have any.[6] These findings provide clear empirical support for our argument that, in a

[5]For example, the sectors of textile, apparel, leather products, wood products, rubber products, plastic products, fabricated metal products machinery and household electronic apparatus have high percentages of advertisements claiming exports. This is consistent with our expectations since China has had comparative advantage in world trade in these sectors.

[6]In fact, even when China was a planned economy before 1978, commodities labeled as "Chu Kou Zhuan Nei Xiao", meaning "originally exported products that are turned into domestic sales", were regraded as high-quality goods.

developing country, a firm's export to developed countries has a signaling effect on domestic consumers' perception of its products' quality.

3. The Basic Analytic Framework

We use the simplest model to highlight the essential idea of the paper. We consider a profit-maximizing firm (monopoly) that faces a home market and a potential foreign market. The firm always produces for the home market, but it may or may not sell its products in the foreign market.

3.1. The Home Market

In the home market, the demand function that the firm faces is

$$p = (1 + \lambda x)z - aq \tag{3.1}$$

where p and q are the price and the quantity demanded for its product in the home market, respectively; z and a are positive coefficients. The product can be of either low quality or high quality. x is the domestic consumers' perceived probability that the quality of the good is of high quality, λ is a positive coefficient. Clearly, the greater the probability that the good is of high quality, the more consumers are willing to pay. This implies that "p" and "x" are positively correlated.

The firm is one of two types: A and B. The firm produces high-quality goods if it is of Type A; and low-quality goods if Type B. For simplicity, we assume that other characteristics of the firm are the same regardless of its type. Specifically, we make the following assumptions: (1) The unit cost of production is constant regardless of the type of the firm, and is denoted by c. (2) The firm's type and its product quality are entirely the firm's private information in the home market.[7] As will be clear, these assumptions guarantee

[7] If we instead assume that the unit cost is higher for producing high-quality goods and/or that consumers may be able to obtain a prior belief about the product quality, then the optimal price that the firm charges in the domestic market would depend on the firm's type even in a pooling equilibrium. Consequently, similar to the logic of Bagwell and Staiger (1989) and Bagwell (1991), in this case the signals that a firm may use include not only exports but also the price charged in the domestic market, which drastically complicates the algebra and the analysis. Thus, we focus only on the most essential signaling strategy, in order to make the main point of the paper more clearly.

that exporting is the only possible signal about product quality that the firm may provide to its domestic consumers, which is the essence of this paper.[8] Further, we assume that the probability that the firm is of Type A is μ, and that the probability that the firm is of Type B is $1-\mu$. In our model, except for the firm's type and its product quality, all the other parameters in the domestic and foreign markets are common knowledge.

Based on the above description, we can express the firm's profit in the home market as follows:

$$[(1+\lambda x)z - aq]q - cq \tag{3.2}$$

We assume that $z > c$, which implies that the optimal solution of q is interior. Then, from the first order condition, we get the optimal solution of q as

$$\frac{(1+\lambda x)z - c}{2a}$$

Consequently, the firm's maximal profit in the home market is

$$\frac{[(1+\lambda x)z - c]^2}{4a} \tag{3.3}$$

3.2. Foreign Market

We will use $*$ to denote the variables and parameters associated with the foreign market. In the foreign market, the demand function that the firm faces is

$$p^* = (1+\lambda^* x^*)z^* - a^* q^* \tag{3.4}$$

where p^* and q^* are the price and the quantity demanded in the foreign market, respectively; z^* and a^* are positive coefficients. x^* is the foreign consumers' perceived probability that the product quality of the firm is of high quality, and λ^* is a positive coefficient. We focus

[8] For example, suppose that we consider that the unit cost of high-quality goods is higher than that of low-quality goods. In this case, the incentive for low-quality producers to signal their types to domestic consumers continue to exist. Meanwhile, it is possible for them to signal through exporting as long as two key assumptions of the paper hold that richer countries have more demand for high-quality products than poor countries and that a firm's product quality is much better revealed in developed countries than developing countries.

our analysis on the exports from the South to the North. Since the demand for low-quality products in the foreign market of the North is low, λ^* can be much larger than λ.[9]

The empirical literature based on firm-level data has consistently demonstrated that there exist fixed costs for a firm to export.[10] We denote the fixed cost by M.[11] Moreover, we consider that there is generally much less asymmetric information about the quality of goods in the foreign market of developed countries, because they have much better quality control, much stricter government regulations on product quality and information disclosure, and a much more developed legal system of consumer protection. To highlight this point, we might as well assume that in the foreign market, if the firm sells low-quality goods, then $x^* = 0$; if the firm sells high-quality goods, then $x^* = 1$.

Thus, if the firm produces low-quality goods, the price for its products in the foreign market will be

$$p^* = z^* - a^* q^* \tag{3.5}$$

Consequently, its profit in the foreign market will be

$$(z^* - a^* q^*)q^* - cq^* - M \tag{3.6}$$

We assume that $z^* > c$, which implies that the optimal solution of q^* is interior. Then, from the first order condition, we get the optimal solution of q^* as

$$\frac{z^* - c}{2a^*}$$

Hence, the firm's maximal profit in the foreign market will be

$$\frac{(z^* - c)^2}{4a^*} - M \tag{3.7}$$

[9]For example, Schott (2004, p.647) states: "*The unit values of U.S. manufacturing imports vary widely even within finely detailed product categories* (depending on the levels of quality).... *Across all U. S. manufacturing imports, the mean high-to-low unit value ratio in 1994 was 24. These differences occur within a single country; to put them in perspective, note that according to the* Economist*, the price of a Big Mac in 1999— across countries—varied by a factor of just 3.*"

[10]For example, see Roberts and Tybout (1997), Clerides, Lach, and Tybout (1998), Bernard, Eaton, Jensen, and Kortum (2003), and the survey by Tybout (2003). This literature explains that the fixed cost may arise because that a firm's selling abroad entails investigating foreign demand and competition, establishing marketing channels, and incurring other expenses.

[11]Note that the existence of the fixed cost implies that it is innocuous to assume that the signaling effect of export is independent of the amount of exported products.

If the firm produces high-quality goods, the price for its products in the foreign market will be

$$p^* = (1 + \lambda^*)z^* - a^*q^* \tag{3.8}$$

Consequently, its profit in the foreign market will be

$$[(1 + \lambda^*)z^* - a^*q^*]q^* - cq^* - M \tag{3.9}$$

From the first order condition, we get the optimal solution of q^* as

$$\frac{(1 + \lambda^*)z^* - c}{2a^*}$$

Hence, the maximum profit in the foreign market will be

$$\frac{[(1 + \lambda^*)z^* - c]^2}{4a^*} - M \tag{3.10}$$

To simplify our exposition, we make the following assumption throughout the paper:

$$\frac{(z^* - c)^2}{4a^*} < M \tag{3.11}$$

This assumption means that if the firm is of Type B, it will incur a loss in the foreign market by exporting.

The current model is on firm behavior under asymmetric information. However, at the outset of the analysis, it is useful to describe briefly the case of symmetric information, which means that both the firm and the domestic consumers know the type of the firm. In the absence of asymmetric information, from Assumption (3.11), we know that the firm will not export if it is of Type B. If the firm is of Type A, it will export if and only if

$$M < \frac{[(1 + \lambda^*)z^* - c]^2}{4a^*}$$

Now, for notational convenience, we define

$$\begin{aligned} \Gamma_B &\equiv \frac{(z^* - c)^2}{4a^*} \\ \Gamma_A &\equiv \frac{[(1 + \lambda^*)z^* - c]^2}{4a^*} \end{aligned}$$

Clearly, the greater is λ^*, the greater is $\Gamma_A - \Gamma_B$.

4. Quality and Export: A Signaling Perspective

4.1. Strategic Equilibria

This section analyzes firms' strategic behavior under asymmetric information. Based on Kreps and Wilson (1982), an equilibrium for this game is a collections of strategies and beliefs that satisfy sequential rationality and the Bayes' rule. In our model, the firm's type and its product quality are its private information in the home market. However, the firm can try to signal or counter-signal its type to domestic consumers. The signal that it can send to domestic consumers is whether to export or not. We assume that domestic consumers can observe whether the firm exports or not. However, they can not observe the price the firm sets or the quantity the firm sells in the foreign market.[12]

After observing the firm's export status, domestic consumers infer the value of "x" through the Bayes' rule, which determines the demand function facing the firm in the domestic market. Then, the firm chooses the optimal domestic price that maximizes its profit. In this model, we refine the set of sequential equilibrium based on the "intuitive criterion" of Cho and Kreps (1987). We therefore arrive at the following proposition, which characterizes the separating and pooling equilibria of the strategic interaction between the firm and domestic consumers.

Proposition 1: (1) *Suppose that*

$$\frac{\lambda z[(2+\lambda)z-2c]}{4a}+\Gamma_B < M < \frac{\lambda z[(2+\lambda)z-2c]}{4a}+\Gamma_A \tag{4.1}$$

Then, there is a unique separating equilibrium in which the firm will export if and only if it is of Type A.

(2) *Suppose that*

$$M < \frac{\lambda\mu z[(2+\lambda\mu)z-2c]}{4a}+\Gamma_B \tag{4.2}$$

[12]Note that this assumption is only to save algebra. As will be intuitively straightforward, the results of the model will materially hold if we instead assume that domestic consumers can only partially observe the price the firm sets or the quantity the firm sells in the foreign market. Thus, we might as well choose the simplest formulation, which significantly saves the algebra.

Then, there is a unique pooling equilibrium in which the firm will export regardless of its type.

(3) *Suppose that*

$$M > \frac{\lambda z[(2+\lambda)z - 2c]}{4a} + \Gamma_A \tag{4.3}$$

Then, there is a unique pooling equilibrium in which the firm does not export regardless of its type.

Proof. See Appendix.

Proposition 1 formalizes the idea that in a developing country, a firm's decision to export to rich countries can serve as a signal to domestic consumers about the quality of its products. Suppose that domestic consumers believe that the firm produces low-quality goods if it does not export. Then, the equilibria exist (under this belief) if the outcome is either that (i) the firm will export if and only if it is of Type A, or that (ii) the firm will export regardless of its type. The first case is a separating equilibrium, while the second case is a pooling equilibrium.

In Proposition 1, a crucial parameter is the fixed cost of export, M, whose role in international trade has been much emphasized in the empirical literature (e.g. the literature listed in Footnote 9). If M is sufficiently small such that (4.2) is satisfied, the firm will export regardless of its type, which leads to a pooling equilibrium. (In this paper, we only use strict inequality to describe the conditions (e.g. the above inequalities) to facilitate the discussions and comparisons.) If M becomes larger such that (4.1) is satisfied, the firm will export if and only if it is of Type A, which results in a separating equilibrium. If M is too larger such that (4.3) is satisfied, then the firm will not export, regardless of its type.

Further, noting that since $\mu < 1$, we have

$$\frac{\lambda\mu z[(2+\lambda\mu)z - 2c]}{4a} < \frac{\lambda z[(2+\lambda)z - 2c]}{4a}$$

Thus, when

$$\frac{\lambda\mu z[(2+\lambda\mu)z - 2c]}{4a} + \Gamma_B < M < \frac{\lambda z[(2+\lambda)z - 2c]}{4a} + \Gamma_B$$

then from the proof of Proposition 1 in the appendix, we know that in this case there will be neither a separating nor a pooling equilibrium. If domestic consumers believe that there is a separating equilibrium in which the firm will export if and only if it produces high-quality goods, then $x = 1$ if the firm exports and $x = 0$ if it does not. In this case, the firm will export even if it is of Type B, which contradicts the belief of a separating equilibrium. On the other hand, if domestic consumers believe that there is a pooling equilibrium in which the firm will export regardless of its type, then $x = \mu$ if the firm exports and $x = 0$ if it does not. In this case, the firm will not export if it is of Type B, which contradicts the belief of a pooling equilibrium. Therefore, the firm will adopt hybrid strategies, which leads to a hybrid equilibrium.

Based on the above reasoning, we have the following result.

Proposition 2: *Suppose that*

$$\frac{\lambda\mu z[(2+\lambda\mu)z - 2c]}{4a} + \Gamma_B < M < \frac{\lambda z[(2+\lambda)z - 2c]}{4a} + \Gamma_B \tag{4.4}$$

Then there is a hybrid equilibrium in which (1) if the firm is of Type A, it will export; (2) if the firm is of Type B, it will export with a certain probability, π^* $(0 < \pi^* < 1)$*, and will not export with a certain probability,* $1 - \pi^*$*.*

Proof. See Appendix.

With probability, π^*, the firm will export if it is of Type B. (From the proof in the appendix, we can see that π^* maximizes the firm's profit if it is of Type B in strategic equilibrium.) Thus, if domestic consumers observe that the firm exports, they will infer that the probability that the products are of high quality is

$$\frac{\mu}{\mu + (1-\mu)\pi^*} \tag{4.5}$$

Clearly, this probability decreases with π^*. With probability, $1-\pi^*$, the firm will not export if it is of Type B. In this case, domestic consumers will be able to infer accurately the firm's type if they observe that the firm does not export.

4.2. Losses and Gains in Strategic Equilibria

Section 4 studies a firm's strategic behaviors in a signaling and imitating game. Based on the results in the last section, we now analyze under what conditions, a firm will incur a loss in the foreign market. First, from Proposition 1, we have the following corollary.

Corollary 1: (1) *Suppose that the following condition is satisfied*

$$M < \min\{\Gamma_A, \frac{\lambda\mu z[(2+\lambda\mu)z - 2c]}{4a} + \Gamma_B\} \tag{4.6}$$

Then the firm will incur a loss in the foreign market if and only if it is of Type B.

(2) *Suppose that the following condition is satisfied*

$$\Gamma_A < M < \frac{\lambda\mu z[(2+\lambda\mu)z - 2c]}{4a} + \Gamma_B \tag{4.7}$$

Then the firm will incur a loss in the foreign market regardless of its type.

(3) *Suppose that the following condition is satisfied*

$$\max\{\frac{\lambda z[(2+\lambda)z - 2c]}{4a} + \Gamma_B, \Gamma_A\} < M < \frac{\lambda z[(2+\lambda)z - 2c]}{4a} + \Gamma_A \tag{4.8}$$

Then the firm will incur a loss in the foreign market if and only if it is of Type A.

Proof. See Appendix.

In relation to Corollary 1, several comments are in order. First, when Condition (4.6) is satisfied, we know from Proposition 1 that there exists a pooling equilibrium in which the firm exports regardless of its type. In this case, the firm (Type B) will choose to export even though it will incur a pure loss in the foreign market. However, by imitating the action of export, the firm (Type B) can hide its type from domestic consumers, which will increase its profit in the domestic market by the amount of

$$\frac{\lambda\mu z[(2+\lambda\mu)z - 2c]}{4a}$$

In this case, the "bad-type" firm imitates the behavior of the "good-type" firm.

Second, when Condition (4.1) is satisfied, there exists a separating equilibrium in which the firm exports if and only if it is of Type A. In this case, the firm (Type A) will choose to export even when

$$M > \Gamma_A$$

that is, the firm (Type A) will incur a pure loss in the foreign market. (Note that Condition (4.8) is the combination between Conditions (4.1) and $M > \Gamma_A$.) However, by exporting, the firm can signal to domestic consumers that its products are of high quality, which will increase its profits in the domestic market by the amount of

$$\frac{\lambda z[(2+\lambda)z - 2c]}{4a}$$

In this case, the "good-type" firm chooses to distinguish itself from the "bad type" even though it loses money in the foreign market.

Third, when Condition (4.2) is satisfied, there exists a pooling equilibrium in which the firm exports regardless of its type. In this pooling equilibrium, if $\Gamma_A < M$, then the firm will incur a pure loss in the foreign market even if it is of Type A. Thus, clearly, the firm would be better off by not exporting if domestic consumers do not have the belief that it produces low-quality goods if it does not export. In other words, when both (4.2) and $\Gamma_A < M$ are satisfied, which yields Condition (4.7), the pooling equilibrium is Pareto inefficient. Furthermore, from the proofs of Proposition 1 and Corollary 1 in the Appendix, we can see that this possible equilibrium cannot be eliminated by the "intuitive criterion" of Cho and Kreps (1987). Thus, in this case the firm's strategy of signaling and imitating in the domestic market leads to an outcome that is inefficient for domestic firms.

Next, from Proposition 2, we have the following corollary.

Corollary 2: (1) *Suppose that the following condition is satisfied*

$$\frac{\lambda\mu z[(2+\lambda\mu)z - 2c]}{4a} + \Gamma_B < M < \min\{\Gamma_A, \frac{\lambda z[(2+\lambda)z - 2c]}{4a} + \Gamma_B\} \tag{4.9}$$

Then the firm will not incur a loss in the foreign market if it is of Type A, while the firm will incur a loss in the foreign market with a certain probability, π^*, if it is of Type B.

(2) *Suppose that the following condition is satisfied*

$$\max\{\frac{\lambda\mu z[(2+\lambda\mu)z-2c]}{4a}+\Gamma_B,\Gamma_A\}<M<\frac{\lambda z[(2+\lambda)z-2c]}{4a}+\Gamma_B \tag{4.10}$$

Then the firm will always incur a loss in the foreign market if it is of Type A, while the firm will incur a loss in the foreign market with a certain probability, π^*, if it is of Type B.

Proof. See Appendix.

The intuitions of this corollary is similar to Corollary 1's.

4.3. A Simple Welfare Assessment

For simplicity, this paper does not specify a social welfare function explicitly, and hence it does not attempt to conduct a comprehensive and rigorous welfare analysis. Instead, in this section we simply discuss the intuitions of the welfare implications of the model.

From the previous analysis, we can see that if there is a separating equilibrium or a hybrid equilibrium, the quality of a product will be at least partially revealed to domestic consumers. In this case, clearly, domestic consumers will experience an increase in welfare. Also, if

$$\Gamma_A > M$$

then a Type A firm enjoys a positive profit in the foreign market. Thus, in this case, the signaling effect of exporting to the developed countries results in an increase in welfare for both domestic consumers and high-quality producers. Moreover, the recent literature of industrial organization (e.g. Ohkawa et al., 2005) shows that in an imperfectly competitive environment, the market selection may result in not only the wrong number of firms but also the wrong type of firms that survive, which decreases social efficiency and social welfare. This paper shows that exporting to the foreign market of developed countries can help the

domestic market select the more efficient firms (i.e. high-quality producers) in developing countries.

In relation to Akerlof's (1970) observation that quality uncertainty is much greater in developing than developed countries, this paper demonstrates that firms in developing countries can utilize the transparency of quality in developed countries to signal their product qualities to domestic consumers, which reduces the informational asymmetry about product quality between producers and consumers in the developing countries. Therefore, the current paper suggests that for developing countries, international trade not only can bring them the familiar benefits (for producers) of enhanced production efficiency from global specialization and international technological spillovers, but also may reduce the informational asymmetry about product quality for consumers and hence increase their welfare.

However, we also note that under some other circumstances, the strategic interactions will result in a pooling equilibrium, in which domestic consumers do not obtain any information from observing firms' export behaviors. Meanwhile, from the perspective of the whole economy, its firm's expected net profit in the foreign market is

$$\begin{aligned} & \mu(\Gamma_A - M) + (1-\mu)(\Gamma_B - M) \\ = \; & \mu\Gamma_A + (1-\mu)\Gamma_B - M \end{aligned} \tag{4.11}$$

Thus, this expected net profit in the foreign market will be positive if and only if μ and Γ_A are sufficiently large. In particular, if $\Gamma_A < M$, this expected profit will be negative. In such a case, firms' strategic actions of exporting to the foreign market will lead to an unambiguous decrease in social welfare of the home country.

5. A New Model of Dumping

The last half century has witnessed continuous and significant reductions in tariffs and quotas under the discipline of GATT/WTO.[13] But against this trend, antidumping measures

[13] For example, Bagwell and Staiger (2002, p.3) summarize: "*(T)hrough the eight rounds of GATT negotiations, the average ad valorem tariff on industrial goods has fallen from over 40% to below 4%. Over this period, GATT/WTO membership has also grown in number from 23 to now over 140 countries.*"

have proliferated, and have become the most effective tool of import restrictions. However, as highlighted by some leading textbooks of international trade,[14] several important questions as for the phenomenon of dumping have not been fully addressed. For example, are there any underlying reasons that a firm may usually charge a lower price in the foreign market than in the domestic market? Are firms from developing countries more likely to engage in dumping than firms from developed countries? Is it possible that antidumping measures can lead to an improvement in production efficiency and welfare for both home and foreign countries? This section attempts to provide a new model of dumping, which intends to complement the existing literature to yield new answers to these questions.

5.1. Dumping

Following most of the existing literature (e.g. Brander and Krugman, 1983; Markusen et al, 1995; Krugman and Obstfeld, 2003), we define dumping as follows.[15]

Definition 1: *A firm engages in dumping if and only if it charges a lower price in the foreign market than in the home market.*

Let p_i and p_i^* denote the prices that a firm of Type i (i = A or B) charges in the home market and the foreign market, respectively. Then, according to Definition 1, a firm dumps in the foreign market if and only if

$$p_i^* < p_i \ (i = A \text{ or } B)$$

In the following, we analyze how the firm's incentives to signal or imitate in the home market can result in its dumping behaviors in the foreign market that are consistent with the above definition. As in the existing literature (e.g. Brander and Krugman, 1983), to highlight our main points, in this subsection we consider the case in which there is no possibility that the foreign government imposes antidumping duties so that a firm's pricing decision is not

[14] For example, see Markusen et al. (1995) and Krugman and Obstfeld (2003).

[15] This definition is used by the WTO. For example, in the website of wto.org, it states: "If a company exports a product at a price lower than the price it normally charges on its own home market, it is said to be "dumping" the product."

affected by this possibility. Then, after we present the new model of dumping, in the next subsection we will discuss the implications of antidumping policies.

If the firm is of Type B, the price that it charges in the foreign market will be

$$p_B^* = z^* - a^* q^* = z^* - a^* \frac{z^* - c}{2a^*} = \frac{z^* + c}{2} \tag{5.1}$$

If the firm is of Type A, its optimal price in the foreign market will be

$$p_A^* = (1+\lambda^*)z^* - a^* q^* = (1+\lambda^*)z^* - a^* \frac{(1+\lambda^*)z^* - c}{2a^*} = \frac{(1+\lambda^*)z^* + c}{2} \tag{5.2}$$

Then, from Proposition 1, we have the following lemma.

Lemma 1: (1) *Suppose that (4.1) is satisfied such that the firm will export if and only if it is of Type A. Then, the firm will dump in the foreign market if and only if*

$$z^* < \frac{(1+\lambda)z}{1+\lambda^*} \tag{5.3}$$

(2) *Suppose that (4.2) is satisfied such that the firm will export regardless of its type. Then,* (i) *if the firm is of Type A, it will dump in the foreign market if and only if*

$$z^* < \frac{(1+\lambda\mu)z}{1+\lambda^*} \tag{5.4}$$

(ii) *if the firm is of Type B, it will dump in the foreign market if and only if*

$$z^* < (1+\lambda\mu)z \tag{5.5}$$

Proof. See Appendix.

It should be noted that the condition for that a Type A firm engages in dumping in a separating equilibrium is different from that in a pooling equilibrium. It is because in a separating equilibrium, a Type A firm sets a domestic price at the (rational) expectation that domestic consumers know its type; in a pooling equilibrium, a Type A firm sets a domestic price at the expectation that domestic consumers do not know its type. In others

words, the domestic price that a Type A firm sets in a separating equilibrium is different from that in a pooling equilibrium. Also, as shown in (5.2), the foreign price that a Type A firm sets in a separating equilibrium is the same as that in a pooling equilibrium. Therefore, the condition for a Type A firm engaging in dumping in a separating equilibrium is different from that in a pooling equilibrium.

Similar to Lemma 1 and the above reasoning, we now discuss the case in a hybrid equilibrium. First, we define

$$\rho \equiv \frac{\mu}{\mu + (1-\mu)\pi^*} \tag{5.6}$$

Then, from Proposition 2, we have the following lemma.

Lemma 2: *Suppose that (4.4) is satisfied such that there is a hybrid equilibrium in which if the firm is of Type A, it will export; if the firm is of Type B, it will export with a certain probability. Then, we have the following results:*

(i) *When the firm does not export if it is of Type B, a Type A firm will dump in the foreign market if and only if (5.3) is satisfied.*

(ii) *When the firm exports if it is of Type B, a Type A firm will dump in the foreign market if and only if*

$$z^* < \frac{(1+\lambda\rho)z}{1+\lambda^*} \tag{5.7}$$

and a Type B firm will dump in the foreign market if and only if

$$z^* < (1+\lambda\rho)z \tag{5.8}$$

Proof. See Appendix.

From Lemmas 1 and 2, obviously, we have the following proposition.

Proposition 3: (1) *If (4.2) and the following condition are satisfied,*

$$\frac{(1+\lambda\mu)z}{1+\lambda^*} < z^* < (1+\lambda\mu)z \tag{5.9}$$

then the firm will dump in the foreign market if and only if it is of Type B.

(2) *If (4.4) and*

$$\frac{(1+\lambda\rho)z}{1+\lambda^*} < z^* < (1+\lambda\rho)z \tag{5.10}$$

are satisfied, then the firm will dump in the foreign market with a certain probability, π^*, if and only if it is of Type B.

Proposition 3 emphasizes that the producers of low-quality goods are likely to engage in dumping if they choose to export. Since foreign consumers' willingness to pay increases substantially with an increase in product quality, from (3.4) it implies that the value of λ^* is large; since foreign consumers' willingness to pay is small for low quality goods (even when x^* is small), from (3.4) we know that the value of z^* is small.[16] Note that (5.9) and (5.10) are likely to be satisfied if λ^* is sufficiently large and z^* is sufficiently small. Therefore, because consumers' preference for low-quality goods is much weaker in developed countries than developing countries, a firm that produces low-quality goods (i.e. a Type B firm) is likely to charge a price in the foreign market of the developed countries lower than its domestic price, which means that the firm (Type B) may engage in "dumping".[17]

Moreover, recall that since there is a fixed cost of export and the revenues from exporting low-quality goods are low, a Type B firm suffers a loss in the foreign market. Therefore, Proposition 3 implies that informational asymmetry between producers and consumers in a developing country is a possible source of dumping. If there is no informational asymmetry, a Type B firm would not export and "dumping" would not take place. However, when asymmetric information exists between firms and domestic consumers, a Type B firm will choose to export (and consequently engage in "dumping") if its increased profit in the domestic market (resulting from the counter-signaling effect of exporting) is greater than

[16] For example, Schott (2004, p.647) states: "*The unit values of U.S. manufacturing imports vary widely even within finely detailed product categories* (depending on the levels of quality).... *Across all U. S. manufacturing imports, the mean high-to-low unit value ratio in 1994 was 24. These differences occur within a single country; to put them in perspective, note that according to the* Economist*, the price of a Big Mac in 1999— across countries—varied by a factor of just 3.*"

[17] Also, note that a Type B firm's act of export increases the domestic demand for its products and hence increases its domestic price, which further increases its likelihood of dumping.

the loss in the foreign market. Thus, this paper formalizes a new model of dumping, which complements the existing literature.

In addition, a few comments are in order as for Proposition 3. First, Part (1) of this proposition describes the case of continuous dumping, Part (2) presents a case of "sporadic" dumping.[18] Second, this proposition suggests that firms from developing countries have a further incentive to dump in foreign markets than firms from developed countries.[19] Third, it implies that if a firm from a developing country engages in "dumping" in a developed country, it may also truly suffer a loss in the foreign market. Finally, if anti-dumping policy is implemented strictly according to Definition 1 (rather than mainly politically motivated), then we would observe that higher-quality producers from developing countries are less likely to engage in "dumping".

5.2. Antidumping

In this subsection, based on the new model of dumping presented in Subsection 5.1, we examine the implications of antidumping policies. For simplicity, we now make the following assumptions: (1) antidumping policies are implemented strictly according to Definition 1; (2) if antidumping duty is imposed, then the antidumping duty is sufficiently high such that the firm will stop exporting. Then, from Proposition 3 and Corollary 1, we have the following corollary.

Corollary 3: (1) *Suppose that (4.2) and (5.9) are satisfied, then the implementation of*

[18] A number of important studies have analyzed theory of cyclical (or sporadic) dumping. For example, Ethier (1982), Das (1992), and Staiger and Wolak (1992) show that cyclical dumping arises due to fluctuations in demand in home and foreign markets and the firm's inability to fully adjust its output to these fluctuations. Proposition 3 provides an alternative explanation by suggesting that sporadic dumping can be a feature of a hybrid equilibrium. Thus, this result complements the existing literature.

[19] In fact, this result provides an explanation for why dumping from foreign firms was more of a concern in developed countries than in developing countries. Indeed, the use of antidumping measures was confined to a few most developed countries until the 1980s (e.g. Niels and ten Kate, 2004). More recently, antidumping measures have also been widely used by developing countries. However, this is probably because developing countries are increasingly aware that using antidumping policies is the most effective or even the only way to defend themselves against antidumping measures against them by developed countries (e.g. Prusa (2001), Aggarwal (2004)).

antidumping policy by the foreign country will reveal the type of the firm's product quality to the consumers of the home country.

(2) *Suppose that (4.7) and (5.4) are satisfied, then the implementation of antidumping policy by the foreign country will result in a Pareto improvement for the home country.*

(3) *Suppose that (5.3) is satisfied and*

$$\frac{\lambda z[(2+\lambda)z - 2c]}{4a} + \Gamma_B < M < \Gamma_A \tag{5.11}$$

then the implementation of antidumping policy by the foreign country will result in an unambiguous decrease in the welfare for the home country.

Proof. See Appendix.

Corollary 3 illustrates that antidumping measures imposed by foreign countries can have both positive and negative impacts on the welfare of the home country, depending on the parameter configurations of the model. (However, it should be emphasized that we assume that antidumping policies of foreign countries are implemented in strict accordance with the definition of the WTO (as stated in economics textbooks) rather than politically motivated and manipulated.) Parts (1) and (2) of this corollary analyze some positive impacts, while Part (3) examines some negative impacts.

Part (1) of this corollary suggests that in the case of a pooling equilibrium in which domestic consumers cannot distinguish a firm's type, the implementation of antidumping policy by the foreign country will deter a Type B firm from exporting under some circumstances, which will effectively turn a pooling equilibrium into a separating equilibrium. Consequently, domestic consumers will be able to correctly infer the quality of a product they purchase.

Part (2) of Corollary 3 yields a somewhat surprising result about the consequences of implementing antidumping policies. This result is related to the last part of Subsection 4.3, and its logic is as follows. When (4.7) is satisfied, the firm will export and incur a loss in

the foreign market regardless of its type if there is no antidumping measure. Also, if (5.4) is satisfied, an antidumping policy will apply to the firm regardless of its type,[20] which will result in that the firm stops exporting regardless of its type after the implementation of anti-dumping policy. Consequently, the firm faces the same domestic demand but does not have to incur the pure loss from engaging in strategic export, which implies that the firm will experience an increase in net profit regardless of its type. Moreover, domestic consumers are not affected by the firm's choice of not exporting in this case, because otherwise the firm would export regardless of its type, so that domestic consumers would also not be able to distinguish the firm's type and discern its product quality. Thus, in this case the firm's strategy of signaling and imitating in the domestic market through the act of exporting results in pure wastes. Therefore, the implementation of antidumping measures by the foreign government can eliminate the equilibrium in which the firm is caught in the "Prisoner's Dilemma" of strategic exporting. Consequently, it can lead to a Pareto improvement for the home country.

However, under some other parameter configurations, anti-dumping measures can reduce the welfare of the home country. For example, if the conditions in Part (3) of Corollary 3 are satisfied, without anti-dumping policy there is a separating equilibrium in which only the firms that produce high-quality goods export and make positive profits in the foreign market. However, the implementation of anti-dumping policy will turn the separating equilibrium into a pooling equilibrium, which reduces not only Type A firms' profits from export but also eliminates consumers' information about product quality in the domestic market. In this case, the home country will likely experience a significant decrease in social welfare.

6. Summary

Quality is a core issue in the study of international trade. In particular, as highlighted by Akerlof (1970), asymmetric information in the quality of goods between producers and consumers is widely observed in developing countries. The purposes of this paper are of

[20] Note that if (5.4) is satisfied, then clearly (5.5) will also be satisfied.

two folds. First, by extending the received literature, we show that exporting to developed countries can potentially serve as a signaling mechanisms for high-quality producers in developing countries. Second, we provide a new model of dumping based on the signaling model presented in this paper.

Drawing from the literature on quality and trade and supported by the empirical evidence obtained from China, we demonstrate that in a developing country, a firm's export to developed countries has a potential signaling effect on domestic consumers' perception of its product quality. This happens because the goods exported to rich countries are generally of high quality by poor country standards. The model considers two types of firms (A and B) in a developing economy. Type A firms produce high-quality goods, while Type B firms produce low-quality goods. In the home market of the developing country, a firm's type and its product quality are the firm's private information. However, there is generally much less asymmetric information about the quality of goods in the foreign market of developed countries. Thus, if firms export, the quality of their products will be largely revealed to foreign consumers. As a firm's profit or loss in the foreign market may significantly depend on its type, the analysis shows that a firm's act of exporting can potentially serve as a signal to domestic consumers that it produces high-quality goods. For example, even if a Type A firm incurs a loss in the foreign market, it may want to distinguish itself from Type B firms by exporting. Consequently, it would obtain a higher profit in the domestic market, which would outweigh its loss in the foreign market. Also, a Type B firm may try to hide its type by imitating Type A firms by exporting, provided that its loss in the foreign market is small enough. The model analyzes the signaling and imitating strategies of different types of firms, and yields three possible equilibria: a separating equilibrium, a pooling equilibrium and a hybrid equilibrium.

The second part of this paper derives a new model of dumping. Because consumers' preference for low-quality goods is much weaker in developed countries than developing countries, a firm that produces low-quality goods (i.e. a Type B firm) is likely to charge a price in the foreign market of the developed countries lower than its domestic price.

Moreover, since there is a fixed cost of export and the revenues from exporting low-quality goods are low, a Type B firm is likely to suffer a loss in the foreign market. Therefore, it implies that informational asymmetry between producers and consumers in a developing country is a possible source of dumping. If there is no informational asymmetry, a Type B firm would not export and "dumping" would not take place. However, when asymmetric information exists between firms and domestic consumers, a Type B firm will choose to export (and consequently engage in "dumping") if its increased profit in the domestic market (resulting from the counter-signaling effect of exporting) is greater than the loss in the foreign market. Thus, this paper presents a new model of dumping, which complements the existing literature.

Further, the analysis implies that if antidumping policies of foreign countries are implemented in strict accordance with the definition of the WTO rather than politically motivated, then they may have both positive and negative impacts on the welfare of the home country. For example, under some parameter configurations, a firm incurs a loss in the foreign market in the pooling equilibrium regardless of its type. In this case, firms' strategy of signaling and imitating results in pure waste for the home country. Thus, the implementation of antidumping measures by the foreign country may eliminate this equilibrium in which the firms of the home country are caught in the "Prisoner's Dilemma" of strategic exporting. Consequently, it can lead to a Pareto improvement for the firms and consumers of the home country. However, under some other parameter configurations, anti-dumping measures can reduce the welfare of the home country. For example, suppose that without anti-dumping policy there is a separating equilibrium in which only the firms that produce high-quality goods export and make positive profits in the foreign market. In this case, the implementation of anti-dumping policy will turn the separating equilibrium into a pooling equilibrium, which reduces not only high-quality producers' profits but also eliminates consumers' information about product quality in the domestic market. Consequently, the home country will likely experience a significant decrease in social welfare.

7. Appendix: Proofs

In the proofs of the appendix, recall that

$$\Gamma_A \equiv \frac{[(1+\lambda^*)z^* - c]^2}{4a^*}, \Gamma_B \equiv \frac{(z^* - c)^2}{4a^*}$$

Proof of Proposition 1.
Suppose that domestic consumers believe that the firm produces low-quality goods if it does not export. Then, the equilibria exist (under this belief) if the outcome is either that (i) the firm will export if and only if it is of Type A, or that (ii) the firm will export regardless of its type.

(**i**) Suppose that it is an equilibrium that the firm will export if and only if it is of Type A. Then, if the firm is of Type A, under such a belief, its total profit by engaging in export must be greater than that by not engaging in export; if the firm is of Type B, under such a belief, its total profit by engaging in export must be smaller than that by not engaging in export.

Under such a belief and in equilibrium, if the firm is of Type A, its profit is

$$\frac{[(1+\lambda)z - c]^2}{4a} + \frac{[(1+\lambda^*)z^* - c]^2}{4a^*} - M \tag{7.1}$$

if the firm is of Type B, its profit is

$$\frac{(z-c)^2}{4a} \tag{7.2}$$

If the firm chooses to deviate from the equilibrium when it is of Type A, we must have

$$\frac{[(1+\lambda)z - c]^2}{4a} + \frac{[(1+\lambda^*)z^* - c]^2}{4a^*} - M < \frac{(z-c)^2}{4a} \tag{7.3}$$

which can be reduced to

$$M > \frac{\lambda z[(2+\lambda)z - 2c]}{4a} + \frac{[(1+\lambda^*)z^* - c]^2}{4a^*} \tag{7.4}$$

If the firm chooses to deviate from the equilibrium when it is of Type B, we must have

$$\frac{[(1+\lambda)z - c]^2}{4a} + \frac{(z^* - c)^2}{4a^*} - M > \frac{(z-c)^2}{4a} \tag{7.5}$$

which can be reduced to

$$M < \frac{\lambda z[(2+\lambda)z - 2c]}{4a} + \frac{(z^* - c)^2}{4a^*} \tag{7.6}$$

Thus, when

$$\frac{\lambda z[(2+\lambda)z - 2c]}{4a} + \frac{(z^* - c)^2}{4a^*} < M < \frac{\lambda z[(2+\lambda)z - 2c]}{4a} + \frac{[(1+\lambda^*)z^* - c]^2}{4a^*} \tag{7.7}$$

the firm will not deviate from the equilibrium regardless of its type. In this case, there exists a separating equilibrium in which the firm exports if and only if it is of Type A.

(**ii**) Suppose that it is an equilibrium that the firm will export regardless of its type. In this case, domestic consumers do not have complete information of the firm' product quality. Recall that it is common knowledge that the probability that the firm is of Type A is μ. Then, domestic consumers' belief (via Bayes' rule) that the firm's product quality is of high quality will be $x = \mu$. In this case, if the firm is of Type A and it is in equilibrium, its total profit will be

$$\frac{[(1+\lambda\mu)z - c]^2}{4a} + \frac{[(1+\lambda^*)z^* - c]^2}{4a^*} - M \tag{7.8}$$

Similarly, if the firm is of Type B and it is in equilibrium, its total profit will be

$$\frac{[(1+\lambda\mu)z - c]^2}{4a} + \frac{(z^* - c)^2}{4a^*} - M \tag{7.9}$$

If the firm chooses to deviate from the equilibrium when it is of Type A, we must have

$$\frac{[(1+\mu\lambda)z - c]^2}{4a} + \frac{[(1+\lambda^*)z^* - c]^2}{4a^*} - M < \frac{(z-c)^2}{4a} \tag{7.10}$$

namely

$$M > \frac{\lambda\mu z[(2+\lambda\mu)z - 2c]}{4a} + \frac{[(1+\lambda^*)z^* - c]^2}{4a^*} \tag{7.11}$$

If the firm chooses to deviate from the equilibrium when it is of Type B, we must have

$$\frac{[(1+\lambda\mu)z - c]^2}{4a} + \frac{(z^* - c)^2}{4a^*} - M < \frac{(z-c)^2}{4a} \tag{7.12}$$

namely

$$M > \frac{\lambda\mu z[(2+\lambda\mu)z - 2c]}{4a} + \frac{(z^* - c)^2}{4a^*} \tag{7.13}$$

Thus, if

$$M < \frac{\lambda\mu z[(2+\lambda\mu)z - 2c]}{4a} + \frac{(z^* - c)^2}{4a^*} \tag{7.14}$$

the firm will not deviate from the equilibrium regardless of its type. In this case, there is a pooling equilibrium in which the firm export regardless of its type.

Moreover, from the above proof, it is easy to see that if

$$M > \frac{\lambda z[(2+\lambda)z - 2c]}{4a} + \frac{[(1+\lambda^*)z^* - c]^2}{4a^*} \tag{7.15}$$

then the firm will not export regardless of its type. Namely, in this case, there will be a pooling equilibrium in which the firm does not export regardless of its type and domestic consumers believe that $x = \mu$.

Finally, we try to prove that those equilibria are unique (under the mutually exclusive technique conditions). The equilibrium in Part (3) of the proposition is obviously unique. To prove the uniqueness of the equilibria in Parts (1) and (2) of the proposition, we only need to prove the equilibria resulting from the belief that domestic consumers believe that

the firm produces low-quality goods if it exports can be eliminated by utilizing the "intuitive criterion" of Cho and Kreps (1987) when

$$M < \frac{\lambda z[(2+\lambda)z - 2c]}{4a} + \frac{[(1+\lambda^*)z^* - c]^2}{4a^*} \tag{7.16}$$

The belief that domestic consumers believe that the firm produces low-quality goods if it exports can also results in a Nash equilibrium in which the firm does not export regardless of its type. Under this belief and if it is in equilibrium, the firm's profit (regardless of its type) will be

$$\frac{[(1+\mu\lambda)z - c]^2}{4a} \tag{7.17}$$

Clearly, the firm will not deviate from the equilibrium if it is of Type B. If it is of Type A and if it exports, its total profit will be

$$\frac{(z-c)^2}{4a} + \frac{[(1+\lambda^*)z^* - c]^2}{4a^*} - M \tag{7.18}$$

Thus, the firm (Type A) will not deviate from the equilibrium if

$$\frac{(z-c)^2}{4a} + \frac{[(1+\lambda^*)z^* - c]^2}{4a^*} - M < \frac{[(1+\mu\lambda)z - c]^2}{4a} \tag{7.19}$$

namely

$$M > \Gamma_A - \frac{\mu\lambda z[(2+\mu\lambda)z - 2c]}{4a} \tag{7.20}$$

In other words, even if the firm can make a positive profit in the foreign market (i.e. $M < \Gamma_A$), it can still be a Nash equilibrium that the firm does not export regardless of its type. However, this equilibrium cannot satisfy the "intuitive criterion" of Cho and Kreps (1987). This is because if the firm is of Type B, it will be worse off by deviating from the equilibrium under any circumstance. However, if it is of Type A, it may have an incentive to deviate. Thus, if domestic consumers observe that the firm deviates from the equilibrium by exporting, they can infer that the firm must be of Type A. In other words, this equilibrium cannot survive the "intuitive criterion" of Cho and Kreps (1987), and hence can be eliminated. ■

Proof of Proposition 2.
In a hybrid equilibrium, the firm randomizes its decision whether to export or not if it is of Type B. We denote the probability that the firm (Type B) will export by π. Then, with probability, $1-\pi$, it will not export if it is of Type B. In this case, it is a separating equilibrium, and the firm's (Type B) total profit will be

$$\frac{(z-c)^2}{4a} \tag{7.21}$$

With probability, π, it will export if it is of Type B. In this case, it is a pooling equilibrium, in which the domestic consumers will infer that the probability that the firm is of Type A is

$$\frac{\mu}{\mu + (1-\mu)\pi}$$

Then, the firm's profit in the domestic market will be

$$\frac{[(1+\frac{\lambda\mu}{\mu+(1-\mu)\pi})z-c]^2}{4a} \tag{7.22}$$

Thus, if it is of Type B, its total expected profit will be

$$\pi\frac{(z-c)^2}{4a}+(1-\pi)\{\frac{[(1+\frac{\lambda\mu}{\mu+(1-\mu)\pi})z-c]^2}{4a}+\frac{(z^*-c)^2}{4a^*}-M\} \tag{7.23}$$

The optimal choice of π is determined by maximizing (7.23) subject to the constraint $\pi \in [0,1]$. Since (7.23) is a continuous function of π, and $[0,1]$ is a compact set, the optimal solution of π, which we denote by π^*, must exist. Further, π^* can be obtained by solving the first order condition of (7.23), which is as follows

$$\begin{aligned} & \frac{(z-c)^2}{4a}-\{\frac{[(1+\frac{\lambda\mu}{\mu+(1-\mu)\pi})z-c]^2}{4a}+\frac{(z^*-c)^2}{4a^*}-M\} \\ & -(1-\pi)\{\frac{\lambda z[(1+\lambda\frac{\lambda\mu}{\mu+(1-\mu)\pi})z-c]}{2a}\frac{\mu(1-\mu)}{[\mu+(1-\mu)\pi]^2}\} \\ = \; & 0 \end{aligned}$$

■

Proof of Corollary 1.

(1) When (4.2) is satisfied, the firm will export regardless of its type. Recall that Assumption (3.11) implies that if the firm is of Type B, its exporting will result in a pure loss. Meanwhile, if $\Gamma_A > M$, then the firm will make a positive profit in the foreign market if it is of Type A. The combination between (4.2) and $\Gamma_A > M$ yields (4.6).

(2) When (4.2) is satisfied, the firm will export regardless of its type. Then, the firm will incur a loss in the foreign market if it is of Type B. Meanwhile, (4.1) indicates that if the firm is of Type A, it will also incur a pure loss in the foreign market if $\Gamma_A < M$. The combination between (4.2) and $\Gamma_A < M$ yields (4.7).

(3) When (4.1) is satisfied, the firm will export if and only if it is of Type A. Meanwhile, (4.1) indicates that the firm (Type A) incurs a pure loss in the foreign market. The combination between (4.1) and $\Gamma_A < M$ yields (4.8). ■

Proof of Corollary 2.

(1) When (4.4) is satisfied, there will be a hybrid equilibrium in which the firm will incur a loss in the foreign market with a certain probability, π^*, if it is of Type B. Meanwhile, if $\Gamma_A > M$, then the firm will make a profit in the foreign market if it is of Type A. The combination between (4.4) and $\Gamma_A > M$ yields (4.9).

(2) $\Gamma_A < M$ indicates that the firm (Type A) incurs a pure loss in the foreign market. Meanwhile, the firm will suffer a loss in the foreign market with a certain probability, π^*, if it is of Type B. The combination between (4.4) and $\Gamma_A < M$ yields (4.10). ■

Proof of Lemma 1. (1) Suppose that (4.1) is satisfied such that the firm will export if and only if it is of Type A. In this case, the firm's type is revealed to domestic consumers and hence it charges the following price in the domestic market

$$\frac{(1+\lambda)z+c}{2}$$

Thus, by Definition 1, the firm dumps in the foreign market if and only if

$$\frac{(1+\lambda^*)z^*+c}{2} < \frac{(1+\lambda)z+c}{2}$$

namely

$$(1+\lambda^*)z^* < (1+\lambda)z$$

that is, Inequality (5.3) is satisfied.

(2) Suppose that (4.2) is satisfied such that the firm will export if and only if regardless of its type. In this case, the firm's type is not revealed to domestic consumers and hence it charges the following price in the domestic market (regardless of its type)

$$\frac{(1+\lambda\mu)z+c}{2}$$

Thus, by Definition 1, we have the following results. (i) If the firm is of Type A, it dumps in the foreign market if and only if

$$\frac{(1+\lambda^*)z^*+c}{2} < \frac{(1+\lambda\mu)z+c}{2}$$

namely

$$z^* < \frac{(1+\lambda\mu)z}{1+\lambda^*}$$

(ii) If the firm is of Type B, it dumps in the foreign market if and only if

$$\frac{z^*+c}{2} < \frac{(1+\lambda\mu)z+c}{2}$$

namely

$$z^* < (1+\lambda\mu)z$$

■

Proof of Lemma 2. The proof of this lemma is similar to that of Lemma 1. ■

Proof of Corollary 3.

The proofs of Parts (1) and (2) of this corollary are obvious.

As for Part (3), noting that if (5.11) is satisfied, the (4.1) will be satisfied. The rest of the proof is trivial. ■

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Table 1. Percentage of Advertisements That Refer to Exporting to Advanced Countries

Sectors	Percent of Advertisements Claiming Exports to Advanced Countries					
	People's Daily		**Jin Ji Daily**		**Wen Hui Morning Post**	
	1991-2000	1991-1996	1991-2000	1991-1996	1991-2000	1991-1996
Textile Industry	14.34	12.27	5.95	7.94	10.91	16.67
Garments and Other Fiber Products	9.27	6.79	12.83	21.39	5.95	9.92
Leather, Furs, Down and Related Products	18.89	16.67	14.58	10.00	0.70	1.75
Timber Processing, Bamboo, Cane, Palm Fiber and Straw Products	4.06	2.38	6.25	0.00	0.00	0.00
Papermaking and Paper Products	3.57	8.33	3.13	5.00	16.67	16.62
Raw Chemical Materials and Chemical Products	7.94	5.54	7.62	9.04	3.18	1.60
Medical and Pharmaceutical Products	2.39	2.83	2.42	4.03	3.65	6.09
Rubber Products	32.02	45.83	28.52	34.44	44.48	44.44
Plastic Products	4.76	0.00	8.33	0.00	50.00	0.00
Nonmetal Mineral Products	15.22	11.85	0.00	0.00	0.50	0.83
Metal Products	13.37	6.60	0.96	1.60	0.00	0.00
Ordinary Machinery	5.74	4.20	6.80	9.45	2.59	3.89
Special Purpose Equipment	13.34	16.95	4.47	5.60	2.35	2.74
Transport Equipment	2.41	1.73	1.02	0.77	1.67	0.79
Electric Equipment and Machinery, except Household Electronic Apparatus	1.80	0.86	19.37	20.78	7.69	12.82
Household Electronic Apparatus	11.07	2.97	6.47	4.08	10.98	6.43
Electronic and Telecommunications Equipment	4.81	1.82	0.41	0.68	3.25	5.31
Instruments, Meters, Cultural and Office Machinery	1.15	0.21	4.45	6.06	2.90	2.25