

# Quality, Reputation, and Imports

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## Abstract

This paper develops a model of how firms determine the quality of their output in a setting of asymmetric information. In this framework, the few lowest-cost firms produce high quality output and the rest produce at low quality due to a free-rider problem. The presence of imports exacerbates this problem.

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This paper applies previous models on reputation and quality to a situation where consumers do not observe product quality until after purchase and they do not know which producer produced the good or whether the good was imported. The motivation for this model comes from recent efforts to regulate the fresh produce industry, whether by government or by industry self-policing, to reduce the likelihood of outbreaks of food borne illnesses.

In his famous study, Akerlof (1970) demonstrates how asymmetric information between buyers and sellers on the quality of a good in a one-shot game can lead to adverse selection and market failure. One solution to the problem of adverse selection is a minimum quality standard (Leland 1979). This increases the average quality of goods on the market and can increase overall welfare. In a repeated game, firms may have an incentive to provide higher quality due to reputation. Shapiro (1983) shows that even firms in a perfectly competitive industry can earn positive profits (a "quality premium") through consistently providing high-quality goods. The model depends on consumers being able to identify which firm produced the good. Falvey (1989) adds foreign trade to the model and shows that labeling of a product's origin can improve welfare without the disadvantages of tariffs or other trade barriers. Bond (1984) applies foreign trade to a model where consumers cannot identify producers arrives at similar results.

No previous models address the situation where there are repeat purchases, but consumers do not know which firm produced the good. In the model presented here, consumers' quality expectations are based on the average quality provided in the previous period. Firms' willingness to pay for a high quality level is based on developing an industry reputation. Unlike previous models, firms are heterogeneous in their cost of providing quality. The key parameters in determining the level of quality are the number of domestic and importing firms, the cost of improving quality for each firm, and the demand elasticity with respect to quality. Other costs which firms may consider in determining their choice of the level of quality include: expected costs associated with tort liability, administrative fines, potential future (export) supply restrictions, costs of food safety testing when violations occur, and

concern for stricter government regulations. While I do not consider these other factors, they may be less relevant when it is difficult to trace back the source of an outbreak to an individual firm.

In the first section I develop the model in autarky. Foreign trade is introduced in the second section. The effect of imports on the quality decisions of domestic firms is explored in the third section. The paper concludes in section four.

## I. The Model in Autarky

I will first examine consumer behavior. Consumers are heterogeneous in their willingness to pay for quality, denoted by  $\theta$ . The utility gained from purchasing the product depends on their quality preference and the industry's reputation for providing quality, or  $R_t$ . If the willingness to pay for quality times the industry's reputation for providing quality is greater than the price the agent buys one unit of the good.<sup>1</sup> The utility function for consumer  $i$  at time  $t$  is of the form:

$$(1) \quad U_{i,t} = \begin{cases} \theta_i R_t - p_t & \text{If Agent Buys} \\ 0 & \text{Otherwise} \end{cases}$$

The willingness to pay for quality follows a frequency distribution  $f(\theta)$ . The cumulative density function  $F(\theta)$  is the fraction of agents with a quality preference of  $\theta$  or lower and falls within the bounds of  $F(0)=0$  and  $F(B)=1$ . The agent will buy only if  $\theta R_t - p_t \geq 0$ . Thus the values of  $\theta$  where the agent buys is

$$(2) \quad \theta \geq p_t / R_t .$$

The critical value,  $\hat{\theta}$ , is equal to  $p_t / R_t$ . Following Bond (1984), assume that  $\theta$  has a uniform distribution where  $f(\theta)=h \forall \theta$ . This leads to a demand function of the form

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<sup>1</sup>This utility function is also used by Shapiro (1983) and Falvey (1989). Restricting the consumption of agents to one unit allows the model to focus on their willingness to pay for quality. [Explanation of plausibility: consumer either buys a head of lettuce or does not]

$$(3) \quad D_t = \int_{\hat{\theta}}^B f(\theta) d\theta = [B - p_t/R_t]h.$$

There are  $M$  firms producing one unit each. Thus the supply is fixed at  $M$  units and  $D_t=M$ . This simplification allows the model to focus on how firms choose quality. Also, at least in the short-run, agricultural commodities are inelastically supplied. Applying this to equation (3) and solving for  $p_t$  yields

$$(4) \quad p_t = R_t[B - M/h].$$

The price is an increasing function in reputation ( $R_t$ ) and a decreasing function in market supply ( $M$ ).

The price is also an increasing function in the density of demand for any given quality preference level ( $h$ ).

Consumers, being unable to observe quality before purchase and not knowing which firm produced the good, calculate an expected quality based on the average quality of goods offered in the previous time period. This is reasonable since supply is fixed, the same set of firms are supplying the goods each time period. Quality in this situation is the presence of microbial contamination. Other quality characteristics that are observable, such as size or coloration, are already factored into the price. Consumers calculate reputation according to an average of the quality of the output of firms from the previous period. The quality of the output of firm  $i$  at time  $t$  is  $q_{i,t}$ .

$$(5) \quad R_t = \frac{1}{M} \sum_{i=1}^M q_{i,t-1}^n.$$

In determining reputation, consumers give more weight to lower qualities as represented by the exponent  $n$  ( $0 < n \leq 1$ ). In other words the smaller  $n$  is, the smaller the increase in industry reputation when a firm improves the quality of its output. This reflects the possibility that consumers calculate reputation more by number of outbreaks of food borne illness rather than by the lack of one. Studies such as Smith et al. (1988) and Richards and Patterson (1998) find that negative publicity has a greater effect on demand than does positive publicity.

I now examine firm behavior. The  $M$  firms produce one unit of output each at one of two

qualities,  $q_0 < q_1$ .<sup>2</sup> The discrete quality levels represents the choice producers face on whether to change their production methods (such as adopting a HACCP program) or not. Giving the firms two discrete levels from which to choose, as opposed to a continuum of quality levels, simplifies the model while yielding similar results. The two qualities differ by a factor  $v$ , or  $q_0 v = q_1$ . Depending on the quality choice, firms face two possible costs of production,  $c_0 < c_1$ , where  $c_0 z = c_1$ . The number of firms producing at high quality is  $S$ . The proportion of firms producing at high quality is  $s = S/M$ . Equation (6) can be rewritten as

$$(7) \quad \begin{aligned} R_t &= \frac{1}{M} [(1-s) M q_{0,t-1}^n + s M q_{1,t-1}^n] \\ R_t &= q_0^n [1 + s_{t-1} (v^n - 1)]. \end{aligned}$$

The reputation of the industry at time  $t$  depends on the proportion of firms that produced at high quality at time  $t-1$ . It is also clear that as consumers place less weight on observations of high quality (as  $n$  gets smaller), an increase in  $s$  yields a smaller increase in reputation. To find the effect of reputation on price, equation (7) can be combined with equation (4) to yield

$$(8) \quad p_t = q_0^n [B - M/h] [1 + s(v^n - 1)].$$

Firms choose quality based on the cost of providing each quality level relative to the effect on price (which occurs through the reputation function). The effect of the firm  $i$ 's quality choice on industry price in the next period is  $p_{t+1}(R_{t+1}(q_t^i))$ , where  $q_t^i$  is either  $q_0$  or  $q_1$  depending on what the firm chooses in the period  $t$ . The cost firms face in time  $t$ ,  $c_t^i(q_t^i)$ , is either  $c_0$  or  $c_1$  depending on the chosen quality level. The firms are heterogeneous in terms of their cost of providing quality,  $\beta$ , which follows the probability distribution function  $g(\beta)$ . Some firms, due to factors such as location or easy access to clean water, have a lower cost of controlling microbial contamination than others. As with consumers, we will assume that

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<sup>2</sup>In this model there is no entry or exit. The inclusion of firm entry/exit does not affect the conclusions drawn from this model.

$g(\beta)$  is uniform or  $g(\beta)=g \forall \beta$ . Firm  $i$  chooses between two quality and cost levels to maximize both present and next period's profit,

$$(9) \quad \max_{q_t^i} \{ \pi_{t,t} + \gamma \pi_{t+1}^i \}$$

$$= \max_{q_t^i} \{ p_t(R_t(q_{t-1}^i)) - \beta_t c_t^i(q_t^i) + \gamma (p_{t+1}(R_{t+1}(q_t^i)) - \beta_{t+1}^i c_{t+1}^i(q_{t+1}^i)) \}$$

Firms discount the future by a factor of  $\gamma$ . Firms must balance present cost of their quality choice against the future effect of their quality choice on industry reputation and price.

In equilibrium, firms do not have an incentive to switch quality. In other words, the short-term profit from lowering (increasing) quality is less than the long-term losses (gains) from a worsened (improved) reputation with consumers.<sup>3</sup> Assume that the firm produced at high quality at time  $t-1$  and then has the option at time  $t$  to either continue at high quality indefinitely or switch to the lower quality indefinitely. This is expressed as

$$(10) \quad \pi_t(R(q_1), q_1) + \gamma \pi_{t+1}(R(q_1), q_1) + \gamma^2 \pi_{t+2}(R(q_1), q_1) + \dots$$

$$\geq \pi_t(R(q_1), q_0) + \gamma \pi_{t+1}(R(q_0), q_0) + \gamma^2 \pi_{t+2}(R(q_0), q_0) + \dots$$

The firm's profit for time  $t$ , if it is producing at quality  $q_t$  and produced at  $q_t$  in the previous period, is  $\pi_t(R(q_t), q_t)$ . The profit for the next time period is  $\pi_{t+1}(R(q_t), q_t)$ . The right-hand side of equation (10) expresses the gain from supplying lower-quality output. Firms discount future profits by a factor of  $\gamma$  per time period. Substituting the profit function from equation (9) into the inequality above and solving for  $\beta$  yields

$$(11) \quad \beta \leq \frac{\gamma [P(R(q_1)) - P(R(q_0))]}{(c_1 - c_0)}$$

Taking the above inequality as an equality indicates the highest cost factor that a firm may have without having an incentive to lower quality. I will refer to this critical level as  $\beta_t$ . Firms with  $\beta \leq \beta_t$  have such a

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<sup>3</sup>Shapiro (1983) refers to this as the "no-milking condition" or that producers do not have the incentive to milk their reputations for short-term gain.

low cost of providing quality that the increase in industry reputation (and therefore price) from providing high quality output, although diluted across the entire industry, outweighs the additional cost of providing higher quality. In other words these firms are not deterred by the free-rider problem. This applies no matter what quality level the other firms provide.

The next group of firms face a high enough cost of providing quality, or  $\beta > \beta_j$ , that they do not unconditionally provide high quality output. The gains from reducing quality are greater than from maintaining high quality. However, if the free-rider problem is somehow overcome and a large enough group of the firms switch from low to high quality, their profits are higher than if they produced at low quality as a group. The upper-bound of  $\beta$  for this group is the reverse of equation (11). The lower bound is determined by the marginal firm that is indifferent between joining the group by switching to high quality and remaining at low quality. This can be expressed as

$$(12) \quad \begin{aligned} & \pi_t(R(q_1), q_1) + \gamma \pi_{t+1}(R(q_1), q_1) + \gamma^2 \pi_{t+2}(R(q_1), q_1) + \dots \\ & \geq \pi_t(R(q_0), q_0) + \gamma \pi_{t+1}(R(q_0), q_0) + \gamma^2 \pi_{t+2}(R(q_0), q_0) + \dots \end{aligned}$$

Let the number of firms that may switch from low quality to high be  $J$  and the number of firms always producing at high quality ( $\beta \leq \beta_j$ ) be  $S$ . Substituting the production function into equation (12) and solving for  $\beta$  yields

$$(13) \quad \beta \geq \frac{\gamma [P(R(S+J, q_1)) - P(R(S, q_0))]}{(c_1 - c_0)}.$$

This is similar to equation (11) except that an additional term representing the number of firms producing at the higher quality of production is included in the reputation function  $R(\cdot)$ . Taking equation (13) as an equality defines the critical value  $\beta_0$  above which firms are never better off producing at high quality.

Because the reputation function is linear with respect to the number of firms, it can be simplified to

$$(14) \quad \beta \geq J \cdot \frac{[P(R(q_1)) - P(R(q_0))]}{(c_1 - c_0)}.$$

The number of firms in the "switch group", or  $J$ , is a function of  $S$  and the exogenous parameters of the

distribution function for  $\beta$ . To simplify the notation, define  $L = [P(R(q_1)) - P(R(q_0))]/(c_1 - c_0)$  or the change in industry price from changing quality levels relative to the change in costs. Therefore the upper and lower bounds for the switch group can be written as  $\beta_0 = JL$  and  $\beta_1 = \gamma L$ . The variable  $J$  can be written as the distribution of firms between  $\beta_1$  and  $\beta_0$ , or

$$J = \int_{\beta_1}^{\beta_0} g(\beta) d\beta = [\beta_0 - \beta_1]g = [JL - \gamma L]g$$

$$(15) \quad J = \frac{\gamma L g}{Lg - 1}.$$

Simple substitution reveals the upper bound of  $\beta$  for the switch group as  $\beta_0 = \gamma L^2 g / (Lg - 1)$ . The third group of firms have such a high cost of increasing quality,  $\beta > \beta_0$ , that they always produce at the lower quality level. The maximum value of  $\beta$ , which determines the total number of firms  $M$ , is itself determined by the profit condition

$$(16) \quad \pi_i(R(S, q_0), q_0) + \gamma \pi_{i+1}^e(R(S, q_0), q_0) + \gamma^2 \pi_{i+2}^e(R(S, q_0), q_0) + \dots \geq 0.$$

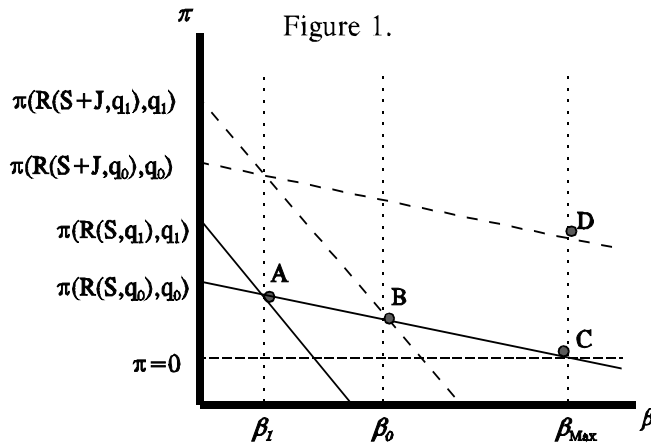
The highest value of  $\beta$  must be low enough for all firms to earn at least a non-negative profit. This is based on the situation where only the  $S$  lowest-cost firms, or  $\beta \leq \beta_1$ , are producing at the higher quality level. This means that when the switch firms are producing at the lower quality level, the firm with the highest  $\beta$ , or the  $M$ th firm, will earn a zero profit. If the switch group produces at the higher quality level, then the  $M$ th firm, benefitting from a better industry reputation, will earn a profit greater than zero.

Taking into account the uniform distribution of  $\beta$  and simplifying equation (16) we get

$$(17) \quad \beta \leq \frac{P(S, q_0)}{c_0} = \frac{P(\gamma L g, q_0)}{c_0}.$$

Taking the above equation as an equality defines the maximum cost of providing quality, or  $\beta_{Max}$ . This also defines, through the parameters of the uniform distribution, the total number of firms and the supply  $M$ .





This model is demonstrated by Figure

1. The vertical axis represents profits and the horizontal axis represents the cost of providing quality. Firms with a low cost of providing quality, or  $\beta < \beta_1$ , will maximize profits by producing at high quality along the line  $\pi(R(S, q_1), q_1)$  to the left of point B. Firms between  $\beta_1$  and  $\beta_0$ , the switch group, are

individually better off producing at the lower level of quality along  $\pi(R(S, q_0), q_0)$  between points A and B. As group, all  $J$  firms would be better off producing at the higher quality level along  $\pi(R(S+J, q_1), q_1)$ . Firms with  $\beta > \beta_0$  are always better off producing at the lower quality level. The  $M$ th firm with a cost of providing quality  $\beta_{Max}$  earns a zero profit if the switch group is also producing at the lower quality. If the switch group somehow overcome the free rider problem and produce at the higher quality, the  $M$ th firm will earn a positive profit, moving from point C to point D. At this point there is room for entry for firms with  $\beta > \beta_{Max}$ .

Changes in parameters will alter the results. If the relative cost of producing at high quality ( $v$ ) decreases, the slope of the high-quality profit lines  $\pi(R(S, q_1), q_1)$  and  $\pi(R(S+J, q_1), q_1)$  also decreases. This increases the critical values  $\beta_1$  and  $\beta_0$ . In other words the proportion of firms that always produce at high quality or might produce at high quality (the switch group) increases. If the relative cost of producing at high quality is small enough, then  $\beta_1$  may be large enough that  $\beta < \beta_1$  for all firms and that all production is at high quality. A reduction in  $v$  could occur through an improvement in production technology reducing the costs of producing higher quality goods. The presence of tort liability would also decrease  $v$  by increasing the cost of low quality production, which has a greater liability risk, relative to high quality production.

Another way in which the average quality of production would improve is through an increase in the demand preference for quality ( $B$ ). This causes the  $\pi(R(S, q_1), q_1)$  curve to shift up relative to the  $\pi(R(S, q_0), q_0)$  curve which increases the  $\beta_1$  and  $\beta_0$ . The increase in preference for quality can represent greater consumer awareness of food-borne diseases or improved detection of food-borne disease outbreaks.

## II. Imports

Since the focus of this paper is on the incentives for domestic firms to change the quality of their output, I consider the situation where the industry is import-competing.<sup>4</sup> A foreign producer faces two decisions; whether or not to export and at which quality to produce. Assume that the foreign producer has the same production function as domestic producers and, in addition, faces a tariff  $T \geq 0$ .<sup>5</sup> The foreign firm chooses between the quality levels to maximize profit,

$$(18) \quad \max_{q_i^f} \{ \pi_t^f + \gamma \pi_{t+1}^f \} = \max_{q_i^f} \{ p_t(R_t(q_{t-1}^f)) - \beta^f c_t^f(q_i^f) - T \\ + \gamma (p_{t+1}(R_{t+1}(q_t^f)) - \beta^f c_{t+1}^f(q_{t+1}^f) - T) \}$$

The tariff does not affect the foreign producer's quality choice because the tariff is the same for either quality level. Instead, the foreign producer's quality choice depends on its cost factor  $\beta$ . The foreign firm faces similar critical values of  $\beta_1$  and  $\beta_0$  that the domestic firms face.<sup>6</sup> If the cost factor for the foreign firm is small enough, it will produce at  $q_1$ . Otherwise it will produce at  $q_0$ .

The highest cost factor a foreign firm may have and still earn a non-negative profit is similar to  $\beta_{Max}$  for the domestic firms. For any positive value of  $T$  the maximum cost factor for an entering foreign firm is smaller than the domestic equivalent, or  $\beta_{Max}^f < \beta_{Max}$ . If  $T$  is large enough, the tariff becomes

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<sup>4</sup>Bagwell and Staiger (1989) examine the interaction of exports and quality when the quality is initially unknown to the foreign customers.

<sup>5</sup>Since firms produce one unit of output, there is no difference between *ad valorem* and fixed tariffs.

<sup>6</sup>The critical values the foreign firm faces will be slightly less than what the domestic firms face without a foreign entrant. This because the foreign entrant causes the total supply of the good to increase from  $M$  to  $M+I$ . The partial derivatives of  $\beta_0$ ,  $\beta_1$ , and  $\beta_{Max}$  with respect to  $M$  are all negative.

prohibitive and even the lowest cost foreign producer does not enter the market.

An entering foreign firm has two effects on the domestic market. The first effect is an increase in supply. The increase in supply reduces the domestic price for the good as shown by taking a partial derivative of equation (8) with respect to  $M$ ,

$$(19) \quad \frac{\partial \mathcal{P}}{\partial M} = -q_0^n \left[ \frac{B}{M} s(v^n - 1) + \frac{1}{h} \right].$$

The negative effect of an increase in supply on price increases with  $s$ , or the proportion of firms producing at the higher quality. If the switch group is producing at high quality, the impact of a foreign entrant on price is greater than if the switch group is at low quality.

The second effect a foreign entrant has on the domestic market is through the entrant's effect on the industry's reputation. Depending on which quality level the entrant chooses, it will raise or lower the industry's reputation, which then affects price. The effect on price is,

$$(20) \quad \frac{\partial \mathcal{P}}{\partial S} = q_0^n \left[ \left( \frac{B}{M} - \frac{1}{h} \right) (v^n - 1) \right].$$

For reasonable parameter values of  $B$ ,  $M$ , and  $h$  the derivative is positive. To the extent to which consumers prefer higher quality (parameter  $B$ ) reflects the extent to which a change in the proportion of firms producing at the higher quality,  $s$ , affects the domestic price. If the foreign entrant produces at the lower quality, it lowers the price through increasing the total domestic supply (equation (19)) and decreasing the proportion of firms producing at high quality. The effect on domestic firms in this case is unambiguously negative. If the foreign entrant produces at high quality, it increases the average quality for the industry which may or may not compensate for the increase in supply. The net effect is,

$$(21) \quad \frac{\partial \mathcal{P}}{\partial S} + \frac{\partial \mathcal{P}}{\partial M} = q_0^n \left[ \frac{B}{M} (v^n - 1)(1 - s) - \frac{1}{h} (v^n) \right].$$

Which effect dominates, the increase in supply versus the increase in quality, depends on several parameters. The greater the consumer preference for quality,  $B$ , the greater the effect of an increase in average quality. The greater the proportion of firms producing at the higher the higher quality level, the

smaller the effect of an increase in average quality on price. In general, the higher the average domestic quality the more likely a foreign entrant will have a negative effect on producers.

### III. Domestic Firm Incentives

In autarky, firms have a greater incentive to produce at high quality the greater is consumer preference for quality ( $B$ ). The incentive is also greater if consumers place more weight on lower quality goods ( $n$ ) than on higher quality goods in evaluating the industry's reputation. The cost of providing quality also plays a role. The higher the cost jump from low to high quality ( $z$ ) and the higher the cost factor ( $\beta$ ), the less likely a firm will produce at high quality. If the cost of providing quality is low enough ( $\beta_{Max} < \beta_1$ ), all firms will always produce at the higher quality level. If the distribution of cost factors is such that there is a switch group, then the chances for the switch group to overcome its free-rider problem decreases in the number of firms in the group ( $D$ ).

The incentive for domestic firms to switch to, or maintain, high quality production in the presence of imports depends on the quality level the foreign entrant chooses. The quality level choice of the foreign entrant depends, in turn, on its cost factor. If the foreign entrant produces at the lower quality level, domestic firms are unambiguously worse off due to a greater supply and a worsened industry reputation both leading to lower prices. The free-rider situation is also exacerbated. The derivative of equation (15) yields,

$$(22) \quad \frac{\partial D}{\partial M} = \frac{\partial \mathcal{L}}{\partial M} \left( \frac{-\mathcal{I}}{(Lg-1)^2} \right) > 0.$$

The size of the switch group ( $D$ ) grows when the number of firms grows ( $M$ ). This makes overcoming the free-rider problem more difficult. The presence of a imports also complicates the free-rider problem because a foreign producer may be more difficult for the domestic firms to monitor and ensure cooperation.

When a foreign entrant produces at the higher quality level, the effect is ambiguous. According to equation (21) the positive effect of a reputation increase is more likely to outweigh the negative effect

of an increase in supply when the proportion of high-quality producers ( $s$ ) is small. As  $s$  grows, the advantage of a high quality entrant decreases. The switch group may be large enough that if they produce at high quality,  $s$  would be large enough that a foreign entrant, even at high quality, makes them unambiguously worse off. This reduces the benefit for the switch group to produce at high quality. In this case the possibility of imports makes producing at high quality by the switch group less likely.

One way to guarantee that foreign firms will produce at high quality is through a tariff. The presence of a tariff lowers the maximum cost factor  $\beta_{Max}^f$  a foreign entrant may have and break even. The tariff may be set high enough such that only a foreign firm with a cost factor below  $\beta_l$  enters the market. Such a firm will always produce at high quality. The intuition behind this result is that the tariff is the same no matter what the quality of the good. A high tariff can be prohibitive for a low quality import (which drives down the domestic price) but not for a high quality good (which can increase the domestic price).

Rather than a tariff, the variable  $T$  can also be viewed as the transportation costs that foreign firms face. It is possible that transportation costs alone could be high enough such that a foreign entrant will only produce at high quality. The presence of high tariffs or transportation costs can help domestic firms overcome their free rider problem by guaranteeing that a foreign entrant will produce at high quality.

#### **IV. Conclusion**

When determining the level of quality of production, producers must balance the costs of increasing quality against the benefits in terms a higher price. As the model in the first section shows, if the cost of producing at high quality is low all producers will produce at high quality. As the cost rises a free-rider problem develops because the benefits of a firm's increase in quality are shared with the entire industry. The presence of imports adds to this problem.

One way to increase the average quality of the industry's output is to lower the cost of improving quality. This could be accomplished through improvements in food safety techniques or through greater

dissemination of current food safety knowledge. An increase in the price response of demand to quality also improves the average quality of production in the industry. Greater awareness of food safety issues among consumers would accomplish this.

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