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Abstract:

We show how a large country's entrance on world markets can lead to lower and less quality diversity available to consumers rather than more. In our model, autarky quality is directly proportional to the willingness to pay for quality and home market size, and inversely proportional to the cost of quality. We formalize strategically interacting firms, and identify the context in which a low-quality producer can lead, driving high-quality producers out of the market despite the existence of customers willing to pay for higher quality. We discuss the feasibility of this 'predatory strategy' by an emerging country. It is more likely in contexts where the emerging exporter is much larger.

Introduction

Jaguars, Porsches, BMWs…, in 2012 about eleven percent of the new vehicles sold in the USA were luxury cars like these. They were bought by people willing and able to pay for high quality goods. Other people purchased less expensive vehicles produced by other auto makers. The fact that some producers specialize in serving high-end customers while others specialize in supplying low-priced goods has been rationalized by industrial organization and international trade theorists for some time. Recently, however, a new pattern has emerged. In some retail markets, despite the existence of customers willing to pay for quality, luxury goods are no longer available. Although the full spectrum of vertically-differentiated goods was available in the recent past, now only low-quality versions are offered. In this paper we attempt to explain why a market may become dominated by only low-price, low-quality goods despite no reduction in the number of consumers willing to pay for high quality.

Over three decades of literature exists concerning world markets for vertically-differentiated goods, also known as intra-industry trade. A large part of this literature is based on industrial organization, e.g.: Gabszewicz and Thisse (1979), Shaked and Sutton (1982), Motta (1993), Crampes and Hollander (1995), and Fajgelbaum, Grossman, and Helpman (2011).

A canonical model by Motta, Thisse and Cabrales (1997) consists of two firms in two countries, each producing a good identified by a quality index, strategically competing for a share of the global market in a two-stage game. Consumers are characterized by their tastes and their willingness to pay for quality. Quality is costly to produce. In the first stage firms simultaneously choose the quality to supply. In the second stage they compete in a non-cooperative Cournot or Bertrand game. In autarky, the quality choice that maximises profits

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depends on the home market size and consumers' willingness to pay for quality relative to the costs of supplying quality.

The literature provides three main implications about what happens when countries open to trade. One, both firms respond to market incentives to change the quality they supply on the global market. Two, in equilibrium the two firms never chose to supply the same quality, as that would drive both firms' profits to zero. Three, there are multiple stable equilibria. It is not possible to predict whether the firm in the country that has the lower quality in autarky will continue to supply low quality globally, or if it will "leapfrog" to supply the high quality product, or vice-versa. These results are consistent with the industrial organisation literature.

Motta, Thisse and Cabrales (1997) assume that the willingness to pay for high quality differs between the countries and that changing quality requires incurring fixed costs. This is why the countries specialize in a different quality good in autarky. When the countries open to trade, intra-industry two-way trade occurs, allowing high quality-loving consumers in both countries to obtain high quality goods, and low price customers in both countries to obtain low price goods. Free trade thus leads to more quality diversity in local markets, not less. And "leapfrogging" on the supply side occurs only if the difference between the two countries' willingness to pay for high quality is sufficiently small.

The importance of domestic demand conditions in determining the patterns of international trade has been recognized since Linder (1961). Linder hypothesized that suppliers tailor their products to the tastes of domestic purchasers. To the extent that the mix of tastes elsewhere are similar, there will be intra-industry trade with other regions. Krugman (1980) highlighted the "home market size effect" in a monopolistically competitive context. Porter (1991) emphasized the importance of domestic demand for high quality to prepare firms to compete in international markets.

The ability to produce high quality goods has been noted as a condition for export success and economic development (Kremer 1993, Grossman and Helpman, 1991). This could be understood as a prescription for leapfrogging. In contrast, China has become a major exporter to global markets in many product lines without switching to high quality. Husted and Nishioka (2012) report that initial Chinese exports were labor-intensive, low quality manufactured items such as clothing, footwear, and toys. According to Berger and Martin (2011) the value of Chinese exports more than quadrupled in the eight years between 2000 and 2007. By 2009, China had become the world's largest global exporter. The entrance of China as a low-cost, low-quality supplier in world markets drove the domestic production of low price, low quality goods out of some countries' economies. But no-one expected it to drive high price, high quality goods out of both production and markets as well.

In sum, the existing international trade and industrial organization theories indicate that as long as consumers have differentiated tastes and willingness to pay for quality, firms have incentives to differentiate supplies to satisfy global market demands. The implication that free trade leads to greater quality diversity in each local market is also a consequence of the assumption that firms play a non-cooperative game in two stages, with simultaneous decision making at each stage. But the relative sizes of trading countries today casts doubt on this simultaneous play assumption. In a world where firms in some countries face huge domestic markets, it may be more realistic to assume that such firms assert their ability to lead, forcing smaller country rivals to follow their (quality, price) offer. For example, why should a Chinese firm engage in a non-cooperative simultaneous game on a level-playing field when it

exports to the Australian market? Given a Chinese firm's huge domestic market, large economies of scale and low unit production costs, why wouldn't a Chinese firm behave as a leader, forcing the Australian firm to adapt its strategy in response?

This is what we analyze in this paper. We propose a model consisting of two countries, one small but implicitly rich, with a share of consumers willing to pay for higher quality, as well as higher labor costs and lower fixed costs for producing high quality goods. The other country is very large, has low labor costs, low willingness to pay for quality, and a high fixed cost to produce high quality goods. Giving these assumptions, in autarky the large country firm produces a lower quality than the small, rich country firm. The difference in home market size is the first essential difference between our model and the existing literature.

The second essential difference is justified by the first assumption about relative size. Because of the low-quality producing country's large home market size, it can credibly lead. We formalize a Stackelberg-like game. We show that a large country can choose the quality and quantity that forces the small country firm to exit the market. Our model thus rationalizes how a low quality product supplied by a large country can capture an entire market.

We analyze the feasibility of this aggressive predatory strategy, demonstrates that it maximizes profit, and investigate the stability of the equilibria of the game. We show that the autarkic characteristics of the large country are primordial. A large domestic market is essential. Even if countries have the same cost characteristics and face the same willingness to pay for quality, only a sufficiently large country's firm can successfully follow a predatory strategy. If the domestic market is large enough, the low quality-producing country can export its autarky quality, wholly avoiding the costs of adapting quality to compete for just a share of the other country's market. This contrasts with the existing finding in the literature that firms always have incentives to adapt the quality of their supplies to the global market when they open to trade. Furthermore, when the small country/high quality producing firm raises its quality in an attempt to relax the competition on its own market, it's global market revenue is not sufficient to cover costs. High quality production shuts down.

The paper is organized as follows: in the next section we present the model and the autarky situation. Section 3 formalizes the open market situation. Assuming the large country leads, we formalize a Stackelberg game in section 4, focusing on the (quality, quantity) strategy that nullifies the profits of the high quality producer, which we call a predatory strategy. We analyze the feasibility conditions for the predatory strategy in section 5, emphasizing the implications of relative size. In section 6 we compare the profitability of the predatory strategy to the profitability of the equilibria in the non-cooperative simultaneous game. The last section concludes.

2. The model and the autarky situation

We model two countries, *H* ("Home") and *F* ("Foreign"). In country *j* (*j=H,F*), consumers indexed by a taste for quality θ are uniformly distributed over the interval [0, b_j] with density S_j. On the supply side, firms incur a quadratic production cost $C_j = c_j q_j^2$ and a fixed cost K_{ju} that is quadratic in quality: $K_{ju} = k_j u_j^2$. Thus in autarky, in each country *j*, a monopoly firm produces a single quality u_j of a good.

Consumers either buy one unit or none at all. Consumers of type θ will buy one unit only if their net consumer surplus is positive, that is, only if $\theta u_j - p_j \geq 0$, where p_j is the price of the good of quality u_j. When only one quality u_{jA} is available, consumers with θ higher than $\hat{\theta}_{JA} = \frac{p_{jA}}{u_{jA}}$ buy one unit of the good. In autarky, market demand in each country is thus:

$$D_{jA} = S_j\left(b_j - \frac{p_{jA}}{u_{jA}}\right), \quad j= H,F.$$

In sum, there are four differences between the two countries:

1) the willingness to pay for quality is lower in *F*oreign than in *H*ome $b_F < b_H$.

2) *F*oreign is larger: $S_F b_F > S_H b_H$, in contrast with the exiting literature, e.g., Motta, *et al*., (1997). We normalize $S_H = 1$.

3) it follows that the marginal cost of production, c_j, is lower in *F* than *H*. Normalizing that cost to zero implies $C_F = 0,\ C_H > 0$.

4) the fixed cost to produce a different quality is lower in Home: $0 < k_H < k_F$.

These four assumptions describe country *H* as a relatively small developed country, with higher wages, more sophisticated consumers, and lower product line switching costs (due to, for example, pre-existing R&D or more flexible or productive infrastructure). Meanwhile, country *F* is a big emerging country, with a relative abundance of labour and thus lower wages, as well as a large population of subsistence consumers.

Given the fixed cost of quality, to maximize profits firms will produce only one quality. Profits are given by:

$$\pi_{jA} = (b_j u_{jA} - \frac{q_{jA} u_{jA}}{S_j}) q_{jA} - C_j - K_{ju}.$$

Maximizing π_{jA} with respect to q_{jA} and u_{jA} we find that:

$$q_{jA} = \left[\frac{S_j u_{jA} b_j}{2(u_{jA} + S_j c_j)}\right],$$

and

$$u_{jA} = \frac{S_j(b_j^2 - 16 c_j k_j + b_j\sqrt{b_j^2 + 32 c_j k_j})}{16 k_j} \qquad (1)$$

Given $c_F = 0$ the autarky quality choice (1) by *F* simplifies to:

$$u_{FA} = \frac{S_F b_F^2}{8 k_F}. \qquad (2)$$

Clearly, *F*'s profit-maximizing quality is increasing in *S* and *b*, and decreasing in *k*, the fixed cost of quality This implication contrasts with the usual explanation that emerging economies export low quality goods strictly because their labour is low-priced. Producing lower quality goods is also a rational outcome where domestic consumers have a low willingness to pay for quality, the country is relatively small, and the fixed costs of higher quality are high.

Finally, recall that consumers with θ higher than $\hat{\theta}_{JA} = \frac{p_{jA}}{u_{jA}}$ will buy one unit of a good. Thus for a given population, the firm in the country where consumers have a higher willingness to pay for quality produces a higher quality, sold at a higher price. This is a another significant implication of asymmetric home market size. When there is a difference in the number of consumers in each quality range (density S_j) abstracting from any differences in consumers' willingness to pay for quality (b) nor difference in the fixed cost of quality (K, or k), the autarky quality produced by the firm in the larger country will be higher.

Thus, to formalize the situation in which the larger country produces the lower quality product in autarky, we use (1) and (2) to obtain the conditions on S_F relative to b_j, c_H, and k_j such that in autarky, *F* produces a lower quality than *H*:

$$1 < S_F < \frac{(b_H^2 - 16c_H k_H + b_H\sqrt{b_H^2 + 32c_H k_H})k_F}{2k_H b_F^2} \qquad (3)$$

For the remainder of this paper, we assume parameters values consistent with this condition.

3. Free Trade

When the two countries open to trade, both low and high quality versions may be available to consumers in each country. In each country *j* the consumer indifferent between buying the higher or the lower quality is indexed by:

$$\tilde{\theta}_j = \frac{p_H - p_F}{u_H - u_F}$$

Thus in each country, the domestic demand for the higher quality (overscored D) is:

$$\overline{D}_j = S_j\left(b_j - \frac{p_H - p_F}{u_H - u_F}\right) \qquad j = H,F \qquad (4)$$

While demand for the lower quality (underscored D) is:

$$\underline{D}_j = S_j\left(\frac{p_H - p_F}{u_H - u_F} - \frac{p_F}{u_F}\right) \qquad j = H,F \qquad (5)$$

When free trade is possible, each firm faces a new set of demands due to the different willingness to pay for quality because $b_H \neq b_F$, and, a different number of consumers at each willingness to pay because $S_H \neq S_F$.

The firms may have incentives to adjust quality to supply the global market. But to do so they must pay a fixed cost to change quality. Some authors assume that this adjustment cost depends on the difference between the autarky and open market quality. Unfortunately with

this assumption, as Motta, *et al,* 1997 explain, it is impossible to find analytical results for the equilibria of the game; numerical simulation is required. In models where it is assumed that firms have constant marginal costs, e.g., Venables (1990) and Motta *et al* (1997), firms segment the market in prices, then maximize the global profit by choosing to supply one quality to both markets. Others, following Brander and Krugman (1983), assume that firms choose prices to maximize profits separately on both markets, which can lead to reciprocal dumping.

In order to focus on quality choice we rule out dumping. And our assumption that production costs are quadratic rules out segmenting the market in prices. Because of the fixed cost of quality, firms choose to supply a single quality on both market places. They also choose the quantity to produce that maximizes their global profit.

From (4), the global market demand for high quality products facing the *H* firm is given by:

$$q_H = \left(b_H - \frac{p_H - p_F}{u_H - u_F} \right) + S_F \left(b_F - \frac{p_H - p_F}{u_H - u_F} \right) \tag{6}$$

given S_H normalized to 1, and assuming both qualities are available in both markets. Similarly, from (5), the global market demand for low quality products facing the *F* firm is:

$$q_F = \left(\frac{p_H - p_F}{u_H - u_F} - \frac{p_F}{u_F} \right) (1 + S_F) \tag{7}$$

The corresponding free trade prices when both versions of the good are transacted are thus:

$$p_H = \frac{u_H (b_H + S_F b_F - q_H) - q_F u_F}{1 + S_F} \tag{8}$$

$$p_F = \frac{u_F (b_H + S_F b_F - q_H) - q_F u_F}{1 + S_F} \tag{9}$$

Recall that demand for the high quality good in country *F* is positive only if $b_F > \frac{p_H - p_F}{u_H - u_F}$.

Given (8) and (9), we obtain that $\tilde{\theta}_{H,F} = \frac{p_H - p_F}{u_H - u_F} = \frac{b_H + S_F b_F - q_H}{(1 + S_F)}$, and the necessary condition for positive demand for the high quality good in country *F* is $b_H - b_F < q_H$.

It follows that there is difference in the willingness to pay for quality at which two-way trade will not occur, that is, although *H* may import low quality versions from *F,* it will not export high-quality versions to *F*. In the following we assume parameter values consistent with positive demand for high quality goods among country *F* consumers, *i.e.*, two-way trade.

4. The Predatory Strategy

Our objective in this paper is to understand how high quality goods could disappear from a developed country's marketplace. We know that this outcome is not rationalized by assuming a situation in which firms play a two-stage non-cooperative game, as in the existing literature. As we shall show, the observed outcome is rationalized if we assume that the larger country

behaves as a Stackelberg leader, to achieve a predatory objective. Taking into account the small country firm's best response, the firm in *F* commits to supply the quality and quantity on the global market such that when the small country firm adapts quality, its profits are non-positive, resulting in the ultimate closure of the *H*-firm.

The game we formalize proceeds in two stages. Similar to the Stackelberg game, anticipating the *H*-firm's best response, the *F*-firm commits to supply the quality and quantity that should nullify the H-firm's profits. In the second stage, the *H*-firm chooses the new quality and quantity that maximizes their profit. As usual, this game is solved by backward induction.

First solve the profit maximization problem of the *H*-firm, as anticipated by the *F*-firm. Assuming that the *H*-firm will adapt quality[2] ($u_H \neq u_{HA}$), *H*-firm profit is:

$$\pi_H = (p_H - (c_H q_H))q_H - k_H u_H^2$$

With free trade and both goods consumed in both countries, the open market price p_H is given by (8). Rearranging, profit is:

$$\pi_H = q_H\left(\frac{(b_H + S_F b_F - q_H)u_H - q_F u_F}{1+S_F} - c_H q_H\right) - k_H u_H^2 \qquad (10)$$

The *H*-firm is assumed to choose the quality u_H and quantity q_H that maximize π_H. The first order conditions with respect to u_H imply that:

$$u_H = \frac{q_H(b_H - q_H + S_F b_F)}{2k_H(1+S_F)} \qquad (11)$$

Expressing π_H in terms of this expression for u_H we have:

$$\pi_H = \frac{1}{(1+S_F)^2} q_H \left[\frac{q_H(b_H^2 - 4k_H c_H(1+S_F)^2 - 2b_F q_H S_F + q_H^2 + b_F^2 S_F^2 - 2b_H(q_H - b_F S_F))}{4k_H} - q_F u_F(1+S_F)\right] \qquad (12)$$

The *H*–firm also chooses the production quantity that maximizes its profit. Let $q_F = \lambda q_H$ ($\lambda > 0$). The first order condition with respect to the profit maximizing quantity is:

$$\frac{\partial \pi_H}{\partial q_H} = q_H\left[\frac{b_H^2 - 4k_H c_H(1+S_F)^2 + 2q_H^2 + b_F S_F(b_F S_F - 3q_H) + b_H(2b_F S_F - 3q_H - 2k_H \lambda u_F(1+S_F)}{2k_H(1+S_F)^2}\right] = 0$$

Of the three solutions for q_H, the one consistent with a negative second derivative is:

$$q_H = \frac{1}{4}\left(3b_H + 3b_F S_F - \sqrt{b_H^2 + 2b_H b_F S_F + b_F^2 S_F^2 + 32k_H c_H(1+S_F)^2 + 16\lambda k_H u_F(1+S_F)}\right) \qquad (13)$$

[2] Analyses of this game assuming *H*ome does not adapt results in theoretical open market outcomes inconsistent with the observed outcome we seek to explain: (i) for (b_H - b_F) too large, *H*ome serves the domestic market only, but free trade still leads to *wider* quality choice in *H*ome; (ii) at lower (b_H - b_F), there is a threshold S_F at which *H*ome also serves only the domestic market, and (iii) at larger S_F, there is leapfrogging, also leading to *higher* quality in the open market than in autarky. Details available from the authors on request.

Equations (11) and (13) express the *H*-firm's profit-maximizing response in terms of the quality u_F and quantity q_F choice variables of the *F*-firm (and the relevant parameters). Note that one obtains the same results by first maximizing π_H with respect to q_H.

Now, solve the "predatory strategy" problem of the *F* firm. What pair (q_F, u_F) nullifies π_H?

Denote $q_F = \lambda q_H$ and express the value function for π_H in terms of q_H as given by(13). This results in an expression for π_H in terms of the parameters (S_F, b_j, c_H, k_j) as well as λ and *F*'s choice of u_F. Find the value of λ that nullifies the *H*-firm's profit by equating $\pi_H(S_F, b_j, c_H, k_j, \lambda, u_F)$ to 0:

$$\lambda = \frac{1}{18k_H u_F(1+S_2)}((b_H + S_F b_F)^2 - 12k_H c_H(1+S_F)^2 + (b_H + S_F b_F)\sqrt{(b_H + S_F b_F)^2 + 12k_H c_H(1+S_F)^2}$$

With this value of λ in (13), the expression for q_H is:

$$q_H = \frac{1}{12}[9b_H + 9S_F b_F - (17b_H^2 + 17S_F^2 b_F^2 + 192c_H k_H(1+S_F)^2 + 8S_F b_F\sqrt{(b_H + S_F b_F)^2 + 12c_H k_H(1+S_F)^2}$$
$$+ b_H(34S_F b_F + 8\sqrt{(b_H + S_F b_F)^2 + 12c_H k_H(1+S_F)^2}\,] \qquad (13')$$

It follows that $q_F = \lambda q_H = \left[\frac{G}{u_F}\right]$, where

$$G = q_H\left(\frac{1}{18k_H(1+S_F)}((b_H + S_F b_F)^2 - 12k_H c_H(1+S_F)^2 + (b_H + S_F b_F)\sqrt{(b_H + S_F b_F)^2 + 12k_H c_H(1+S_F)^2}\right) \qquad (14)$$

In sum, this is a game in which the *F*-firm is able to drive the *H*-firm profits (12) to zero by offering $q_F\, u_F$ = G. A numerical example is given in Appendix 1. Clearly, when the *F*-firm offers the (q_F , u_F) such that $q_F\, u_F$ = G + *eps*, the *H*-firm's revenues will not cover costs, and it will be driven out of the market.

5. The feasibility conditions for a predatory strategy

The predatory strategy by the firm in *F* is to set $q_F . u_F = G$ (14). Under what parametric conditions can the *F*-firm successfully implement this strategy while producing the lower quality version of the good? If the *F*-firm adapts quality ($u_F \neq u_{FA}$), given our normalizations its profit is $\pi_F = (p_F q_F) - k_F u_F^2$. Using (9) to express the open market price of the low quality good, we have:

$$\pi_F = q_F\left(\frac{(b_H + S_F b_F - q_H - q_F)u_F}{1+S_F}\right) - k_F u_F^2 \qquad (15)$$

Alternatively, if the *F*-firm simply specializes in and exports its autarky quality, then it avoids the cost of adapting quality:

$$\pi_F = q_F\left(\frac{(b_H + S_F b_F - q_H - q_F)u_{FA}}{1+S_F}\right) \qquad (15')$$

First alternative: Foreign firm exports its autarky quality

Proposition 1:

The emergent countries able to play a predatory strategy by exporting their autarky quality must have a high density of population. The density of the population must be higher when the rich country consumers' willingness to pay for quality is higher.

The *F*-firm can drive the *H*-firm out of the market by proposing a pair $q_F u_F = G$ where *G* depends on the characteristics of the countries (14). The higher is the willingness to pay for quality in the rich country (the higher is b_H) and the lower is the cost of production in the rich country (the lower is c_H), the larger is *G,* and the more difficult it is for an *F*-firm to successfully follow a predatory strategy.

When the *F* firm exports its autarky quality when it behaves as a leader when it opens to trade, it is constrained by the trade-off formalized in (14). The lower its autarky quality, u_{FA}, the higher quantity, q_F, must be to conform with $q_F u_{FA} = G$. Nevertheless, its production cannot exceed the global market size:

$$q_{F\ Max} = (b_H + S_F b_F - q_H) \qquad (16)$$

In consequence, the minimum autarky quality in country *F* consistent with a predatory strategy is:

$$min\ u_{FA} = \frac{G}{(b_H + S_F b_F - q_H)} \qquad (17)$$

From (2) we have that $u_{FA} = \frac{S_F b_F^2}{8\ k_F}$. This allows us to express the market density, S_F, necessary for a successful predatory strategy by the *F* firm exporting its autarky quality. By successful predatory strategy, we mean $\pi_H = 0$ (10), and that the *F*-firm's profits (15') are higher than under any other strategy. It follows from (17) and (2) that in order for the *F* firm to play the predatory strategy, F must be sufficiently large, *i.e.*, it must be that:

$$S_F > \frac{G(8\ k_F)}{b_F^2(b_H + S_F b_F - q_H)}. \qquad (18)$$

We illustrate via simulation how the minimum predator size (or density), S_F, varies as b_j, c_H and k_j vary in Figure 1. Consider $b_F = 3$, $b_H = 5$, $c_H = 3, k_F = 0.8$ and $k_H = 0.3$. These values of the parameters are consistent with (3). Figure 1 illustrates the feasibility of the predatory strategy when the *F*- firm exports its autarky quality at different levels of S_F

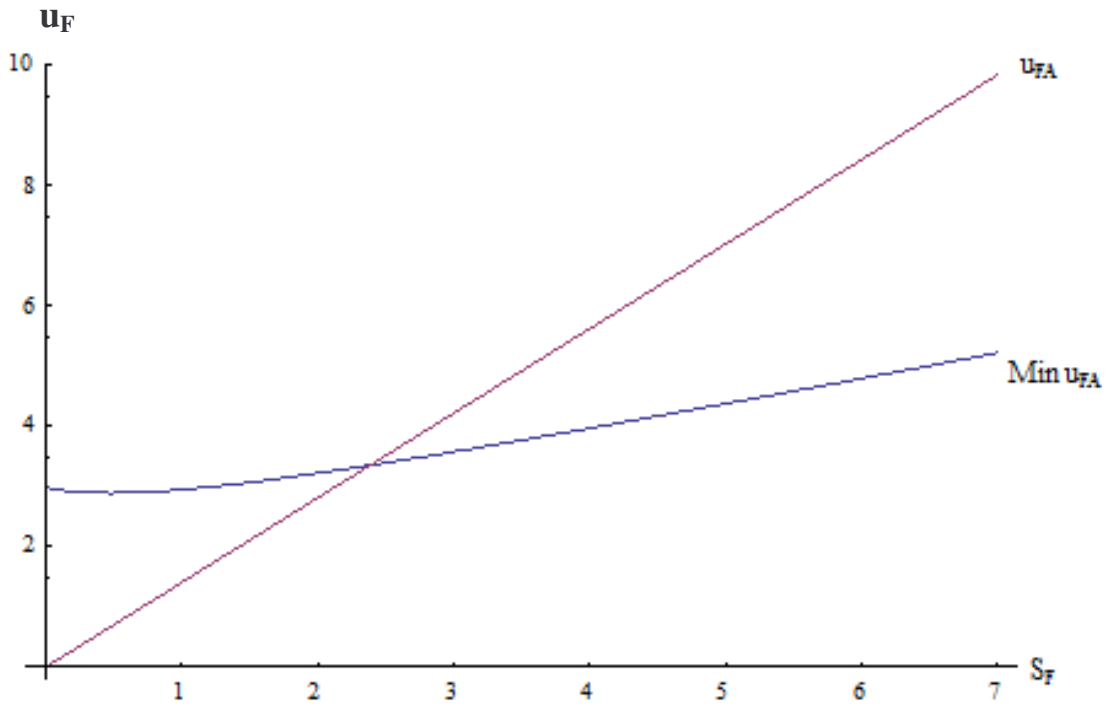

Figure 1. Autarky quality in Foreign, u_{FA}, compared to the minimum quality choice required for a successful predatory strategy (Min u_{FA}) with respect to Foreign size S_F, assuming $b_H = 5$, $b_F = 3$, $c_H = 3$, $k_F = 0.8$, $k_H = 0.3$.

The steeper (red) line in Figure 1 illustrates that Foreign autarky quality is directly proportional to its size, as explained in the second section of this paper. The shallower line (blue) represents how the minimum quality consistent with an implementable predatory strategy summarized by $q_F u_{FA} = G$ varies with respect to S_F. On and under the shallower line, $\pi_F \leq 0$. With the illustrated parameter values, the *F*-firm will not behave as a predator exporting its autarky quality when it is small, up to $S_F \leq 2.4$. At larger size, Foreign's autarky quality (2) exceeds the minimum quality that satisfies (17) for a successful predatory strategy. This underscores our finding that the emerging country must be sufficiently large (about three times larger, depending on the other parameters) to implement the predatory strategy.

The main result is that among emergent countries that have the same cost of quality, cost of production, and their own consumers' willingness to pay for quality, only the large emergent countries-- with sufficiently high S_F -- are able to implement a profit-maximizing predatory strategy while exporting their autarky quality.

Alternatively, when rich country consumers are willing to pay even more for quality (higher values of b_H), the minimum quality of exports from the emergent country ($\min u_{FA}$) for a successful predatory strategy must also be higher.

Furthermore, the higher is the willingness to pay for quality in the rich country, b_H, relative to b_F, the larger the emergent country must be for it to succeed with a predatory strategy. This is illustrated by comparing Figures 2 and 1. Figure 2 is generated using the same parameters as Figure 1, except that $b_H = 7$ in Figure 2. Note also that (3) is satisfied through

$S_F < 14$. Figure 2 shows the higher size of F ($S_F = 4.5$) consistent with a successful predatory strategy in *F*'s autarky quality when the difference in the willingness to pay for quality is larger.

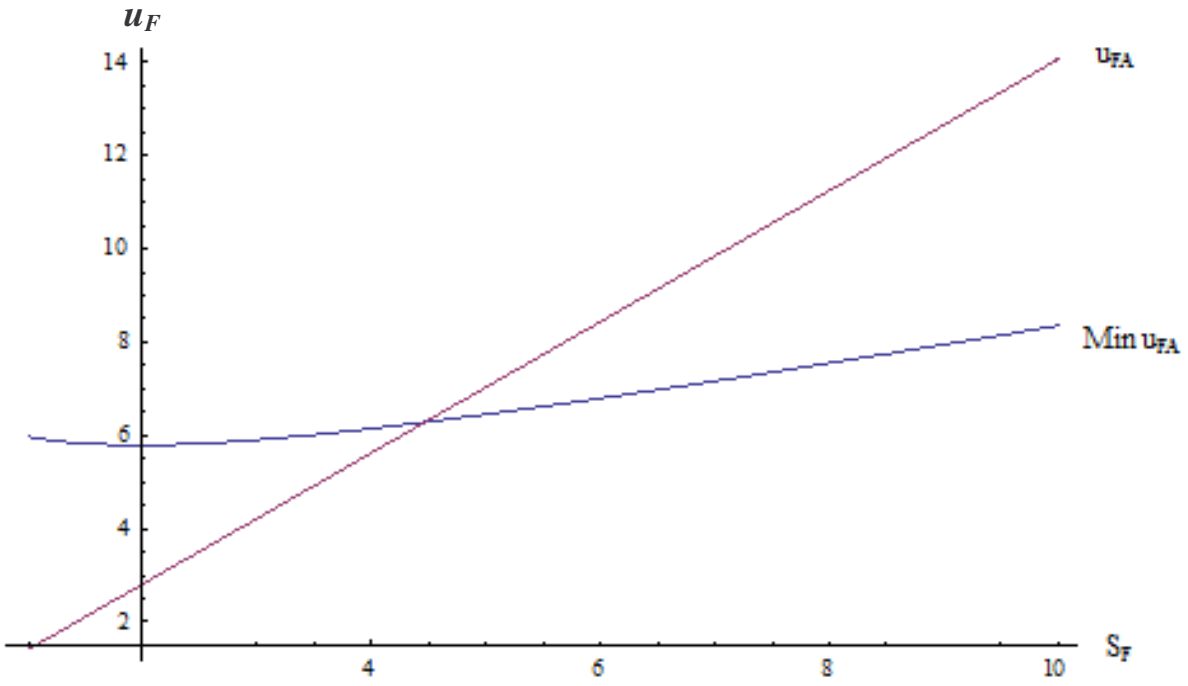

Figure 2. Autarky quality in Foreign, u_{FA}, compared to the minimum quality required for a successful predatory strategy (Min u_{FA}) with respect to Foreign size S_F; assuming $b_H = 7$ (all else the same as in Figure 1)

Second alternative: the Foreign firm adapts quality to supply the global market

Proposition 2:

The emergent country playing a predatory strategy will chose to adapt quality to the new open market when differences between country willingness to pay for quality and in population are sufficiently small. Nevertheless if differences in population are large, the emergent country firm can successfully corner the market while exporting its autarky quality.

Let us consider now the alternative that the *F*oreign firm adapts and exports the quality $u_F \neq u_{FA}$ while satisfying $q_F u_F = G$. In this case the *F*oreign firm incurs the fixed cost of quality, and π_F is defined as in (15).

Using the value of λ which nullifies the *H*ome firm's profit, the corresponding value of q_H (13'), and setting $q_F = \lambda q_H = \left[\frac{G}{u_F}\right]$ in (15), the value of π_F depends on the parameters

(S_F, b_j, c_H, k_j) and is only a function of u_F. We find the level of quality that maximizes the *F*oreign firm's profit by satisfying the first order condition $\frac{\partial \pi_F}{\partial u_F} = 0$.[3]

For parameter values $b_F = 3$, $b_H = 5$, $c_H = 3$, $k_F = 0.8$ and $k_H = 0.3$, Figure 3 illustrates *F*oreign firm's profit under the predatory strategy as a function of density S_F, comparing "adapt quality" to the "don't adapt quality" alternative.

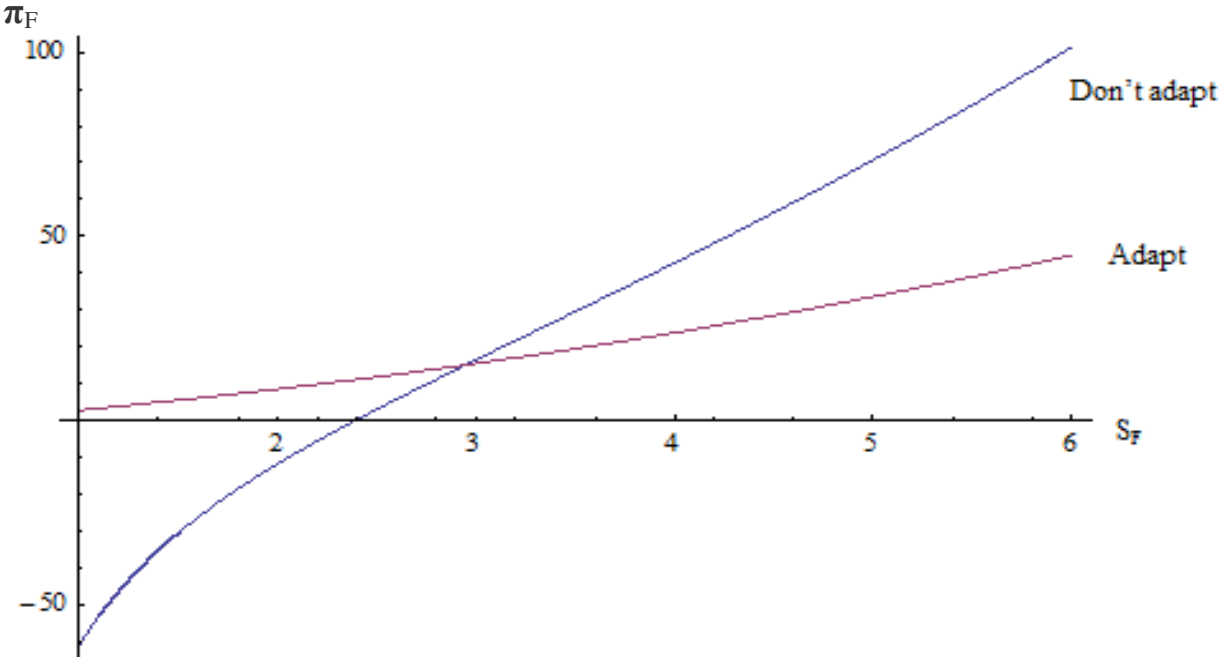

Figure 3. *F*-firm profits under the predatory the "adapt quality" and "don't adapt" alternatives with respect to density S_F, given $b_H = 5$, $b_F = 3$, $c_H = 3$, $k_F = 0.8$, $k_H = 0.3$.

At low levels of S_F the *F*oreign firm maximises profit by adapting quality to the new open market (the red curve). At larger S_F the *F*oreign firm maximises profit by exporting its autarky quality (s the blue curve). Given the parameter values illustrated, the alternatives are equally profitable at S_F=2.9. Above that size, exporting the autarky quality is more profitable. Facing a large number of consumers with a low willingness to pay for quality in *F*oreign, the *F*oreign firm has insufficient incentives to incur a fixed cost of switching to higher quality to sell to the *H*ome country consumers.

Consider how this result varies with respect to b_H. When the willingness to pay for quality in *H*ome, b_H, is higher, it is more difficult for the *F*oreign firm to implement a successful predatory strategy. But there is still a *F*oreign size at which the predatory strategy dominates. As shown in Figure 4, with b_H=7, values of other parameters being the same, the predatory strategy is not profitable at all for $S_F < 2$. For $2 < S_F < 5.2$, the *F*oreign firm has the incentive to adapt quality and serve more *H*ome consumers. The size effect dominates after $S_F > 5.2$. Above that size the *F*-firm most profitably exports its autarky quality in a predatory strategy.

[3] Details of the calculations are available on request to the authors.

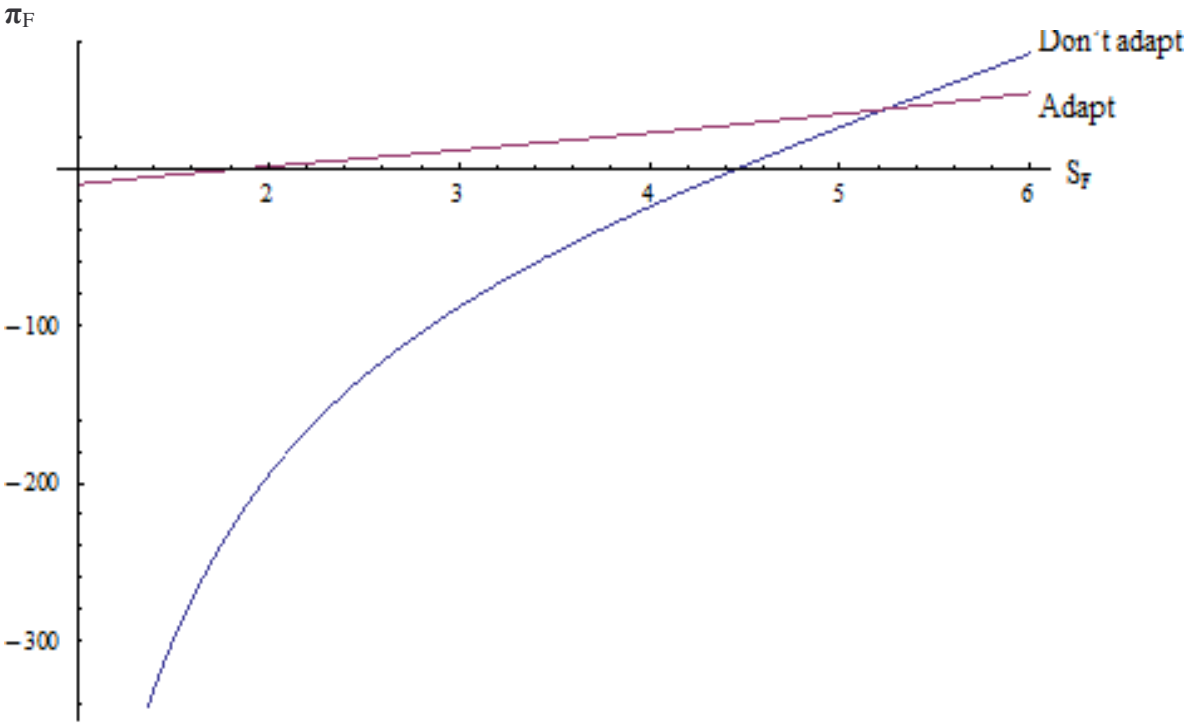

Figure 4. Foreign firm profits under alternative predatory strategies (adapt, not adapt) with respect to S_F , given parameters $b_H = 7$, all else equal to Figure 3.

In this section we have shown that a 'predatory' strategy model rationalizes the observed exclusively low quality goods on an open market following the entrance of a very large, relatively poorer country. The size of the emergent country is key, as is the relative willingness to pay for high quality. When the emergent country is small, as we shall show in the next section, its most profitable strategy is to play a non-cooperative game. That results in the more diverse quality outcomes that have been common in the past on open markets.

When the emergent country is more than thrice the size of its trade partner (depending on other parameters), it maximizes profit by implementing a predatory strategy in which it simply exports its autarky quality when it opens to trade. The threshold size is increasing in the willingness to pay for quality in the *H*ome country, but there is always a sufficiently large size at which the predatory strategy is the most profitable. The best response to the predatory strategy in *H*ome leaves the high quality firm with zero profit (or lower), ultimately driving it out of the marketplace. The ultimate outcome is exclusively lower quality goods after the emergence, compared to before. This is the outcome observed in some markets (e.g., clothing) since China emerged on global markets.

6. Comparison with the simultaneous non-cooperative Cournot Game

In this section, for purposes of comparison we consider the situation where the monopoly firms in the two countries play a non-cooperative game when they open to trade, as in the existing literature (e.g., Motta, *et al* (1997)). In the first stage they simultaneously choose qualities u_H and u_F and in the second stage they compete in quantities q_H and q_F. According to the existing literature, depending on the values of the parameters b_j, S_j, c_j, and k_j, there

may be multiple Nash equilibria, including "leapfrog" equilibria (where the low quality producer switches to a higher quality than the high-quality rival).

Assuming both adapt quality to the open market, as in the existing literature, the firms' profits are as usual, given by equations (10) and (15). We solve by backwards induction. First, find the production quantities that maximize their respective profits. The first order condition solutions consistent with a negative second derivative are:

$$q_H = \frac{(b_H + S_F b_F)(2u_H - u_F)}{(4c_H(1+S_F) + 4u_H - u_F)} \qquad \text{and} \qquad q_F = \frac{(b_H + S_F b_F)(2c_H + (1+S_F) + u_H)}{(4c_H(1+S_F) + 4u_H - u_F)}$$

Substituting these expressions into π_H and π_F we obtain:

$$\pi_H = \left(\frac{(b_H + S_F b_F)^2 (u_H + c_H(1+S_F)(-2u_H + u_F)^2}{(1+S_F)(-4c_H(1+S_F) - 4u_H + u_F)^2} \right) - k_H u_H^2 \qquad (19)$$

And $$\pi_F = \left(\frac{u_F((b_H + S_F b_F)^2 (u_H + 2c_H(1+S_F)^2}{(1+S_F)(-4c_H(1+S_F) - 4u_H + u_F)^2} \right) - k_F u_F^2 \qquad (20)$$

At the first stage, the firms simultaneously choose the quality to supply to maximize these profit 'functions.' The first order condition solutions consistent with negative second derivatives are the Nash equilibria of the game.

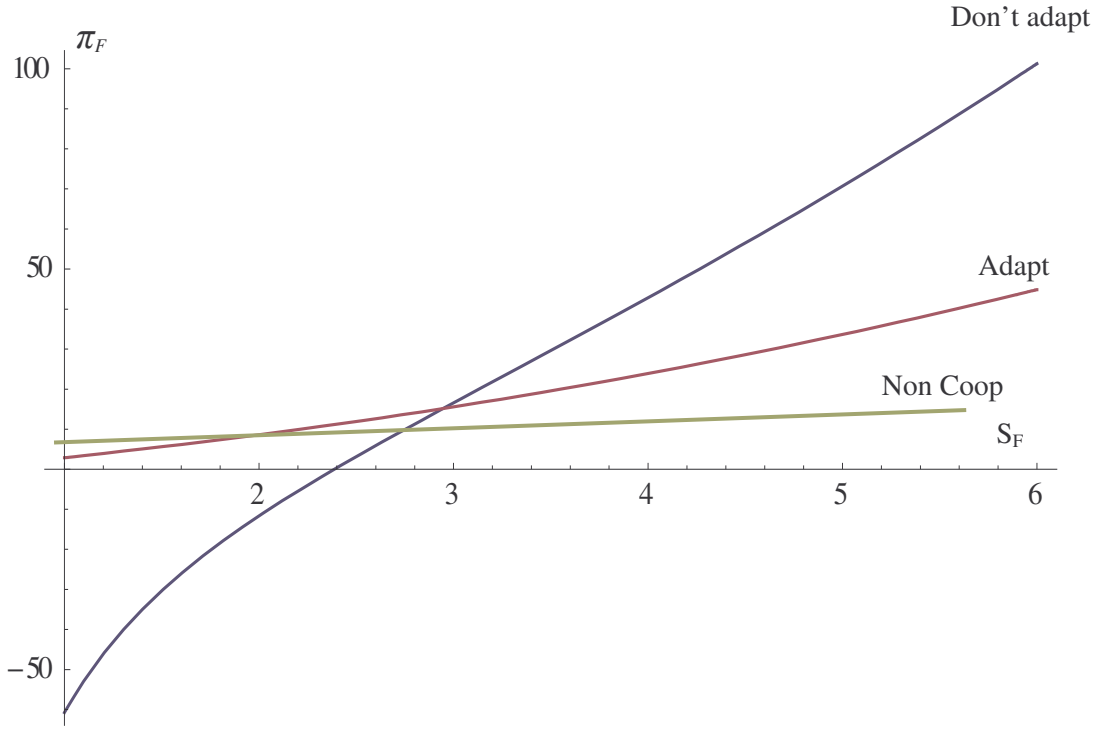

Figure 5: *F*oreign firm profits as a function of S_F for both predatory strategy alternatives and the non cooperative strategy, $b_F = 3$, $b_H = 5$, $c_H = 3$, $k_F = 0.8$ and $k_H = 0.3$

Compare the *F*oreign firm's profits from a non-cooperative game strategy to its profit from the alternative predatory strategies. The analytical solutions are prohibitively difficult. We can, however, identify superior strategies via simulation, assuming values for the parameters

($b_F = 3$, $b_H = 5$, $c_H = 3$, $k_F = 0.8$ and $k_H = 0.3$), and investigate how the strategy rankings vary with respect to the parameters, especially the *F*oreign market size or density, S_F.

In Figure 5 the *F*oreig*n* firm's profit as a function of S_F from both alternative predatory strategies is compared to profits when it participates in a simultaneous non-cooperative game.

Figure 5 shows that at low levels of S_F the *F*oreign firm maximises profit by playing the non-cooperative game. When its size or density S_F is larger than 1.9, the *F*oreign firm maximises profit with the predatory strategy alternative in which it adapts quality. At levels of S_F higher than S_F =2.9, it is most profitable for the *F*-firm to implement the predatory strategy with a low autarky quality, as shown in the previous section.

As seen, this threshold size is directly proportional to the difference in the willingness to pay for quality. This is illustrated in Figure 6. When b_H is raised to 7, all else equal, the predatory strategy is not profitable below $S_F = 5.2$. However, once again, even with a significant difference between the willingness to pay for high quality, the effect of that difference is ultimately overwhelmed by the difference in size. In Figure 6 the size effect dominates after $S_F > 5.2$. Above that size the *F*-firm can most profitably export its autarky quality in a predatory strategy. Note also that when b_H =7, the *F*-firm predatory strategy alternative "adapt" is dominated at all values of S_F.

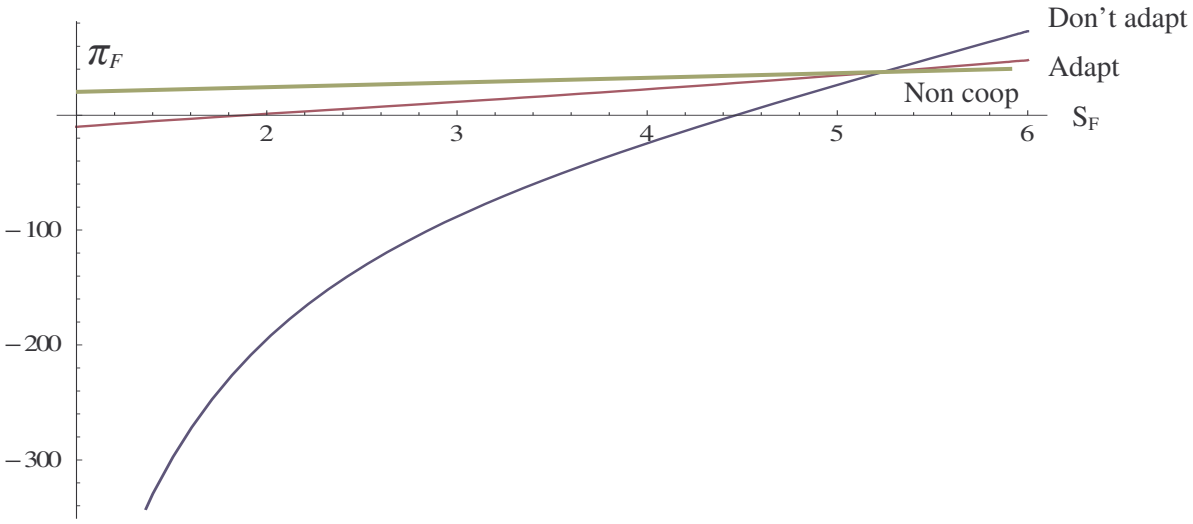

Figure 6. Foreign firm profits with respect to S_F under both predatory strategy alternatives and the non cooperative strategy; $b_F = 3$, $k_H = 0.3$, $c_H = 3$, $k_F = 0.8$, $b_H = 7$.

Conclusions

This paper provides theoretical explanations for what has occurred in many developed countries since China emerged on global markets. We have proven how a large country's low-quality exports can dominate an entire market, not only where low-price, low-quality goods are demanded, but also where there is a number of consumers willing to pay for high quality. We have shown how large can lead to less.

China's exports of low quality manufactured products such as clothing, footwear, and toys have been documented by Amiti and Freund (2010) and Husted and Nishioka (2012). Our model shows that an emergent's country quality is inversely proportional to the cost of quality and directly proportional to its size. The finding augments the typical explanation that emerging economies export low quality goods strictly because their labour is low-priced.

The importance of emergent country size, Proposition 1, helps explain why China has managed to dominate some markets while other low-labour cost countries have not. Proposition 2 clarifies how a very large emerging country's lower quality exports can drive high-quality producers out of the market, despite the existence of customers willing to pay for higher quality. These findings are unprecedented in the literature, but widely observed in open markets for some goods. We have shown how free trade can lead to less quality diversity rather than more.

We have shown that a 'predatory' strategy model rationalizes the observed exclusively low quality goods on an open market following the entrance of a very large, relatively poorer country. The size of the emergent country is key, as is the relative willingness to pay for high quality. When the emergent country is not too much larger than its trade partner, we have shown that its most profitable strategy is to play a non-cooperative game (section 6). Thus, when the countries opening to trade are relatively similar in size, the outcome to be expected is more quality diversity, including high quality, on the open market. That outcome has occurred, especially in the past. This also explains why the previous literature analyzed intra-industry trade in vertically differentiated goods assuming similarly-sized countries a non-cooperative game market structure.

However, when the emergent country is very large, we have shown that it maximizes profit by implementing a predatory strategy in which it exports its autarky quality when it opens to trade. The best response to the predatory strategy in the relatively smaller country can leave its high quality producers unable to cover costs, ultimately driving them out of the marketplace. Again, the size of the emergent country's domestic market is essential. The size at which a predatory strategy can succeed is directly proportional to the trading partner's willingness to pay for quality, but there is always a sufficiently large size at which the predatory strategy is most profitable for the emerging country. The ultimate outcome is exclusively lower quality goods on the open market, compared to before its emergence. This is the outcome observed in some markets (*e.g.*, clothing) since China emerged on global markets.

While our analyses have provided plausible answers to these questions, we have also opened new lines of inquiry for future research. As noted earlier, since 2009 China has been the world's largest exporter. It may be that no single set of assumptions about size, costs, preferences, and market structure can explain China's success on global markets. For example, in *"What's So Special about China's Exports?"* Rodrik (2006) noted that although China exported relatively low quality goods twenty years ago, more recently China has been exporting "goods that are three times more sophisticated than what would be normally expected for a country at its income level" (Rodrik, 2006). It has dominated in markets for high-tech goods such as cell phones, liquid crystal displays, integrated electronic circuits, and laptop computers. In fact, by 2009, China supplied 85 percent of the imported laptops on the US market (Berger and Martin, 2011). Meanwhile there has been an explosion in Chinese demand for these products as well.

Our model provides a point of departure for future research in a few ways. One, domestic market size can be even more important than costs or wages, *i.e.*, incomes, in explaining the quality of goods exported by emerging countries. This is empirically testable. Two, the lower are the costs of switching to higher quality, the more likely is leapfrogging. This is the case in China today with respect to high tech production. Three, in this paper we have abstracted from leapfrogging, because when emerging countries leapfrog the outcome is more quality, not less, which is not the outcome we have sought to explain. We already know that leapfrogging is more likely the more similar are the trading partners with respect to willingness to pay for quality. Clearly it could be interesting to analyze the outcomes of our predatory model allowing for leapfrogging and alternative quality switching costs.

Appendix I. Example of a Successful Predatory Strategy

As an example, consider $b_H = 5$, $b_F = 3$, $k_H = 0.3$, $k_F = 0.8$, $c_H = 3$ and $S_F = 3$.
With these values of the parameters we can see from (1) and (2) that in autarky, the Home firm produces high quality and the Foreign firm produces the lower quality:

$u_{HA} = 9.8488$ and $P_{HA} = 30.3709$; $u_{FA} = 4.218.$ and $P_{FA} = 6.328$

Note that the Foreign firm is able to serve half of its market when the Home firm offers $q_{HA} = 1.916$

If the Foreign firm offers a global quantity and a quality such than $q_F . u_F = G$ (see(14)), then the best response of the Home firm is to offer a different (higher) quality and the quantity that maximizes its profit, given by equations (11) and (13).

Putting these optimal values in (10) with $q_F . u_F = G$, we obtain $\pi_H = 0$.

What happens to the Home firm ? It is able to offer, according to (11) , (13) and (8), a quantity $q_H = 2.932$ and quality $u_H = 13.521$, at the price $p_H = 27.502$. Note that Home firm has raised the quality and decreased the price of its good (relative to autarky) in response to competition from the Foreign firm.

The quantities that the Home firm could offer on each market (see (6)) are

$$q_{HH} = \left(b_H - \frac{p_H - p_F}{u_H - u_F} \right) = 2.233 \qquad \text{and} \qquad q_{HF} = S_F \left(b_F - \frac{p_H - p_F}{u_H - u_F} \right) = 0.699$$

(Note that using (8) and (9), we obtain $\tilde{\theta} = \frac{p_H - p_F}{u_H - u_F} = \frac{b_H - q_H + S_F b_F}{(1 + S_F)}$ so we do not need to know p_F and u_F to obtain these results).

The corresponding revenues from each market are $R_{HH} = 61.412$ and $R_{HF} = 19.223$
However, having chosen to adapt quality, the *H*ome firm must pay the fixed cost ($k_H u_H^2$ =54.845) as well as production costs ($c_H q_H^2 = 25.79$). The resulting profit $\pi_H = 0$.

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