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"A model of international trade with vertical differentiation and Stackelberg leadership"

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A model of international trade with vertical differentiation and Stackelberg leadership.

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ABSTRACT

This paper uses a model of international trade under duopoly to investigate under which conditions a large country's entrance on world markets can lead to lower and less quality diversity available to consumers rather than more. In our partial model, autarky quality is 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. 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 and when the difference in willingness to pay for quality between countries is not too large.

JEL Classification: L13, F12

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Introduction

Our theoretical paper answers the hypothetical question: "is the complete domination of a market by lower quality imported versions possible?"
We attempt to explain under which conditions high-quality goods can be driven out of an open market by lower-quality alternatives, even though there are consumers willing and able to pay for quality. Applying industrial organization theory, we identify the particular conditions under which such an outcome may occur. Those conditions do not obtain in all product lines or markets. In particular, this paper is not about the world market for luxury goods, especially not "Veblen" goods where a high price indicates the status of the consumer rather than the ratio price/quality of the good[2].

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

Using standard duopoly models of vertical differentiation, the trade literature provides four main results consistent with the industrial organisation literature about what happens when two same size countries with a monopoly firm in each 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. But 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. Four, there is a two-way trade in different qualities identified as intra-industry trade[3].

Models of North-South trade such as Falvey and Kierzkowski, 1987, or Flam and Helpman, 1987, predict a simple division of labour in which developed economy firms produce the more expensive high quality goods for high-end consumers, while emerging economy firms satisfy the demand for low-priced, lower quality goods. Two-way North-South trade allows high quality-loving consumers in both countries to obtain high quality goods, and low price customers in both countries to obtain lower quality goods. For Flam and Helpman, 1987, another expected result of North-South trade should be an overall rise in quality of traded goods.

Is this result obtained under all conditions, particularly if we consider the entry of a very large emerging country in international market? Is it possible that the producer of a less developed country, producing a lower quality, can squeeze out the higher quality good initially produced in the developed country?

In this paper, we theoretically answer these questions. As we further demonstrate, the domestic demand conditions are crucial: there is a direct relation between the difference in the sizes of the domestic markets and the feasibility that the firm producing the lower quality can impose a strategy that forces the higher-quality, smaller country firm out of the market.

[2] Also, "lower" quality does not necessarily mean bad quality.

[3] Krugman (1980) referred intra-industry trade as two-way trade in horizontally differentiated products while Brander, Krugman (1983) referred intra-industry trade as two-way trade in similar goods. However, in the type of models used in this literature, goods of different qualities belong to the same industry and it is possible to identify two-way trade as intra-industry trade.

Furthermore, differences in willingness to pay for quality between trading countries constitute a second determining element in this phenomenon.
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.

Motta, Thisse and Cabrales (1997) showed the importance of domestic conditions for international trade in vertically- differentiated goods. Their canonical model consists of two firms in two countries with the same size populations. Consumers are characterized by their tastes and their willingness to pay for quality, which differ between countries. Quality is costly to produce. Firms producing a good identified by a quality index compete strategically for shares of the global market in a two-stage game. 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 equilibrium, two-way trade occurs but multiple Nash equilibria exist. A "leapfrog" equilibrium cannot arise, however, if the difference between the two countries' willingness to pay for high quality is sufficiently large.

Another paper explains how lower-quality goods can come to dominate open markets: Jansen and Faria (2002) showed that in an asymmetric information environment where consumers are unable to recognize product quality without labelling, higher quality products will tend to disappear. If quality costs more to produce but consumers cannot distinguish high from low quality goods, this is not a surprising outcome. Our interest in this paper is to rationalize how it might occur even when consumers can recognize quality without explicit documentation.

In sum, the existing international trade and industrial organization theories indicate that in a perfect information environment in which consumers have different tastes and different willingness to pay for quality, firms have incentives to differentiate supplies to satisfy the various 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.

The assumption that the trading countries are of similar size may be one critical weakness of the existing models. Given size differences, there is reason to doubt the validity of the assumption that strategic interaction is simultaneous. Why should a large country firm engage in a non-cooperative simultaneous game on a level-playing field when it exports to a much smaller market. With a huge domestic market, large economies of scale, and lower unit production costs, why wouldn't such a firm behave as a leader, forcing small-market firms to adapt in response? In a world where firms in some countries enjoy 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, quantity) offers.
This is what we assume in this paper. Our basic set-up is related to the one presented by Motta *et al*, 1997. Our partial equilibrium model consists of two countries, one small but implicitly rich, with a share of consumers willing to pay for higher quality, 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 compared to the small, rich country firm. A 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 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, in some sectors and under some conditions, a low quality product supplied by a large country can capture an entire market.

We analyze the feasibility of this aggressive predatory strategy maximizing profit, and investigate the conditions of 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 firm 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 adjusts its (quality, quantity) offer in an attempt to relax the competition on its own market and export on the foreign market, we find cases where its 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 partial equilibrium model and the autarky situation. Section 3 analyzes 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, focusing on the implications of size and differences in the willingness to pay for quality between trade partners. 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"). On the supply side, in each country (*j=H,F*), a monopoly firm produces a vertically differentiated good. Firms incur a production cost $C_j = c_j q_j^2$ that is quadratic in the quantity q_j produced in country *j*, and a fixed cost of quality $K_{ju} = k_j u_j^2$ that is quadratic in the quality u_j chosen by the firm in *j* .

On the demand side, in each country a continuum of consumers of "normal goods"[4] indexed by their taste[5] for quality θ are uniformly distributed over the interval [0, b_j] with density S_j.

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. In autarky, when just one quality u_{jA} is available, consumers with θ

[4] We exclude from our analysis the luxury goods consumers.

[5] Motta, 1993, p.115, underlines that θ "can be interpreted as the marginal rate of substitution between income and quality" and that "under this interpretation the model proposed here is the analog of the models where consumers differ by their incomes rather than by their tastes".

higher than $\hat{\theta}_{JA} = \frac{p_{jA}}{u_{jA}}$ buy one unit of the good. Autarky market demand in each country is

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

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 existing literature where countries have the same population, e.g., Motta, *et al*., (1997). We normalize $S_H = 1$.

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

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

Thus, we introduce significant asymmetry between countries, allowing us to define 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, and a large population of consumers less willing or able to pay for high quality.

Given the fixed cost of quality, to maximize profits, firms will produce only one quality[6]. 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 autarky quantity is:

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

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

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

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

[6] This is intuitive but proof is available under request.

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 produce low quality goods strictly because their labour is low-priced. Producing lower quality goods is also a rational choice when the domestic consumers have a lower willingness to pay for quality, and the fixed costs of quality are higher.

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 differences in domestic 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), the autarky quality produced by the firm in the larger country will be higher.

To formalize the case 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*. This condition is:

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

For the remainder of this paper, we employ parameter values that are consistent with this initial condition.

3. Free Trade

When the two countries open to trade, both low and high quality versions become 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 version (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 version (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 opening to trade, each firm faces a new set of demands due to the new variety in the willingness to pay for quality since $b_H \neq b_F$, and the new number of consumers at each willingness to pay, since $S_H \neq S_F$.

The usual assumption in the industrial organisation literature is that firms have incentives to adjust quality to supply the global market. To adjust they must pay a fixed cost.

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. For that reason we do not assume that adjustment costs depend on the magnitude of the change in quality.

Following the seminal paper by Brander and Krugman (1983), in models of international trade under oligopoly where it is assumed that firms have constant marginal production costs, e.g., Venables (1990) and Motta *et al* (1997), firms segment the market in prices, then maximize global profit by choosing to supply one quality each, on both markets. Our assumption that production costs are quadratic rules out segmenting the market in prices. Given our assumed fixed cost of quality, firms choose to supply a single quality to both markets and the quantity that maximizes their own profit from the global market.

Taking into account our assumption on strong asymmetries among countries and according to the findings in Motta *et al* (1997), we simplify the model by avoiding leapfrog equilibria because they are not selected when the differences between the trading countries are as large as we assume. The *H*-firm credibly plans to continue to supply the higher quality after *F* opens to trade[7].

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

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

given S_H normalized to 1, and assuming both qualities are available in both markets. Similarly, from (5), the global market demand for lower quality version 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 (see (4)) 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 are differences 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

[7] This is also consistent with the expected division of labour in the models of North-South trade.

with positive demand for high quality versions among country *F* consumers, *i.e.*, consistent with two-way trade.

4. The Predatory Strategy

Our objective in this paper is to challenge if higher quality versions of some goods might disappear from a developed country's open market even when two-way trade is feasible. We know that this outcome is not rationalized by assuming that firms play a two-stage non-cooperative game, as in the existing literature. In contrast, we assume that, in order to maximise its profit, a large country firm most profitably behaves as a Stackelberg leader who ultimately monopolizes the global market.

We give the developing country a first mover advantage, especially for quality. This is not usual. It is assumed in general that innovation mainly takes place in developed countries where firms usually propose new high quality goods as leaders: they are "leaders in quality". This does not mean that they move first in the game. Innovation takes time and rich country firms must adapt their quality/prices to poorer country consumers and lower willingness to pay for quality.

We justify our assumption by the large size of the developing country. With a huge domestic market, large economies of scale, and lower unit production costs, why wouldn't such a firm behave as a leader ? In a world where firms in some countries enjoy huge domestic markets, their exports to a small country represent a small part of their production and it may be realistic to assume that such firms assert their ability to lead, by rapidly offering their autarky quality and forcing smaller country rivals to follow their offers.

The game 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 attempts to choose a quality and quantity that maximizes its 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.

We assume that the *H*-firm in the developed country always adapt the quality produced after trade is allowed. On the contrary, we will see further, in section 5, that the *F*-firm can do it or not, depending of its domestic market size. Why do we introduce such an asymmetry ? First, the choice (adapt or not) is related to the cost of adapting quality. If developing a new quality had no cost, it would always be better to do it. We assume therefore that, with lower product line switching costs the *H*-firm has always incentives to adapt its quality after the market is opened while the *F*-firm bearing high cost of adapting quality has no incentives to adapt. Second, this assumption relies on the countries' size difference. Facing a very large domestic market with a lower willingness to pay for quality, the *F*- firm has insufficient incentives to incur a high fixed cost of switching to higher quality to sell to the small *H*ome market. At the opposite, the *H*-firm with low fixed cost of quality is concerned by the possibility to sell on a huge Foreign market by adapting its quality to the *F*-consumers[8].

[8] Analyses of this game assuming *H*ome does not adapt results in theoretical outcomes inconsistent with the narrower diversity and lower open market quality outcome we seek to explain. If *H*ome does not adapt, (i) for (b_H - b_F) very large, the necessary condition for positive demand for the high quality good in country *F*

Assuming that the *H*-firm will adapt its quality ($u_H \neq u_{HA}$), *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:

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

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. Is there a pair (q_F, u_F) which nullifies π_H?

($b_H - b_F < q_H$) is not verified. Without adaptation, poor country consumers cannot buy the *H*-firm high quality good and *H*ome serves its domestic market only; (ii) at lower (b_H - b_F), there is a threshold S_F at which *H*ome also serves only its domestic market, and (iii) with (ii) and a larger S_F, there is leapfrogging, also leading to *higher* quality in the open market than in autarky. Proofs are available from the authors on request.
For that reason, the remainder of this paper focuses on the cases in which *H*ome does adapt.

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. Finding the value of λ that nullifies this *H*-firm's profit by equating $\pi_H(S_F, b_j, c_H, k_j, \lambda, u_F)$ to 0, we obtain:

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

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

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

Setting $q_F = \lambda q_H$, we obtain $q_F = \left[\frac{G}{u_F}\right]$ with

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

In sum, this is a game in which the *F*-firm is able to drive the *H*-firm profits (12) to zero by offerring $q_F . u_F$ = G. Clearly, when the *F*-firm offers the pair (q_F , u_F) such that $q_F . u_F$ = G + ε, the *H*-firm's revenues will not cover costs, which drives the higher quality version out of the market.

5. The feasibility conditions for a predatory strategy

The predatory strategy by the firm in country *F* is to offer a pair $\{q_F, u_F\}$such that $q_F . u_F = G$ (14).

Under what conditions can the *F*-firm successfully--most profitably-- 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. In this case:

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

Thus there are two alternatives. The F-firm either does, or does not, adapt its quality when it emerges as an exporter on the world market.

We analyze each in turn.

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 be sufficiently large (have a high density of population). The threshold density for a feasible predatory strategy is positively related to rich country consumer's willingness to pay for quality (b_H).

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 relatively to b_F) 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 in open market, 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 net of the supply by the *H*-firm:

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

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

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

From (2) we know that $u_{FA} = \frac{S_F b_F^2}{8\ k_F}$, which must be higher than the minimum as per (17) .

This allows us to express the magnitude of 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 profit (15') is higher than under any other strategy. It follows from (17) and (2) that in order for the *F* firm to be able to propose a pair $q_F.\ u_F = G$ leading to $\pi_H = 0$, S_F must be sufficiently large, *i.e.*, it must be that:

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

We illustrate via simulation how the autarky quality (given by (2)) and the minimum autarky quality consistent with a predatory strategy by country *F* (17) vary with the density, S_F. 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

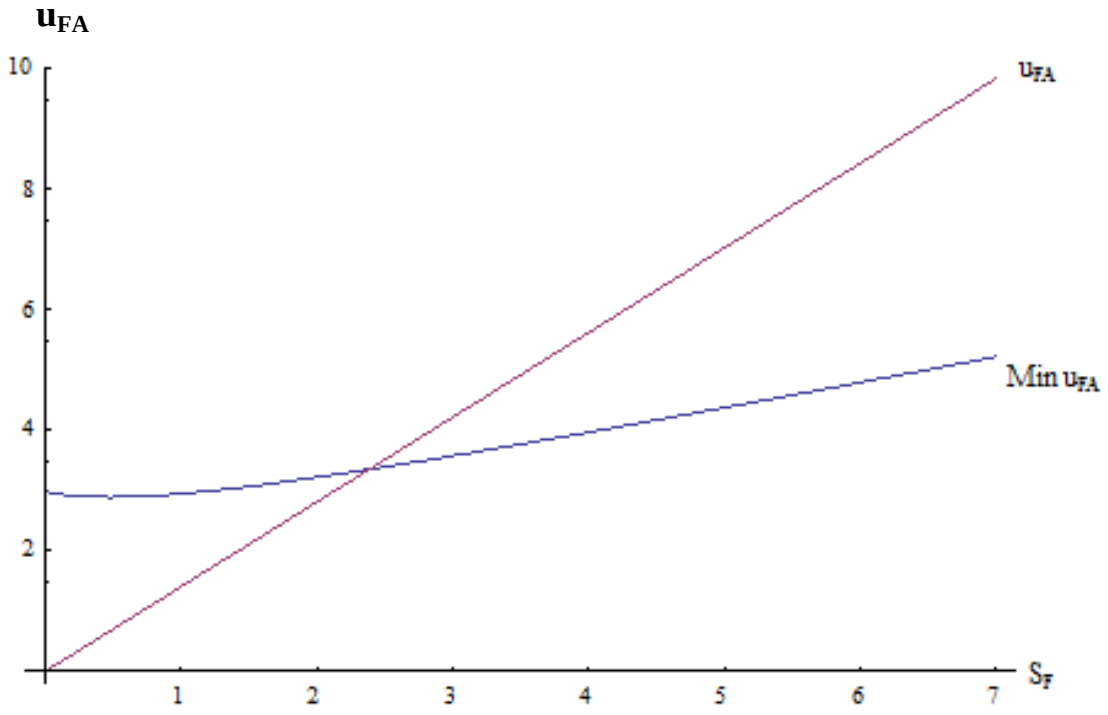

Figure 1. Autarky quality in Foreign, u_{FA}, compared to the minimum quality choice required for a successful predatory strategy (Min u_{FA}) with respect to Foreign size S_F, assuming b_H = 5, b_F = 3, c_H = 3, k_F = 0.8, k_H = 0.3.

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 cannot 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 to be able 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 sufficiently 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, or the emergent country density must be higher, 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.

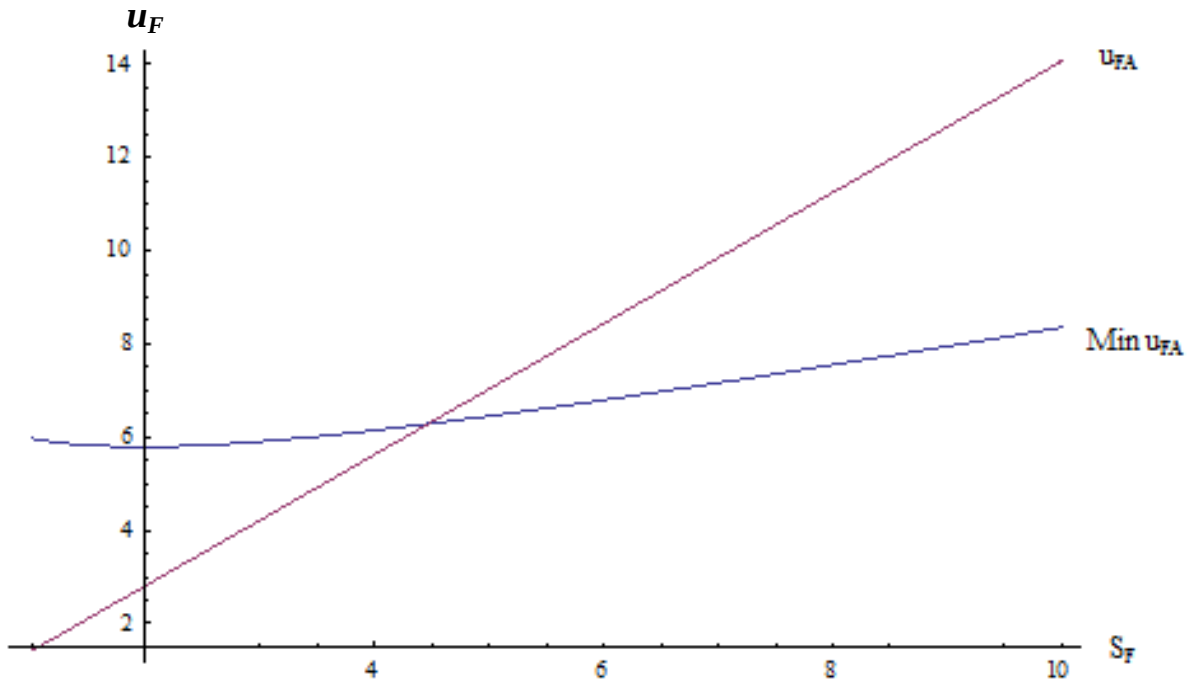

Figure 2. Autarky quality in Foreign, u_{FA}, compared to the minimum quality required for a successful predatory strategy (Min u_{FA}) with respect to Foreign size S_F; assuming $b_H = 7$ (all else the same as in Figure 1)

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

Proposition 2:

The emergent country playing a predatory strategy will choose to adapt quality to the new open market when the differences between country willingness to pay for quality and market densities are sufficiently small. Nevertheless if the difference in densities is large, the emergent country firm can successfully dominate the market by exporting its autarky quality.

Now consider the alternative that the *F*oreign firm adapts and exports a different 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 $\frac{\partial \pi_F}{\partial u_F} = 0$.[9]

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.

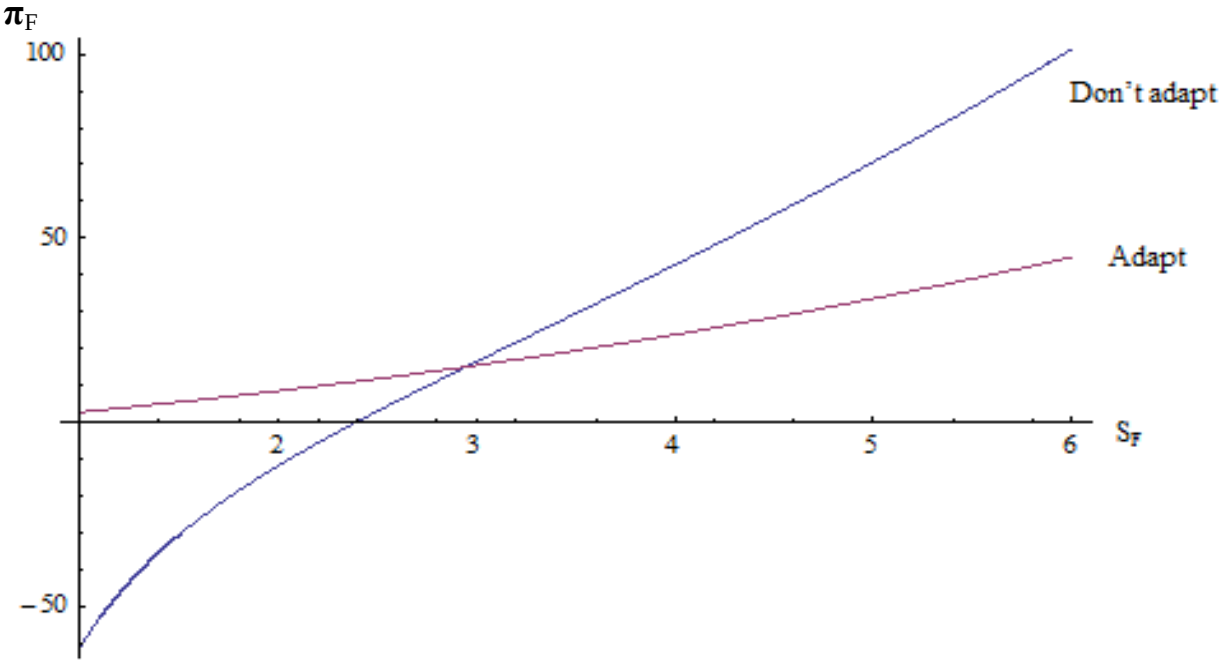

Figure 3. *F*-firm profits under "adapt quality" and "don't adapt" alternatives with respect to density S_F, given $b_H = 5$, $b_F = 3$, $c_H = 3$, $k_F = 0.8$, $k_H = 0.3$.

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 (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 implementable (see Figure 1) and more profitable. Facing a very large number of domestic 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, if the difference between the countries' willingness to pay for quality is not too large.

Moreover, it is straightforward to underline that if the developing country firm has higher cost of adapting quality, all else equal, the "adapt quality" strategy is never possible (the red curve goes down when the value of k_F increases).

Consider how this result varies with respect to b_H. As the willingness to pay for quality in *H*ome, b_H, rises, it is less likely that the *F*oreign firm can 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, all else equal, the predatory strategy is not profitable at all for $S_F \leq 2$. For $2 < S_F < 5.2$, the *F*oreign firm has the incentive to adapt quality (again if the cost of adapting is not too large) and serve more *H*ome consumers.

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

The market size effect dominates after $S_F > 5.2$. Above that size the *F*-firm is able to implement the "not adapt" alternative (see also Figure 2) and most profitably exports its autarky quality in a predatory strategy.

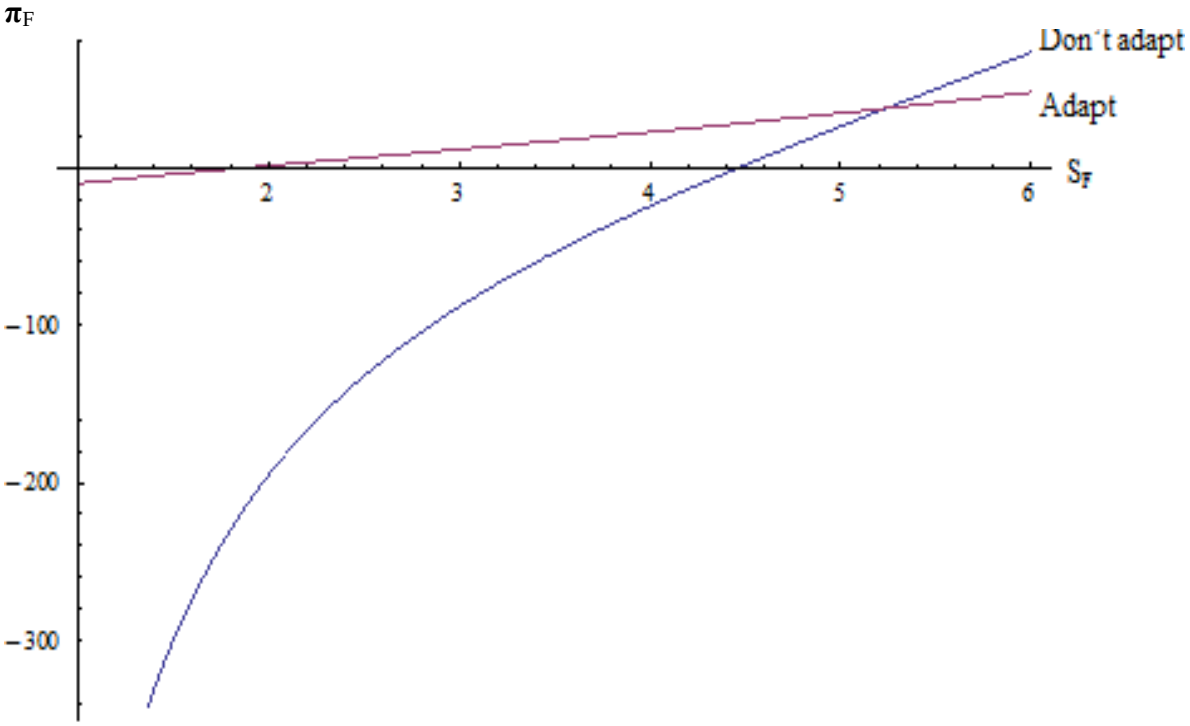

Figure 4. Foreign firm profits under alternative predatory strategies (adapt, not adapt) with respect to S_F , given parameters $b_H = 7$, all else equal to Figure 3.

In this section we showed the conditions under which a 'predatory' strategy is possible. Our model rationalizes the possibility of the dominance of an open market by lower quality versions of normal goods 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 and the Stackelberg assumption of leadership.

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 predicted by the existing literature.

When the emergent country is large enough relatively to the size of its trade partner (depending on other parameters), its firm is able to maximize profit by implementing a predatory strategy in which it simply exports its autarky quality when it opens to trade.
The critical size is increasing in the willingness to pay for quality in the *H*ome country, but there is always a sufficiently large size of the foreign country 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, ultimately driving it out of the marketplace. The ultimate outcome is exclusively lower quality goods after the emergence, compared to before. This is a possible outcome in some normal good markets where the willingness to pay for quality is weak in the rich countries. The intuition is that for some goods, even rich consumers know that the use of their purchases will not last and that they will have to soon renew the good (e.g., child clothing and footwear, toys). Their willingness to pay for quality is weak. When *H*ome consumers really care about quality, because of safety reasons (for example on the tire

market or the medicament sector), a predatory strategy is not possible and both high and low quality goods are offered on open markets.

6. Comparison with the simultaneous non-cooperative Cournot Game

The *F*-firm will implement a predatory strategy if and only if its profit, given by (15) or (15') is higher under that strategy than under any other strategy.

In this section, for purposes of comparison, we investigate the profitability for the *F*-firm if the monopoly firms in the two countries play a non-cooperative game when they open to trade, as in the existing literature. 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.

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

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

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 equations. The first order condition solutions consistent with negative second derivatives are the Nash equilibria of the game.

The analytical expressions of the equilibria (available on request) are prohibitively difficult to solve analytically. We can more easily compare the *F*oreign firm's profits from a non-cooperative game strategy to its profit from the alternative predatory strategies via simulation.

Figure 5 illustrates how the strategy rankings vary with respect to density S_F. We show *F*oreig*n* firm's profit as a function of S_F from both alternative predatory strategies compared to profits when it participates in a simultaneous non-cooperative game.

We show that at low levels of S_F (small differences between countries' densities) the *F*oreign firm maximises profit by playing the non-cooperative game. This outcome is consistent with the existing literature. When its 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 its autarky quality, relying on its large market size, as shown in the previous section.

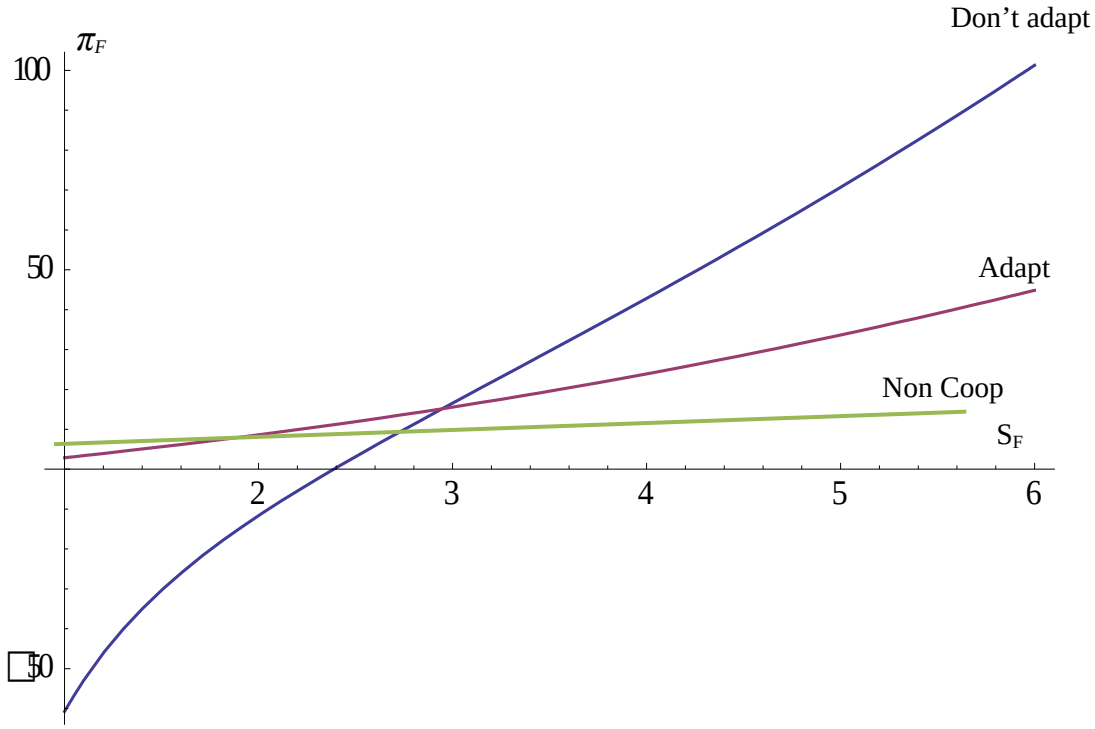

Figure 5: *F*oreign firm profits as a function of S_F for both predatory strategy alternatives and the non cooperative strategy, $b_F = 3$, $b_H = 5$, $c_H = 3, k_F = 0.8$ and $k_H = 0.3$

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.

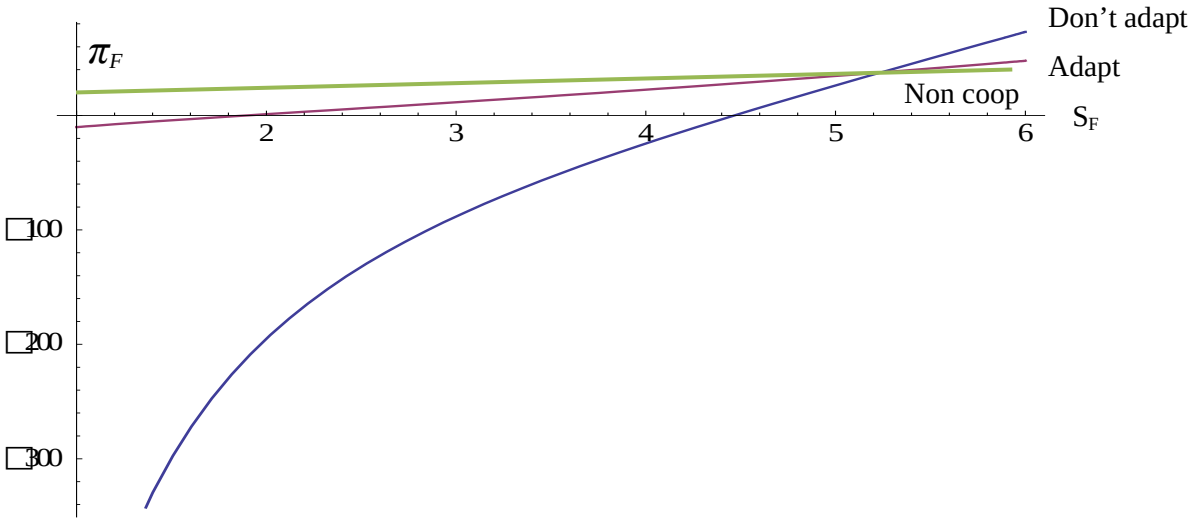

Figure 6. Foreign firm profits with respect to S_F under both predatory strategy alternatives and the non cooperative strategy; b_F = 3, k_H = 0.3, c_H = 3, k_F = 0.8, b_H = 7.

Conclusions

In this paper we asked the hypothetical question: "is the complete domination of a market by lower quality imported versions possible?"
We have showed under which conditions a large country's lower quality exports might dominate a market, or, how free trade can lead to lower quality and less diversity on open markets, rather than more. That kind of outcome was not rationalized by existing theories on the provision of quality under international competition.

We used an industrial organization approach presenting a two different size country partial model with a vertically differentiated duopoly .

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 a two-way-trade, more quality diversity, including high quality, on the open market. This is in accordance with the literature analyzing intra-industry trade in vertically differentiated goods, assuming similarly-sized countries and a non-cooperative game market structure.

Our proposition 1 shows the importance of the market size effect. 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, avoiding the high cost of adapting quality, at the condition that the willingness to pay for quality in the other country is not too high. 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 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.

Proposition 2 shows again that the size of the emergent country's domestic market is essential. At lower differences in the countries' sizes, the larger country firm must adapt its quality in order to play a predatory strategy. But there is a thresholds of the fixed cost of adapting quality where the "adapt strategy" is not possible. In that case, as usually, the *F*oreign firm maximises profit by playing the non-cooperative game.

While our analyses have provided plausible answers to our question, we have also opened new lines of inquiry for future research.

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.

Other further theoretical lines can also be considered.

Our model assumes quantity competition. This is important because under price competition the Stackelberg leader has a first mover advantage, and also because in trade models quantity and price competition sometimes deliver different predictions. One should discuss the possible different impact of price competition assumption.

At last our analysis is a partial equilibrium model. Particularly, in the line of the literature using standard duopoly models of vertical differentiation, we consider trade between two asymmetric countries. We know that we are in a multi-country world. Wouldn't third markets that supply and demand high quality goods undo the results? Future research must verify how robust are our results to a multi-country world.

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