

Title: “Quality in Open Markets: The Sumo Conjecture”

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Abstract:

How can trade expansion lead to lower quality and less diversity? Autarky quality is hypothetically positively related to domestic market size and willingness to pay for quality, and inversely related to the cost of quality. To investigate open market outcomes we formalize strategically interacting firms. We identify when low-quality producers can lead and drive high-quality producers out of the market, despite the existence of customers willing to pay for quality. The strategy is more likely when the emerging exporter is very large but the difference in willingness to pay for higher quality between it and the trade partner is small.

1. Introduction

This paper attempts to explain how high-quality goods can be driven out of an open market by imported lower-quality alternatives, even though there are consumers willing and able to pay for quality. We apply industrial organization theory to rationalize an observed collapse in two-way intra-industry trade in some sectors, resulting in a market dominated by lower price and quality versions. We identify the particular conditions under which such an outcome may occur.¹

Over three decades of literature concerning world markets for vertically-differentiated goods exists. 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).

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 countries with a monopoly firm in each open to trade. One, both firms respond to market incentives to change the qualities 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 two-way trade in different qualities, also known as intra-industry trade. Krugman (1980) defined intra-industry trade as two-way trade in horizontally differentiated products, while Brander and Krugman

¹ The conditions do not obtain in all markets or all product lines. 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. Also, "lower" quality does not necessarily mean bad quality.

(1983) defined intra-industry trade as two-way trade in similar goods. Two-way trade in vertically-differentiated goods of the same industry is a version of intra-industry trade.

Models of “North-South” trade such as Falvey and Kierzkowski (1987) or Flam and Helpman (1987) predict a 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 demands for lower 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.

According to Flam and Helpman (1987) another expected outcome is an overall rise in the quality of traded goods. They predicted that technical progress should result in the production of new, higher quality products from the North, and the disappearance of the old low quality products from the South. Using firm-level data, Martin and Mejean (2014) offer empirical evidence that the average quality of French manufactured exports did increase between 1995 and 2005, following expanded competition from low-wage countries. The average, however, masks reductions in quality in some French sectors.

Consider the effects of the emergence of China on world markets. Berger and Martin (2011) report that Chinese exports more than quadrupled between 2000 to 2007; by 2009 China had become the world’s largest exporter. Evidence of the predicted higher quality diversity and two-way intra-industry trade outcomes has been sparse. Husted and Nishioka (2012) document that initial Chinese exports were low quality manufactured items such as toys, footwear and clothing (adding high quality high technology good exports over the years). Abraham and Van Hove (2011) did not find convincing evidence of either variety expansion or quality upgrading in their study of the impact of Chinese competition on OECD markets. Focusing on China’s longstanding exports of clothing (SITC 84 or CN 61-62), by 2013 China exported 21 billion

euros worth to the European Union eurozone, while importing only 0.97 billion euros worth of clothing from the EU (Eurostat <http://ec.europa.eu/eurostat/web/international-trade/data/data-base>).

According to Gereffi and Frederick (2010), the estimated extra-EU import penetration shares in retail clothing sales range from 55% in Spain to 85% in France and 95% in Germany and the UK. Rather than engage in two-way intra-industry clothing trade with China, the EU's main export destinations for garments are other developed economies: the USA, Switzerland, Japan, Russia, and Norway (European Commission, 2011). Meanwhile the European apparel industry has shrunk dramatically, shedding half its labour force since 1998 (EC 2011, op. cit.).

The entrance of that low-price supplier on the global market for normal apparel goods has not resulted in two-way intra-industry trade and has not resulted in wider quality diversity. The quality of normal or non-luxury apparel available also may have declined, in contrast with theoretical predictions. Is that possible? How could a market become dominated by one-way-trade flows of lower-priced, lower quality goods, despite the existence of more consumers willing to pay for higher quality?

In this article we theoretically answer this question. We call it the “sumo conjecture” because in the strategic game we pose, a player wins (maximizes profit) by forcing the other out. Also as in sumo wrestling, we find that being large is crucial. There is a direct relationship 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.

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 the 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.

One yet unpublished 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 customers 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.

Empirical evidence of one-way trade and a narrower range of quality is inconsistent with those hypotheses. 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 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, price) 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. Given these assumptions, in autarky the large country firm produces a lower quality good 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. We show that the autarkic characteristics of the emerging country are primordial. A large domestic market is essential. We also investigate the

stability of the equilibria of the game, and prove that both this game and the “sumo” strategy maximize a very large emerging country firm’s profit.

The paper is organized as follows: in the next section we present the partial equilibrium 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 small but high quality producer, which we call a sumo strategy. We analyze the feasibility conditions for the sumo 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 sumo 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, “Home” (H) and “Foreign” (F). 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 each country j , and a fixed cost $K_{ju} = k_j u_j^2$ 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 indexed by their taste for quality, θ , are uniformly distributed over the interval $[0, b_j]$ with density S_j .² (Luxury or Veblen goods and their consumers are not the focus of this analysis.) Consumers either buy one unit, or none at all. Consumers of type θ will buy one unit 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

² Motta (1993, p.115) asserts 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 models where consumers differ by their incomes rather than by their tastes.”

autarky, when just 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. Autarky market demand in each country is thus: $q_{jA} = S_j \left(b_j - \frac{P_{jA}}{u_{jA}} \right)$, $j = H, F$.

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

- 1) the willingness to pay for quality is lower in *Foreign* than in *Home* $b_F < b_H$.
- 2) *Foreign* 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 quality is lower in *Home*: $0 < k_H < k_F$.

Thus there is significant asymmetry between the countries. Our assumptions 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 country with a relative abundance of labour, lower wages, and a large population of consumers less willing or able to pay for high quality.

Given the fixed costs 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 autarky quantity $q_{jA} = \left[\frac{S_j u_{jA} b_j}{2(u_{jA} + S_j c_j)} \right]$, and autarky quality is:

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

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

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

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 country is smaller, domestic consumers have a lower willingness to pay for quality, or 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 another significant implication of the differences in domestic market sizes. When there is a difference in the number of consumers in each quality range ('density' S_j), abstracting from differences in consumers' willingness to pay for quality (b) and differences 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:

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

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 demand for the higher quality version (overscored D) is:

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

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

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

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 firms face incentives to adjust quality to supply the global market. To adjust they must pay a fixed cost. Some authors assume an adjustment cost that depends on the difference between the autarky and open market quality. Unfortunately with that 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.

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 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, at the quantity that maximizes their own profit from the global market. According to the findings in Motta *et al* (1997), we avoid 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. The situation in which the *H*-firm supplies higher quality, higher priced versions while the *F*-firm supplies lower priced, lower quality versions is also the division of labour predicted by models of North-South intra-industry trade.

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

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

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 versions facing the *F* firm is:

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

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

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

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

Recall (see (4)) that demand for the high quality good in country F is positive only if

$$b_F > \frac{p_H - p_F}{u_H - u_F}. \text{ Given (8) and (9), we obtain that } \tilde{\theta}_{H,F} = \frac{p_H - p_F}{u_H - u_F} = \frac{b_H + S_F b_F - q_H}{(1 + S_F)}, \text{ and the}$$

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 lower quality versions from F , it will not export high-quality versions to F . This outcome is consistent with the observed pattern of EU-China trade in apparel, for example. To avoid simply “assuming the result,” in the following we assume parameter values consistent with positive demand for high quality goods among country F consumers, *i.e.*, consistent with two-way trade.

4. The Sumo Strategy

Our objective in this paper is to understand how 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 find that in order to maximise its profit, a large country firm most profitably behaves as a Stackelberg leader who ultimately monopolizes the global market. 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 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 adapt³ 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:

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

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:

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

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

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

³ When *Home* does not adapt, the theoretical outcomes are not the narrower diversity and lower open market quality outcomes we seek to explain. In particular, when *Home* does not adapt (i) for $(b_H - b_F)$ very large, *Home* serves its domestic market only (see above), but free trade still leads to *wider* quality choice in *Home*; (ii) at lower $(b_H - b_F)$, there is a threshold S_F at which *Home* 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 available from the authors on request.) For that reason, the remainder of this paper focuses on the cases in which *Home* does adapt.

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:

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

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 “sumo strategy” problem of the F firm. Is there a pair (q_F, u_F) which 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 . Finding 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, we obtain:

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

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

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

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

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

In sum, this is a game in which the F -firm is able to drive H -firm profits (12) to zero by offering $q_F \cdot u_F = G$. When the F -firm offers the pair (q_F, u_F) such that $q_F \cdot u_F = G + \textit{epsilon}$, the H -firm's revenues will not cover costs, which drives the higher quality product out of the market.

5. The feasibility conditions for a sumo strategy

The sumo strategy by the firm in country F is to offer a pair $\{q_F, u_F\}$ such that $q_F \cdot u_F = G$ (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:

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

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

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

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 sumo strategy by exporting their autarky quality must be sufficiently large (have a high density of population in each quality increment, S_F). The threshold density for a feasible sumo strategy is positively related to rich country consumers' willingness to pay for quality (b_H).*

The F -firm can drive the H -firm out of the market by proposing a pair $q_F, u_F = G + \epsilon$ where G depends on the characteristics of the two 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 sumo strategy.

When the F firm exports its autarky quality while behaving as a leader on the open market, it is constrained by the trade-off formalized in (14). The lower its autarky quality, u_{FA} , the higher its global quantity, q_F must be to conform with $q_F \cdot u_{FA} = G$. Nevertheless, its production cannot exceed the global market size net of the supply by the H -firm:

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

In consequence, the minimum autarky quality from country F consistent with a sumo strategy is:

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

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 size (magnitude of market density, S_F) necessary for a successful sumo strategy by the F -firm exporting its autarky quality. A successful sumo strategy is one that

drives $\pi_H = 0$. 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:

$$(18) \quad S_F > \frac{G8k_F}{b_F^2(b_H + S_F b_F - q_H)}.$$

We illustrate via simulation how the minimum domestic market size or density S_F for a successful sumo strategy varies as b_j, c_H and k_j vary, shown in Figure 1. Consider parameter values are consistent with (3) and two-way trade such as $b_F = 3$, $b_H = 5$, $c_H = 3, k_F = 0.8$ and $k_H = 0.3$. Figure 1 illustrates the feasibility of the sumo strategy when the F -firm exports its autarky quality, at different levels of S_F .

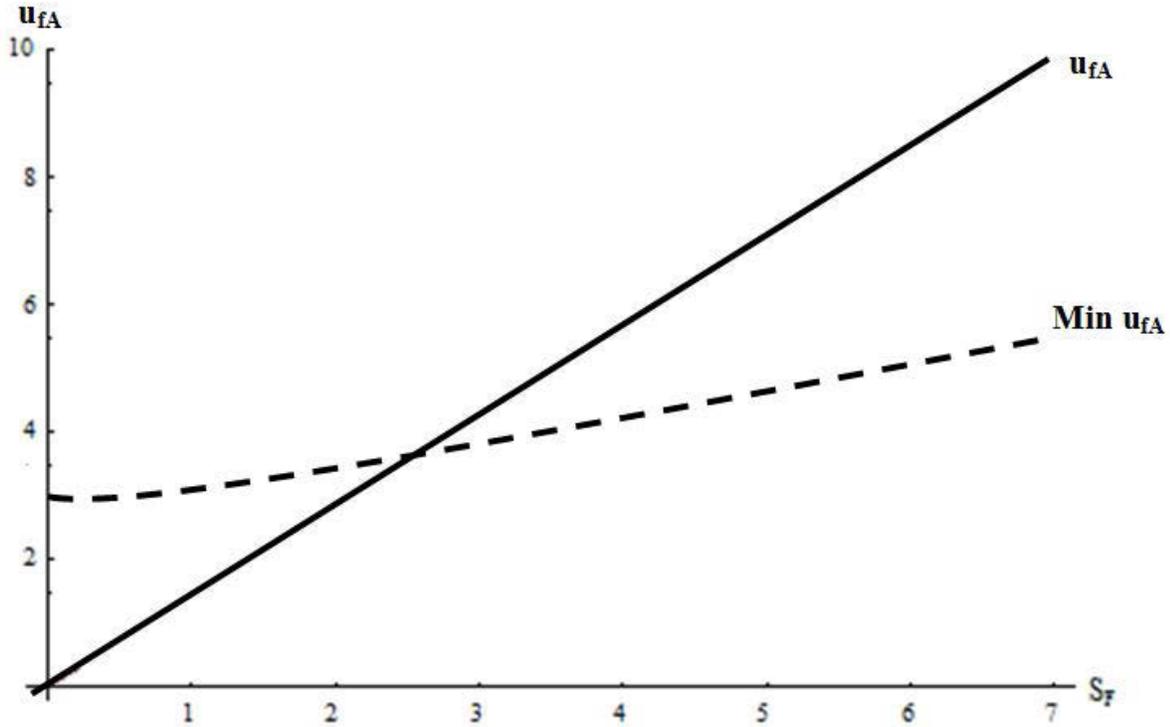


Figure 1. Autarky quality in Foreign, u_{fA} , compared to the minimum quality choice required for a successful sumo strategy ($\text{Min } u_{fA}$) with respect to Foreign size S_F , assuming $b_H = 5, b_F = 3, c_H = 3, k_F = 0.8, k_H = 0.3$.

The steeper (solid) 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 (dashed) represents how the minimum quality consistent with an implementable sumo strategy summarized by $q_F u_{FA} = G$ varies with respect to S_F . On and under the dashed line, $\pi_F \leq 0$. With the illustrated parameter values, the F -firm will not behave as a sumo 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 sumo strategy. This underscores our finding that the emerging country must be sufficiently large to successfully implement a sumo 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 sumo strategy while exporting their autarky quality.

Furthermore, when rich country consumers are willing to pay even more for quality (when b_H is higher), the minimum quality of exports from the emergent country ($\min u_{FA}$) for a successful sumo strategy must also be higher, or the emergent country size (density) must be higher, to succeed with a sumo 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 sumo strategy in F 's autarky quality when the difference in the willingness to pay for quality is larger.

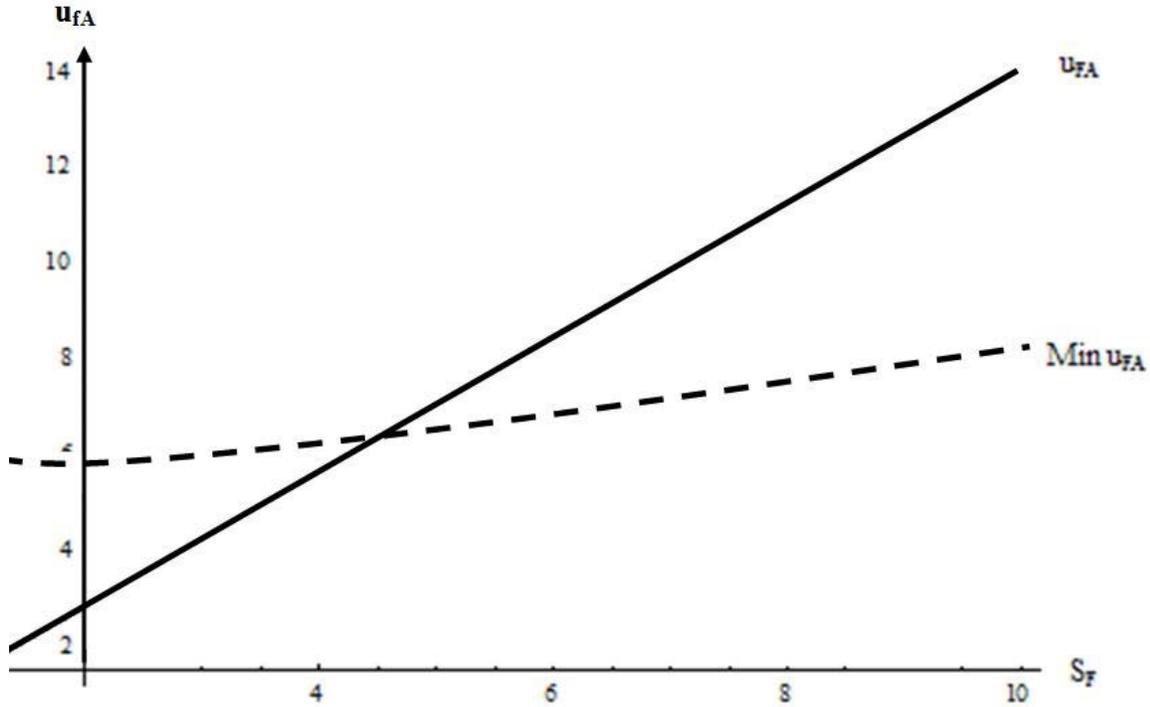


Figure 2. Autarky quality in Foreign, u_{fA} , compared to the minimum quality required for a successful sumo strategy ($\min u_{fA}$) with respect to Foreign size S_F ; assuming $b_H = 7$ (all else the same as in Figure 1) .

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

Proposition 2: *The emergent country playing a sumo strategy will chose 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 market densities is large, the emergent country firm can successfully dominate the market by exporting its autarky quality.*

Now consider the alternative that the Foreign firm adapts and exports a different quality $u_F \neq u_{fA}$ while satisfying $q_F \cdot u_F = G$. In this case the Foreign firm incurs the fixed cost of quality, and π_F is defined as in (15). Using the value of λ which nullifies the Home 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 *Foreign firm's* profit by satisfying the first order condition $\frac{\partial \pi_F}{\partial u_F} = 0$.

Figure 3 illustrates *Foreign firm's* profit under the sumo strategy as a function of size (density) S_F , comparing “adapt quality” to the “don't adapt quality” alternative.

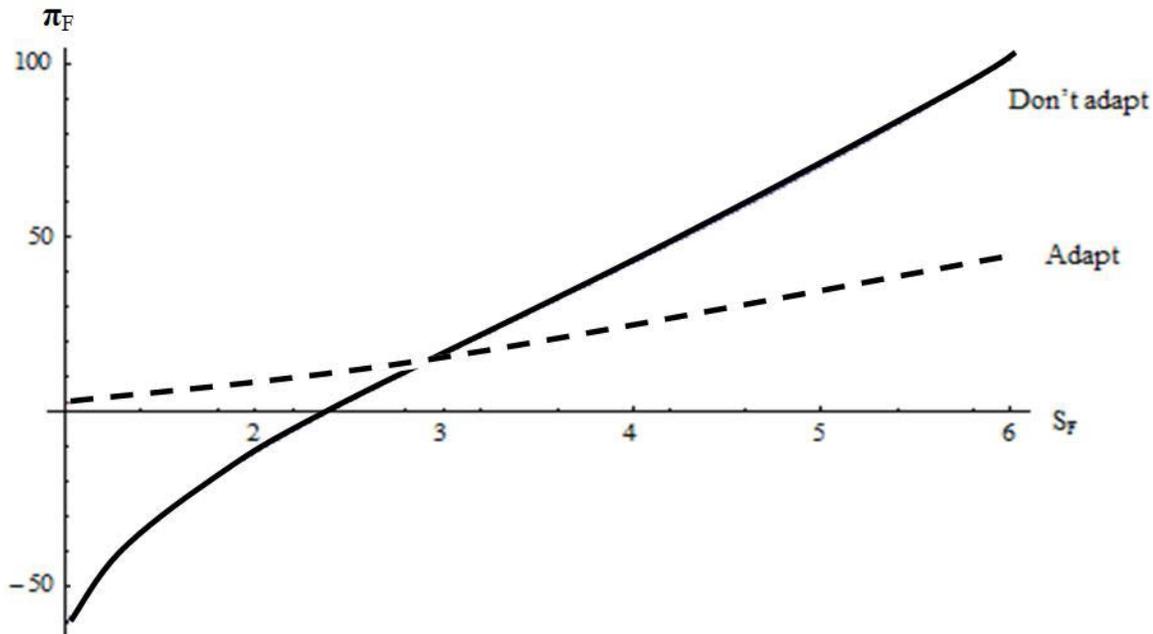


Figure 3. *F*-firm profits under “adapt quality” and “don't adapt” alternatives with respect to density S_F , when $b_H = 5$, $b_F = 3$, $c_H = 3$, $k_F = 0.8$ and $k_H = 0.3$.

At low levels of S_F the *Foreign firm* maximises profit by adapting quality to the new open market (the dashed curve). At larger S_F the *Foreign firm* maximises profit by exporting its autarky quality (the solid 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 very large number of domestic consumers with a low willingness to pay for quality, the *Foreign firm* has insufficient incentives to incur a fixed cost of switching to higher quality to sell on the world market.

Consider how this result varies with respect to b_H . As the willingness to pay for quality in *Home*, b_H , rises, it is less likely that the *Foreign* firm can implement a successful sumo strategy. But there is a *Foreign* size at which the sumo strategy dominates. As shown in Figure 4, with $b_H=7$ (140% of b_H in Figure 3, all else equal), the sumo strategy is not profitable for $S_F < 2$. For $2 < S_F < 5.2$, the *Foreign* firm has the incentive to adapt quality and serve more *Home* consumers. The size effect dominates after $S_F > 5.2$. Above that size the *F*-firm most profitably exports its autarky quality in a sumo strategy.

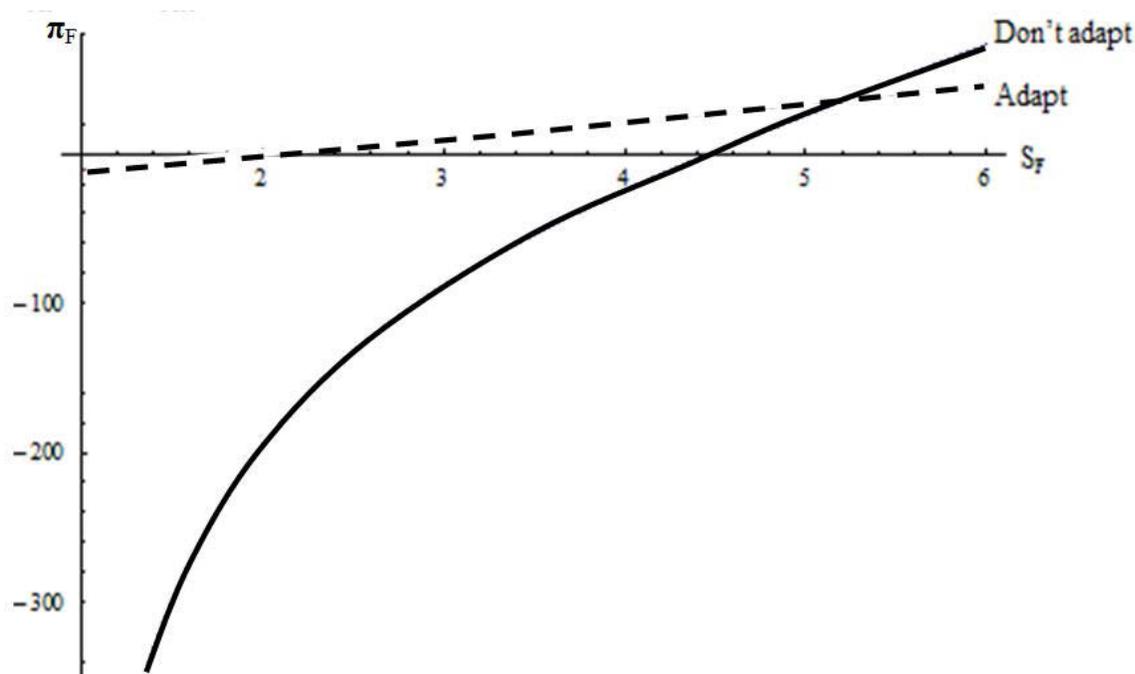


Figure 4. Foreign firm profits under alternative sumo strategies (adapt, don't adapt) with respect to S_F , given $b_H = 7$, all else equal to Figure 3.

In this section we showed that a 'sumo' strategy rationalizes the observed dominance of an open market by lower quality versions of normal goods following the entrance of a very large, poorer country. Depending on the other parameter values, when the emergent country is more than thrice the size of its trade partner, it maximizes profit by exporting its autarky quality when it opens to trade. The critical size is increasing in the willingness to pay for quality in the *Home*

country, but there is always a size at which the sumo strategy is most profitable. The best response to the sumo strategy in *Home* leaves the higher quality producer unable to cover costs, marginalizing it in the marketplace. The outcome is an open market dominated by lower quality versions after the emergence of the large exporter. This is the outcome observed in markets for normal goods such as apparel since China emerged on global markets, which we have sought to explain in this paper.

The size of the emergent country is key. When the emergent country is very large, it can feasibly lead and dominate the market without raising quality. Indeed, as we show in the next section, if the emergent country not larger, its most profitable strategy is to play a non-cooperative game, which results in more diverse quality available to global consumers after its emergence. That outcome was predicted by the existing literature. We analyze the situation in order to demonstrate the importance of emergent country size for the observed outcomes.

6. Comparison with the simultaneous non-cooperative Cournot Game

The *F*-firm will implement a sumo 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 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:

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

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

At the first stage, the firms simultaneously choose the quality to supply to maximize these profit equations. The first order conditions 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 *Foreign* firm's profits from a non-cooperative game strategy to its profit from the alternative sumo strategies via simulation. Figure 5 illustrates how the strategy rankings vary with respect to size S_F .

Figure 5 shows that when *Foreign* is not larger than *Home* ($S_F \leq 1$ while $S_H = 1$) the *Foreign* firm maximises profit by playing a non-cooperative game. When S_F is between 1 and 2.9, the *Foreign* firm maximises profit with the sumo strategy alternative in which it adapts quality. At levels of $S_F > 2.9$, it is most profitable for the *F*-firm to implement the sumo strategy without adapting its lower autarky quality (as in the previous section). Again, however, the market size at which not raising quality for the open market is most profitable is directly proportional to the difference in the willingness to pay for quality, illustrated in Figure 6.

When b_H is as high as 7, all else equal, the sumo 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 sumo strategy. Note also that when $b_H=7$, the F -firm sumo strategy alternative “adapt” is dominated at all values of S_F .

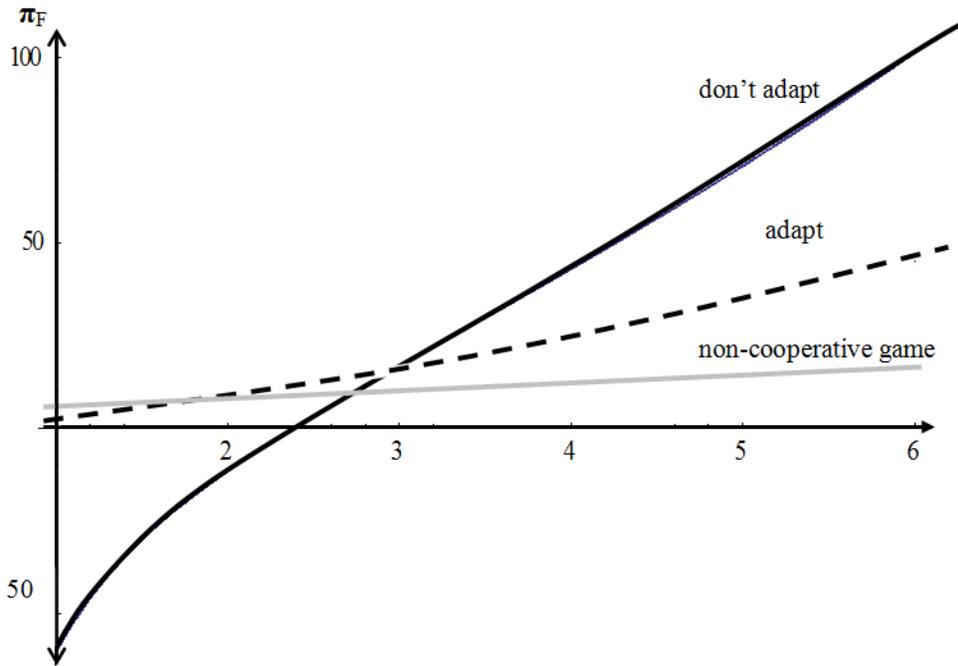


Figure 5. Foreign firm profits as a function of S_F for each sumo strategy alternative and the non cooperative strategy, assuming $b_F = 3$, $b_H = 5$, $c_H = 3$, $k_F = 0.8$ and $k_H = 0.3$

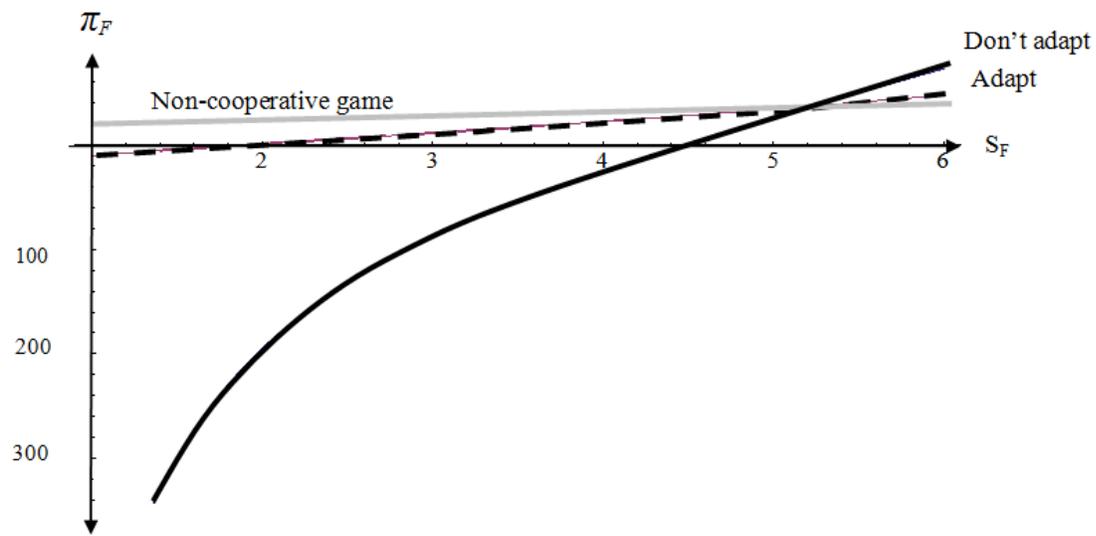


Figure 6. Foreign firm profits with respect to S_F under both sumo strategy alternatives and the non cooperative strategy; $b_F = 3$, $k_H = 0.3$, $c_H = 3$, $k_F = 0.8$, $b_H = 7$.

Conclusions

This paper provides theoretical explanations for what may have occurred in the markets for some normal goods in developed countries since China emerged on global markets. The trend towards one-way trade in clothing, footwear, and toys from China to European markets has been documented by Clothesource (2008), Amiti and Freund (2010), the European Commission (2011), Husted and Nishioka (2012), Eurostats (2014), and others. That kind of outcome was not rationalized by existing theories. Here we have proven why 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.

We showed in Section 2 that a country's autarky quality may be inversely proportional to its cost of quality but directly proportional to its domestic market size. The finding is a useful alternative to the typical explanation that emerging economies export low price/low quality goods because their labour is low cost. The importance of emergent country size, Proposition 1 (Section 5), explains why China's lower cost/lower quality products managed to dominate open markets while other lower cost exporting countries' exports have not. Furthermore, Proposition 2 clarifies how a very large emerging country's lower quality exports can drive higher-quality producers out of the market, despite the existence of customers willing to pay for higher quality.

We also showed in Section 6 that when an emergent country is not larger than its trade partner, its most profitable strategy is to play a non-cooperative game. When trading partners are relatively similar in size, two-way-trade and more quality diversity are to be expected on the open market, as shown in the existing literature about intra-industry trade in vertically differentiated goods. That underscores our finding about the importance of emergent country size.

When an emerging country is large, its firms can maximize profit when it opens to trade by implementing a sumo strategy of exporting the same lower cost, lower quality goods it produced in autarky. The size at which an emerging country's sumo strategy can succeed is directly proportional to the trading partner's willingness to pay for quality. Even the best response by a firm in a smaller, richer country to the sumo strategy nevertheless does not cover costs, driving it out of the market. The ultimate outcome is lower quality and less diversity on the open market, compared to before the opening of the large country to trade.

We have also indentified when or how the lower quality diversity outcome may be avoided (Section 3). If $(b_H - b_F)$ is sufficiently large and the firm in *Home* does not adapt, though the *Home* firm would shrink in size, sell only on its domestic market, and trade would still be one-way; wider quality choice --on the lower end-- would be available to *Home* consumers. Alternatively, if the difference in willingness to pay for quality is small enough to allow leapfrogging, trade expansion could result in higher quality available in the open market, albeit supplied by the *Foreign* firm. The actual outcome is an empirical question. The data on EU apparel markets and trade cited in Section 1 indicate one-way trade with China in normal apparel goods and a precipitous decline in home firm production. The level and range of quality diversity available to EU consumers of normal apparel is yet to be objectively measured.

Testable hypotheses implied by our analyses and those measures include one, that domestic market size may be more important than costs, wages or incomes in explaining the quality of goods produced and exported. Two, the domestic market size of an emerging country also hypothetically explains its ability to expand market share in other countries. Other hypotheses may also be testable. As in Motta, *et al* (1997), the closer are the countries' willingness to pay for quality or costs of switching to higher quality, the more likely is leapfrogging. Low switching costs and high willingness to pay for quality tech goods in China

today may explain their production and exports of high tech goods, and may provide another plausible answer to Rodrik's (2006) question "*What's So Special about China's Exports?*"

Further theoretical work is also indicated. Consistent with the previous literature, we applied a duopoly model. Are our findings robust to the actual conditions in a multi-country, multi-firm world? Also, a general equilibrium model would enable an analysis of the welfare impacts of this kind of free trade.

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