Quality Uncertainty and Intermediation in International Trade *

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AUGUST 2017

Abstract

Uncertainty about product quality is endemic in international trade. We develop a dynamic, two-country model, where home producers differ in terms of the quality of their products. Quality is not fully observed by foreign consumers initially but known once the product is consumed. We show that this lack of information generates an information cost of exporting, over and above the usual fixed costs used in standard heterogeneous firm models. We use the model to examine the role played by intermediaries in alleviating quality uncertainty. In the process, we uncover a positive externality of using intermediaries. The model generates a novel prediction about price dynamics that finds support in the data.

KEYWORDS : Intermediaries, quality, screening, incomplete information.

JEL Classification : D83, F10, F19, L15.

*We would like to thank two anonymous referees, Bernardo Blum, Richard Chisik, Arnaud Costinot, Rahul Deb, Gilles Duranton, Elhanan Helpman, Ignatius Horstman, Amit Khandelwal, Steve Redding, Daniel Trefler, Eric Verhoogen, Jon Vogel and especially, Robert Johnson and Peter Morrow for helpful discussions. Kunal Dasgupta and Jordi Mondria greatly acknowledge financial support from the Social Sciences and Humanities Research Council of Canada (SSHRC).

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1 Introduction

Intermediaries – firms that facilitate the exchange of goods between producers and final consumers – play a crucial role in trade. Spulber (1996) documents that in 1995 (i) intermediaries accounted for about a quarter of the U.S. gross domestic product and (ii) close to two million firms operated in the U.S. intermediation industry, providing various services to producers and consumers. Spulber suggests that among other things, intermediaries arise when there is uncertainty about demand and supply, or un-observability of the buyers' and sellers' characteristics. Given that such problems of incomplete information are more acute when goods cross national borders, it is all the more surprising that intermediaries have been relegated to the background in the study of international trade. But that is changing.

Recently, a number of papers have shed light on the prevalence of intermediaries in international trade.[1] This literature makes two important observations: First, a significant fraction of international trade is routed through intermediaries. Second, there are systematic variations in the mode of export (i.e., using intermediaries or exporting directly) not only across firms within an industry, but also across industries and destinations. Although these papers have highlighted the importance of intermediaries in international trade, they differ in their view of the exact role being performed by the intermediary firms. The lack of a consensus is partly because intermediaries perform a wide variety of roles.

One such role that trade intermediaries perform is providing quality assurance. Uncertainty about product quality is endemic in international trade. This uncertainty creates familiar problems of adverse selection and, when firms choose the quality of their products, moral hazard. Intermediaries alleviate this problem by screening the quality of products and then revealing it to consumers (something that would be prohibitively expensive for individual consumers to perform). Examples abound. Li & Fung, a multinational trading and sourcing firm based in China, claims that they are committed to meeting the demands of international business through "impeccable quality; reliable, on-time delivery; and the highest standards of service".[2] Similarly, Home Depot, the world's largest home improvement retailer, has a Quality Assurance (QA) program in place, which "evaluates supplier performance in the areas of factory, product, and packaging quality".[3] Feenstra and Hanson (2004) argue that one of the factors behind Hong Kong's success in intermediating trade between China and the rest of the world is information. Hong Kong's traders have an informational advantage in identifying Chinese producers who

[1] See Blum et al. (2017) for a nice survey.

[2] `www.lifung.com/eng/business/efficiency.php`

[3] `https://suppliercenter.homedepot.com/wps/portal`

can meet foreign quality standards.[4]

In this paper, we develop a model to understand the role of intermediaries in facilitating trade in the presence of incomplete information about product quality. We begin in Section 2 by developing a benchmark model of quality uncertainty. Our model has two countries, home and foreign, and we focus on the home producers' decision to export to the foreign country. Producers live for two periods and produce varieties of a good that is differentiated both horizontally as well as vertically. The quality of these varieties, however, are stochastically revealed to foreign consumers in the first period. If producers export a positive amount in the first period, their quality is fully revealed at the beginning of the second period.

In this setting, we solve for a pooling equilibrium, where every exporter whose quality (i.e., whose product's quality) has not been revealed charges a common price $\bar{p}$ in period one and exports the same quantity. In this equilibrium, every producer above a threshold level of quality exports in both periods, while the remaining producers never export. Due to incomplete observability of quality, producers have to forego a part of their full information profits, with this part being producer-specific. Thus, quality uncertainty generates an "information cost" of exporting, lowering the profits of most of the exporters relative to a full information world.

In Section 3, we introduce intermediaries into the benchmark model. Intermediaries are foreign firms that reveal the quality of a product to foreign consumers in lieu of a fee from the producers. Hence, intermediaries solve the problem of quality uncertainty in the first period. We show that in the presence of intermediaries, there exists a semi-separating equilibrium with some producers exporting through intermediaries, others exporting directly and the remaining producers not exporting.

In the model, intermediaries allow some exporters to signal the true quality of their goods to foreign consumers. These exporters do not have to incur the information cost of exporting. Selling through intermediaries, however, also raises the final price of the goods, resulting in lower sales. We show that the benefit of using intermediaries relative to costs is highest for firms with intermediate levels of quality. As a result, the firms with the highest levels of quality export directly, while those with intermediate levels of quality export through intermediaries. The presence of exogenous fixed costs ensures that the firms with the lowest levels of quality do not export. If high quality firms are also larger, our model predicts that larger firms are more likely to export directly rather than use intermediaries relative to smaller firms, a prediction that

[4] An alternative way to mitigate the problem of quality uncertainty is the introduction of a third party which evaluates the quality of a product. Examples include Moody's bond ratings or the *U.S. News & World Report's* ranking of college. See Dranove and Jin (2010) for a survey on the state of the theoretical and empirical literature on quality assurance.

finds support in the data.

In the model, every exporter above a threshold level of quality exports directly – the high quality exporters signal their quality by *not using* intermediaries. These exporters continue to charge the price $\bar{p}$ in the event their quality is not revealed, but the quantity sold by these exporters is higher than in Section 2. This is because the entry of intermediaries creates a positive externality for direct exporters: in the presence of intermediaries, the direct exporters with the lowest quality switch to exporting through intermediaries, thereby raising the average quality of the ones who continue to export directly. Because foreign consumers have rational expectations, they correctly anticipate this increase in average quality, resulting in higher demand for the goods sold by direct exporters.

We use the model to study how the equilibrium cutoffs and, in particular, the share of producers exporting through intermediaries depends on the degree of product differentiation, as well as the level of information. First, we show that when goods are more horizontally differentiated, a greater share of producers export through intermediaries. A higher degree of horizontal differentiation implies that consumers care less about quality. Because producers signal higher quality by exporting directly, there is less need to incur this costly signal when quality matters less. Second, with less information, the share of producers exporting through intermediaries goes up. If distance is a measure of information cost, our results imply that intermediaries should be more important for exporting to destinations that are further away. Both of these predictions find support in the data.

Finally, we test a novel prediction about price dynamics. The quality of varieties sold by the indirect exporters in our model is revealed in the first period. The implication is that the FOB (free-on-board) price of these exporters do not change over time. The direct exporters, on the other hand, have to signal their quality through prices. In particular, they charge a price that is lower than the first-best price in period one. Because the price charged in the second period is the full information price, the direct exporters experience an increase in price over time. Using Chilean firm-level export data over the period 1992-2006, we provide evidence that is consistent with this prediction.

Our paper contributes to the growing literature examining the role of intermediaries in international trade.[5] Motivated by the recent backlash against intermediaries in the developing world, Antràs and Costinot (2011) present a model with search frictions where intermediaries provide market access to farmers. Antràs and Costinot show that depending on the kind of

[5] Our paper is also related to several papers that study the role of intermediaries in a closed economy like Gehrig (1993), Spulber (1996), Rubinstein and Wolinsky (1987), Biglaiser (1993) and Shi and Siow (2011).

integration being considered, intermediation could raise or lower welfare of farmers in developing countries. The role of agricultural intermediaries in developing countries is also examined by Sheveleva and Krishna (2016). They show how a hold-up problem between farmers and intermediaries, arising from contractual incompleteness, leads to the non-existence of markets for certain agricultural goods. Search frictions also feature in the model of Blum, Claro, and Horstmann (2012), who are motivated by the finding that within the universe of Chilean exporters and Colombian importers, there are no small matches – matches between small importers and small exporters do not occur in the data. In their model, firms have an exogenous cost of finding consumers, with this cost being larger for small firms. In equilibrium, small firms match with large intermediaries, while large firms match directly with consumers (who can be interpreted as small importers). Facilitating international matches, however, is not the only role performed by intermediaries. Ahn, Khandelwal, and Wei (2011) and Akerman (2012) argue that intermediaries arise primarily to overcome trade costs. Both of these papers augment the Melitz (2003) model by adding an intermediation technology. In their model, firms have the option of direct exporting or exporting through an intermediary, with the latter entailing a lower fixed cost and a higher per unit cost.

To our knowledge, the only papers that theoretically study uncertainty about product quality and the role of intermediaries in alleviating this uncertainty in an international trade context are Bardhan, Mookherjee, and Tsumagari (2013) and Tang and Zhang (2011). Bardhan et al. develop a model where an intermediary's (broadly defined) concern for reputation leads to the solution of a quality moral hazard problem. They are, however, interested in the impact of trade liberalization on income distribution. Incomplete contracts lie at the heart of the model of trade intermediaries developed by Tang and Zhang. In their model, exporting through intermediaries entails a lower fixed cost. In an incomplete contracting environment, however, intermediaries under-invest in costly quality verification, effectively raising the unit cost of firms exporting through intermediaries. The resultant differences in cost between the two modes of export lead to a productivity sorting of firms.[6]

The fundamental difference between our paper and most of the other papers in the trade and

[6]Other theoretical contributions to the literature include Rauch and Watson (2004), Felbermayr and Jung (2008) and Petropoulou (2008). Rauch and Watson (2004) study the formation of intermediation networks and how intermediaries provide access to their network of contacts to other interested parties. Matching and endogenous network building by intermediaries also feature in the work by Petropoulou (2008) while in Felbermayr and Jung (2008), trade intermediaries arise endogenously due to contractual frictions. Chaney (2014) presents a model of network formation in international trade. Although not formally introducing trade intermediaries, Chaney argues that the mechanism presented in his paper could be a way in which intermediaries connect exporters with consumers.

intermediation literature is that we develop a dynamic model. This not only generates differential dynamics of prices and quantities for firms choosing different export modes, it suggests that the choice of whether to export through intermediaries itself evolves over time. We provide evidence that is supportive of the dynamics of prices predicted by our model and cannot be explained by any of the other models.

The rest of the paper is organized as follows. We present the model without intermediaries in Section 2. Intermediaries are introduced in Section 3 and the equilibrium is compared with the one in the previous section. We also perform comparative statics with respect to some of the parameters of our model in this section. Section 4 discusses the empirical relevance our model. Section 5 concludes.

2 A Model of Quality Uncertainty

In this section, we develop a framework to study the problem of exporters in the presence of asymmetric information about product quality. In the following section, we use this framework to evaluate the effect of intermediaries on the producer's decision to export as well as the effect on price, quantity and expected quality.

2.1 Set-up

Preferences. Consumer preferences are captured by an additive random utility model. There are J varieties of a differentiated good available to consumers. There is a measure one of consumers in each country. Each consumer can consume a single unit of the differentiated good. Given quality q_j and price p_j of a variety j, a consumer i derives the following utility from consuming a unit:

$$u_j^i = q_j - p_j + \epsilon_j^i,$$

where ϵ_j^i is an idiosyncratic shock drawn from a cumulative distribution $\Phi^i(\epsilon_1^i, \epsilon_2^i, ..., \epsilon_J^i)$.[7] To ease exposition, we assume that ϵ_j^is are independently and identically distributed across individuals, i.e., $\Phi^i = \Phi$. Hence, we can drop the superscript i from the preferences. The

[7] The indirect utility function can be obtained from a problem where a consumer allocates his income between a homogeneous numeraire good and one unit of a differentiated good of quality q_j and price p_j. Consider the following representation of the consumer's utility function: $U_j^i = v(Y^i - p_j) + q_j + e_j^i$, where $Y^i > p_j$ is the consumer's income. Taking a first-order Taylor series expansion, we have $U_j^i \approx v(Y^i) - v'(Y^i)p_j + q_j + e_j^i$. Dividing by $v'(Y^i)$, normalizing $1/v'(Y^i)$ to one and re-defining the error term gives us $u_j^i \approx q_j - p_j + \epsilon_j^i$ (See Tirole, 1988).

probability that a consumer chosen at random selects variety j is given by

$$f_j = Prob(u_j = \max_s u_s), \quad s = 1, 2, ...J.$$

Following McFadden (1973), we assume that Φ is a Type I Extreme Value Distribution with variance σ^2. The choice probability then becomes

$$f_j = \frac{\exp\{\frac{1}{\sigma}(q_j - p_j)\}}{\sum_{s=1}^{J} \exp\{\frac{1}{\sigma}(q_s - p_s)\}}.$$

The derivation of the choice probability from the indirect utility function is quite standard (see Anderson et al., 1992). From the Law of Large Numbers, it follows that f_j is also the fraction of consumers who demand variety j. The total demand for variety j is then given by f_j. As the number of available varieties becomes arbitrarily large (the set of varieties converging to a continuum in the limit), f_j reduces to a choice density:

$$f(j) = \frac{\exp\{\frac{1}{\sigma}(q(j) - p(j))\}}{\int_{s\in\Omega} \exp\{\frac{1}{\sigma}(q(s) - p(s))\}ds}, \tag{1}$$

where Ω is the subset of varieties that are available to the consumers (Anderson et al., 2001). Two features of the above demand function are noteworthy and play important roles in our analysis. First, conditional on price, consumers demand more of higher quality varieties. This property captures the vertical differentiation aspect of the differentiated good. Second, as long as $\sigma > 0$, there is positive demand for every variety, provided that its price does not go to infinity. This property reflects the horizontal differentiation aspect of the differentiated good. It ensures that an equilibrium exists where producers sell varieties of different quality.

Production. Every period, a measure one of producers enter the market, produce for two periods and then exit. Therefore, there is a "young" and an "old" cohort of producers in every period. After entering, each producer draws a quality q, where q is distributed according to $G(q)$ with $q \in [q_L, q_H]$. Assuming that the blueprint for a new variety is freely available, every producer manufactures a unique variety, and accordingly, has some market power. The cost of producing a unit of a variety with quality q is cq, where c is the same across firms.[8] We impose

[8] An alternative modelling assumption would be that upon entry, a producer draws a marginal cost of producing quality from some given distribution. It then chooses the quality of its product.

the following restriction on the magnitude of c.

ASSUMPTION 1: $c < 1$.

Producers choose the price of their variety, which in turn determines the corresponding demand. For the remainder of the paper, we shall refer to a producer who sells a variety of quality q simply as producer q.

Exporting. The home country is a small open economy. Home firms could choose to only serve the domestic market or export as well.[9] Exporting is costly. Following Melitz (2003), we assume that producers have to pay a one time fixed cost F in order to access the foreign market. This could be anything from the cost of obtaining export licenses to the cost of membership in a trade association, among other things. Importantly for our purpose, an exporter has to bear this cost *irrespective* of the mode of export.

Quality Uncertainty. Under asymmetric information, the quality of a home product is not perfectly observed by foreign consumers in the first period. Once a product is consumed, its quality is known. Accordingly, we are back in a full information world in period two. The likelihood of producer q's true quality being observed in the export market is captured by $\alpha(q)$. We make the following assumptions about $\alpha(q)$.

ASSUMPTION 2: $\alpha'(q) > 0; \lim_{q \to q_L} \alpha(q) = 0; \lim_{q \to q_H} \alpha(q) = 1$.

The dependence of α on quality can be interpreted in different ways. First, one could interpret $\alpha(q)$ as being tied to a producer's reputation. $\alpha'(q) > 0$ is then a consequence of producers with higher quality being older and having developed a reputation that spills over international borders. Second, it can be justified in a model with marketing/advertisement costs. In such a model, producers use advertisement expenses to signal their quality. The higher the quality of a producer, the higher is the expenditure on advertisement, making it more likely that his quality is revealed.[10] We term $\alpha(q)$ the "visibility" of producer q.

[9] In the absence of a fixed cost of accessing the home market, all home firms serve the domestic market.

[10] Kihlstrom and Riordan (1984) and Milgrom and Roberts (1986) among others theoretically predict a positive correlation between unobserved product quality and advertising expenses. Based on the insights from these models, Thomas et al. (1998) find a positive relationship between advertisement expenditures and product quality using data from the U.S. automobile industry.

2.2 Equilibrium

For completeness, and to point out the distortions created by asymmetric information, we first solve for the full information benchmark. Throughout the paper, our focus is on the problem faced by a home producer in the foreign market.

Full Information. Every producer maximizes profits. The full information profit, $\pi_F(q)$, is given, up to a normalization, by

$$\pi_F(q) = \max_p (p - cq) \exp\left\{\frac{1}{\sigma}(q-p)\right\}.$$

Profit-maximization yields the following:

$$p_F(q) = \sigma + cq,$$

where $p_F(q)$ is the full information price. The price charged by producer q is the marginal cost cq, shifted up by the constant σ. Although price is increasing in quality, quality-adjusted price is in fact decreasing in q.

The price charged depends on σ, the dispersion in the taste of the consumers. Intuitively, an increase in σ increases the mass on the tails of the distribution of ϵ_j. Because the demand for a particular variety comes from individuals who value it highly (i.e., those who draw ϵ_j from the upper tail of the distribution), fattening of the upper tail raises demand, while fattening of the lower tail has no effect on demand. Replacing equilibrium price in the expression for profit, we get

$$\pi_F(q) = \sigma \exp\left\{\frac{1}{\sigma}(1-c)q - 1\right\},$$

When $c < 1$, producers exporting higher quality varieties enjoy higher profits. Essentially, as quality rises, there are two effects on profit. There is a positive effect arising from the assumption that consumers desire higher quality. But there is also a negative effect arising from the assumption that higher quality goods are more costly. The restriction $c < 1$ ensures that the negative effect does not dominate the positive effect.

Total (or lifetime) profits of a producer in the export market is simply $2\pi_F(q)$. A producer exports if $2\pi_F(q) \geq F$. In an equilibrium where some, but not all producers export, there is an interior quality level q_F^* such that producers with $q \geq q_F^*$ export.[11] The cut-off quality q_F^* is

[11] This follows from the fact that the full information profit function is monotone increasing in quality.

given by

$$q_F^* = \sigma\Big(1 + \ln\frac{F}{2\sigma}\Big)/(1-c). \tag{2}$$

The condition for the existence of such a *perfect sorting* equilibrium is $q_L < q_F^* < q_H$. In the presence of asymmetric information about product quality, the set of exporters will typically be different, as we explore next.

Asymmetric Information. The timing of the game is as follows: (i) Producers incur the fixed cost and enter the export market; (ii) Quality of the product is revealed with some probability; (iii) Producers post prices; (iv) Foreign consumers form beliefs about producers' qualities (when quality is not revealed) and place their demand; (v) Varieties are exported and consumed; (vi) Second period price and quantity are determined. Asymmetric information and the sequential nature of moves implies that this is a dynamic game with incomplete information. Accordingly, the solution concept we shall use is Perfect Bayesian Equilibrium (PBE).

Within the class of PBE, we focus on a pooling PBE. Let q_{NI}^* (where the subscript NI stands for no intermediaries) be the quality of the marginal producer who exports. We propose an equilibrium where (a) every exporter whose quality has not been revealed charges a price $\bar{p}$ and (b) foreign consumers, who have rational expectations, believe that the exporters have quality $\bar{q}_{NI}$ given by

$$\bar{q}_{NI} = E[q|q \geq q_{NI}^* \text{ and } q \text{ not revealed}].$$

A PBE allows foreign consumers to assign any posterior belief whenever $p \neq \bar{p}$. This leeway in specifying off-the-equilibrium-path beliefs generates multiple equilibria (Fudenberg and Tirole, 1991). We assume that foreign consumers have the following off-the-equilibrium beliefs:

$$\mu(q = q'|p > \bar{p}) = 1,$$

and

$$\mu(q = \bar{q}_{NI}|p \leq \bar{p}) = 1,$$

where $q' < \bar{q}_{NI}$. In words, if a foreign consumer observes any price higher than $\bar{p}$, he thinks that the producer is selling a variety that has low quality. The underlying reason behind such beliefs is the expectation that high quality producers should offer low introductory prices to signal their quality.[12]

Note that any equilibrium must have $\bar{p} > cq_H$. If this inequality is not satisfied, then an

[12]Consumers could, instead, expect the producers to charge higher prices to signal higher quality. See the discussion at the end of Section 2.

exporter with quality q_H incurs a loss by charging a price of $\bar{p}$. But he can do strictly better by deviating and charging a price $p' > cq_H$, whereby his operating profits will be strictly positive. At the same time, we must have $\bar{p} < \sigma + cq^*_{NI}$. Otherwise, the exporter with quality q^*_{NI} can do strictly better by charging a price $\sigma + cq^*_{NI}$. Reducing price below $\bar{p}$ has no effect on the foreign consumers' expectation of quality and hence, no effect on demand. And conditional on demand, the profit-maximizing price corresponding to quality q^*_{NI} is $\sigma + cq^*_{NI}$ (the full information price).

In a perfect sorting equilibrium, $q_L < q^*_{NI}$. Combining this observation with the above two inequalities, we can state that a pooling equilibrium price exists if

$$\frac{\sigma}{c} > q_H - q_L.$$

Note that the above condition for the existence of $\bar{p}$ is sufficient, not necessary. The condition is more likely to be satisfied the smaller is the range for quality, the smaller is the marginal cost of quality and the bigger is the dispersion in the taste of the consumers.

Let the first period profit of an exporter, whose quality has not been revealed, be denoted by $\bar{\pi}(q)$, where

$$\bar{\pi}(q) = (\bar{p} - cq) \exp\left\{\frac{1}{\sigma}(\bar{q}_{NI} - \bar{p})\right\}.$$

Because price as well as demand is the same across producers when quality is not revealed, producers with higher quality earn lower profits. The expected first period profit of a direct exporter is given by

$$\pi^D_{NI}(q) = \alpha(q)\pi_F(q) + [1 - \alpha(q)]\bar{\pi}(q),$$

Although direct exporting is the only mode of exporting in this section, this will change once we introduce intermediaries in the next section. To understand the role played by quality uncertainty, let us re-write firm q's expected first period profit as

$$\pi^D_{NI}(q) = \pi_F(q) - \Phi(q),$$

where

$$\Phi(q) = [1 - \alpha(q)][\pi_F(q) - \bar{\pi}(q)],$$

is the *information cost* created by uncertainty. The information cost enters the producer's net profit expression in the same way as the exogenous fixed cost F. The first thing to note about the information cost is that it is heterogenous across producers, through its dependence on $\alpha(q)$, $\pi_F(q)$ and $\bar{\pi}(q)$. Inspection of the term $\Phi(q)$ further reveals the following properties.

PROPERTY A1: The information cost could be non-monotone in quality.

Note that $\frac{\partial \pi_F(q)}{\partial q} > 0$ and $\frac{\partial \bar{\pi}(q)}{\partial q} < 0$. Conditional on their qualities *not* being revealed, higher quality producers have larger foregone profits. This tends to increase the information cost. The likelihood of quality not being revealed is, however, smaller for higher quality producers. This tends to reduce the information cost. The change in information cost depends on which of these two effects dominate. For producers with quality approaching q_H, the information cost is negligible because their qualities are very likely to be revealed. The non-monotonicity of the information is displayed in Figure 1.

PROPERTY A2: The information cost could be positive or negative.

The expression information cost is really an abuse of notation because the term $\pi_F(q) - \bar{\pi}(q)$ could be negative. In that case, information asymmetry actually benefits some firms. To see this, observe that there are two differences between the full information profit, $\pi_F(q)$, and the pooled equilibrium profit, $\bar{\pi}(q)$. Charging the pooling price causes the consumers to believe that the quality being supplied is $\bar{q}_{NI}$. For certain q producers, this has a positive effect on profit because $q < \bar{q}_{NI}$ (E.g., the q^*_{NI} firm). But when a q producer charges $\bar{p}$ instead of the first-best price $\sigma + cq$, this has a negative effect on profit. *Ceteris paribus* the lower is $\bar{p}$, the farther it is from the first-best price of every producer, and the lower is the pooling equilibrium profit. Figure 1a represents a situation with low $\bar{p}$ where the information cost happens to be positive for every exporter, while Figure 1b represents a situation with high $\bar{p}$ where the lower quality producers actually benefit from the information friction.

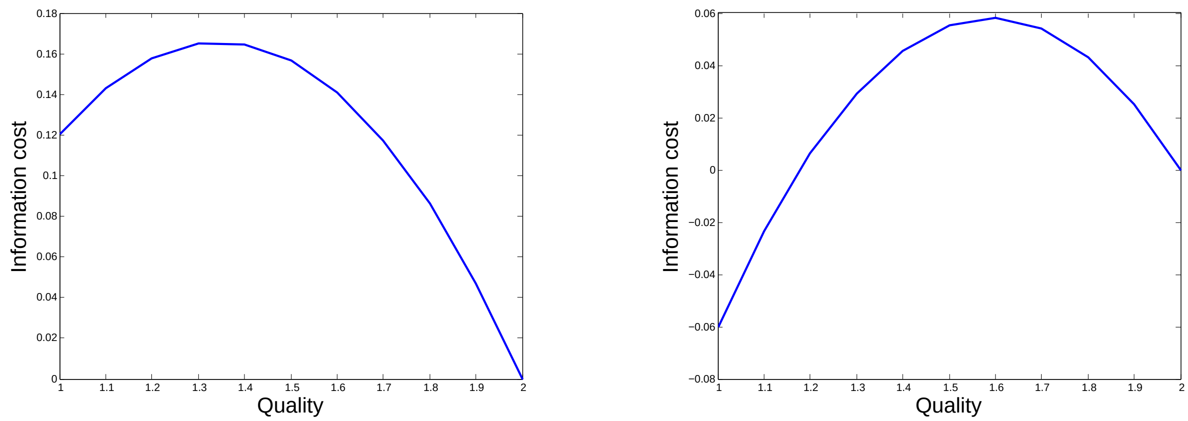
Notice that a producer, who is deciding whether to export or not, compares the gross export profits over two periods, $\pi^D_{NI}(q) + \pi_F(q)$, with F. A perfect sorting equilibrium is characterized by a cut-off q^*_{NI} that solves

$$[1 + \alpha(q^*_{NI})]\pi_F(q^*_{NI}) + [1 - \alpha(q^*_{NI})]\bar{\pi}(q^*_{NI}) = F, \tag{3}$$

where the left-hand side of the above equation denotes expected gross profit from exporting. The existence of such a perfect sorting equilibrium depends on the slope of the first period profit function:

$$\frac{\partial \pi^D_{NI}(q)}{\partial q} = \frac{\partial \alpha(q)}{\partial q}(\pi_F(q) - \bar{\pi}(q)) + \alpha(q)\frac{\partial \pi_F(q)}{\partial q} + [1 - \alpha(q)]\frac{\partial \bar{\pi}(q)}{\partial q}.$$

If we assume that the information cost is positive for all producers, then the first term on



(a) *When $\bar{p}$ is low* **(b)** *When $\bar{p}$ is high*

Figure 1: *Heterogenous information costs*

the right-hand side of the above equation is positive. So is the second term. The sign of the derivative then depends on the third term. Notice that $\frac{\partial \bar{\pi}(q)}{\partial q}$ is negative while $1 - \alpha(q)$ is decreasing in q. For the total derivative to be positive, we therefore require $1-\alpha(q)$ to decrease fast enough, i.e., $\alpha(q)$ to increase fast enough. In other words, if $\alpha(q)$ is convex enough, the profit function is monotone increasing in quality. The next proposition formally establishes the existence of a perfect sorting equilibrium.

Proposition 1. *There exists quality distribution $G(q)$ that leads to a perfect sorting equilibrium with cut-off q^*_{NI}. In such an equilibrium, all exporters whose quality has not been revealed, charge a price of $\bar{p}$ in period one.*

How does q^*_{NI} compare with the full information export cut-off, q^*_F? To answer this, re-write (3) as

$$2\pi_F(q^*_{NI}) - \Phi(q^*_{NI}) = F.$$

Recall that q^*_F solves $2\pi_F(q^*_F) = F$. Comparing with the above equation we can then conclude that

$$q^*_{NI} \gtreqqless q^*_F \text{ if } \Phi(q^*_{NI}) \gtreqqless 0.$$

Whether the presence of information frictions generates inefficiency in terms of entry into the export market depends crucially on whether the marginal exporter benefits or loses from the friction. As discussed above, this depends on a number of parameters such as the pooling equilibrium price, the underlying quality distribution (which determines $\bar{q}_{NI}$ for a given q^*_{NI}), etc.

To summarize, in the presence of quality uncertainty, there exists a quality level q_{NI}^* such that producers with quality above q_{NI}^* export. Observe that in equilibrium, if a producer chooses to export in the first period, he will do so in the second period too. On the other hand, if a producer does not export in the first period, he does not export in the second period either. By not exporting in the first period, a producer faces the problem of a young exporter in period two. Hence, if exporting was not profitable in the first period, it cannot be profitable in the second period either.

2.3 Discussion

The analysis presented above does not critically depend on our choice of a pooling equilibrium. We could have, instead, solved for a partial pooling (or semi-separating) equilibrium characterized by multiple quality intervals for exporters. In such an equilibrium, exporters in the same interval would charge the same price (and sell the same quantity) and the key insight derived above would remain unchanged. The presence of asymmetric information would still create an information cost of exporting, but this cost faced by individual producers would be smaller. Although the varieties sold by high quality producers would still be treated as having average quality, this average quality itself would differ across intervals; in particular, the average quality of an interval with high quality producers would be higher than one with low quality producers. Nevertheless, the information cost would not disappear. Because a partial pooling equilibrium would complicate the analysis without providing additional insights, we choose to focus on a pooling equilibrium.

The off-the-equilibrium belief held by foreign consumers, $\mu(q = q'|p > \bar{p}) = 1$, is motivated by the expectation that a producer who introduces a new good should charge a low price to signal high quality. The underlying reasoning is that a low price today implies lower profits (or even losses) today and only a high quality producer, who can earn large profits in the future when his quality is revealed, can benefit from such a strategy. Thus, loosely speaking, charging a low price is an incentive compatible strategy for a high quality producer. In the real world, however, it is quite often observed that producers signal high quality by charging a high price. Is that incompatible with our model?

The belief $\mu(q = q'|p > \bar{p}) = 1$ is not essential for the results that we have obtained. Observe that the price affects profit through two channels – (i) directly, and (ii) indirectly through expected quality. Now, *conditional* on expected quality, when a producer charges a price equal to $\bar{p} + \epsilon$ as opposed to $\bar{p}$, profit rises.[13] For $\bar{p}$ to be an equilibrium, we then require that consumer's expectation of quality, when the price charged is greater but in the neighbourhood of $\bar{p}$, must be low. But if the price charged is significantly higher than $\bar{p}$ (and higher than the first-best price), then one could allow the expected quality corresponding to that price to be high. In conclusion, our proposed equilibrium would survive under much weaker beliefs.

3 The Model with Intermediaries

In this section, we introduce trade intermediaries in the model of quality uncertainty developed above and evaluate its effect on entry into export market, firm profitability and price dynamics. To examine the role of intermediaries in facilitating export, we assume that the information cost is *positive* for all the exporters in an equilibrium without intermediaries.

3.1 Intermediation technology

Intermediaries are firms located in the foreign country that buy goods from the home producers and sell them to foreign consumers.[14] We model the intermediation sector as perfectly competitive. What that effectively means is that intermediation can be viewed as a technology: home exporters can pay a fee of τ per unit to reveal the quality of the products that they carry. As discussed in the Introduction, there exists intermediaries (wholesalers and retailer) who tend to have an ability to screen quality, and at the same time enjoy the trust of consumers. The fee τ can then be thought of as the value of the screening service that they provide. Producers simultaneously decide whether to export or not and how to export (i.e., the mode). Given this set-up, the first-period price charged by producer q who chooses to export through intermediaries is given by

$$p_I^{In}(q) = \sigma + \tau + cq,$$

and the corresponding profit is

$$\pi_I^{In}(q) = \sigma \exp\left\{\frac{1}{\sigma}(1-c)q - 1 - \frac{\tau}{\sigma}\right\}, \tag{4}$$

where the subscript $i = \{I, NI\}$ stands for the type of equilibrium (Intermediation or No intermediation) while the superscript $j = \{In, D\}$ denotes the mode of export chosen by a

[13] This is because $\bar{p}$ is less than the first-best price.

[14] Blum et al. (2010) provide evidence that while import intermediaries are very important, export intermediaries carry very little of Chile's exports, except in agricultural and food products.

producer (export through intermediaries or directly). We continue to assume, as in the previous section, that producers who choose to export directly charge a common price, $\bar{p}$, in the event the quality of their product is not revealed. An equilibrium allocation is defined as:

Definition 1. *An equilibrium of this model consists of*
(i) Sorting of producers into non-exporters, In exporters and D exporters;
(ii) A price $\bar{p}$ charged by D exporters when their quality is not revealed; such that
(a) utilities of consumers and profits of producers are maximized and (b) consumer's beliefs about quality are consistent with the sorting of producers.

3.2 Characterizing the equilibrium

In this section, we characterize the full equilibrium of the model with intermediaries. Comparing the profits from direct exporting and selling through intermediaries is hard because of the non-monotonicity of the function π_I^D. Accordingly, we shall characterize the equilibrium in some limiting cases.

(i) When $q \to q_H$: Observe that for q in the neighbourhood of q_H, the profit from direct exporting is

$$\lim_{q \to q_H} \pi_I^D(q) = \sigma \exp\left\{\frac{1}{\sigma}(1-c)q - 1\right\}.$$

This follows from the assumption that $\lim_{q\to q_H} \alpha(q) = 1$. Comparing with (4), it is clear that the producers with quality close to q_H are better off selling directly. Therefore, we can state the following property:

PROPERTY B1: The producers selling the varieties with the highest quality always choose to export directly.

(ii) When $q \to q_L$: Recall that the benchmark full information equilibrium is one where the producers with the lowest quality varieties do not export. Now, $\pi_I^{In}(q) = e^{-\frac{\tau}{\sigma}}\pi_F(q) \leq \pi_F(q)$, with the inequality being strict when $\tau > 0$. Hence, we must have

$$\pi_F(q) + \pi_I^{In}(q) \leq 2\pi_F(q) < F.$$

The above inequality suggests that producers with quality in the neighbourhood of q_L cannot be exporting through intermediaries. Note that this conclusion is different from models which assume that intermediaries facilitate exporting by lowering the fixed cost but raising the marginal cost (Ahn et al., 2011; Bernard et al., 2011; Akerman, 2012). In these models, the producers who benefit the most are those with the lowest quality. In our model, however, the intermediaries do not reduce F, the exogenous fixed exporting cost. Instead, they eliminate the endogenous information cost, which is likely to be negative for the lowest quality producers. Therefore, intermediaries raise the marginal cost of exporting for these producers, without any corresponding benefit.

PROPERTY B2: The producers selling the varieties with the lowest quality will never export through intermediaries.

Notice that when τ is large, all the exporters choose to export directly. This is not a particularly interesting equilibrium. Hence, we focus on the case where τ is not too large. In fact, in order to obtain sharp characterizations, we consider the limiting case where $\tau \to 0$. Because the profit function under intermediation is continuous in τ, the same properties will then hold for τ small. As in the previous section, there could be many different ways in which producers sort into export modes. We focus on equilibria where intervals of producers choosing the same export mode are connected, i.e., a perfect sorting equilibrium.

3.3 A perfect sorting equilibrium

As before, we continue to assume that F is such that the producers with the lowest quality do not export. Combining this with Property B1 above, a perfect sorting equilibrium looks like the one shown in Figure 2.

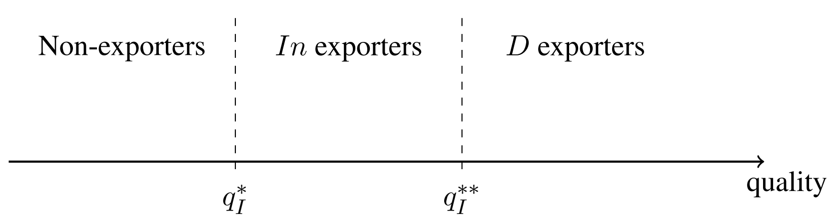


Figure 2: *Equilibrium allocation of exporters*

A perfect sorting equilibrium with intermediaries is characterized by two cut-offs: q_I^* and q_I^{**} such that producers with $q < q_I^*$ do not export, while those with $q > q_I^{**}$ export directly. Those in the middle export through intermediaries. The existence of such a separating equilibrium requires the incentive compatibility constraint to be satisfied for both low and high quality producers.[15] When would such an allocation be an equilibrium? When a producer exports

[15] To be technically correct, it is a semi-separating equilibrium.

directly, his quality is revealed with some probability, with this probability increasing in the producer's quality. Accordingly, a low quality producer choosing to export directly is more likely to receive $\bar{\pi}(q)$, which would typically be less than what it can earn by using intermediaries, $\pi_I^{In}(q)$, especially when τ is small. This leads the low quality firms to use intermediaries. On the other hand, for the high quality firms, using intermediaries is relatively more costly. The quality of these firms is revealed with a high probability if they export directly. If they use intermediaries, this probability increases by a small amount. Hence, the benefit of using intermediaries is small.

How does q_I^* compare with q_{NI}^*, the export cut-off in the absence of intermediaries? The q_{NI}^* producer exports directly in the no-intermediary scenario. Under our assumption that the information cost is positive for all exporters, i.e., $\bar{\pi}_{NI}(q_{NI}^*) < \pi_F(q_{NI}^*)$,

$$\begin{aligned}\pi_{NI}^D(q_{NI}^*) &= \alpha\pi_F(q_{NI}^*) + [1-\alpha(q)]\bar{\pi}_{NI} \\ &< \pi_F(q_{NI}^*).\end{aligned}$$

Now, when τ is small, $\pi_I^{In}(q_{NI}^*) \approx \pi_F(q_{NI}^*)$. Because q_{NI}^* is the marginal exporter under no-intermediation, we must then have

$$\begin{aligned}F &= \pi_{NI}^D(q_{NI}^*) + \pi_F(q_{NI}^*) \\ &< \pi_I^{In}(q_{NI}^*) + \pi_F(q_{NI}^*).\end{aligned}$$

But the expression on the second line above denotes the total profit of a producer who exports using intermediaries. Accordingly, the q_{NI}^* producer is strictly better off exporting through intermediaries than not exporting. We conclude:

PROPERTY B3: When the cost of intermediation is small, the availability of intermediaries allows some non-exporters to start exporting.

The quality level separating the In and D exporters, q_I^{**}, would normally be different from q_{NI}^* as well. Before establishing the next property, note that the pooling equilibrium profit schedules in the two scenarios, with and without intermediaries, never cross. For a given q_I^{**}, let us consider three different values for q_{NI}^* (q_a, q_b and q_c) as shown in Figure 3.

Suppose $q_{NI}^* = q_a$. This is possible if $\pi_{NI}^D > \pi_I^D$. But if the direct exporters under intermediation are a strict subset of those without intermediation, we must have $\bar{q}_{NI} < \bar{q}_I$. But then, $\bar{\pi}_{NI} < \bar{\pi}_I$ and hence, $\pi_{NI}^D < \pi_I^D$ – a contradiction. Instead, suppose $q_{NI}^* = q_c$. This is possible if $\pi_{NI}^D < \pi_I^D$. But if the direct exporters without intermediation are a strict subset of

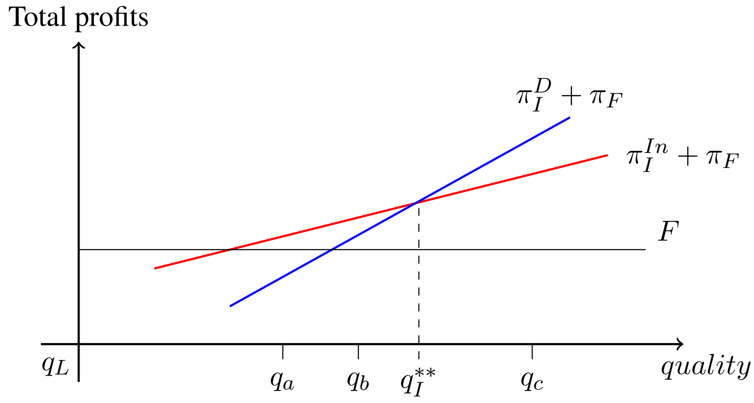


Figure 3: *Comparing cut-offs across equilibria*

those under intermediation, we must have $\bar{q}_{NI} > \bar{q}_I$. But then, $\bar{\pi}_{NI} > \bar{\pi}_I$ and hence, $\pi_{NI}^D > \pi_I^D$ – a contradiction. Applying a similar argument, we can show that the only value of q_{NI}^* that is consistent with equilibrium is q_b. We can then conclude the following:

PROPERTY B4: With the introduction of intermediaries, some direct exporters start using intermediaries.

In a perfect sorting equilibrium, the introduction of intermediaries generates a *positive externality*: by causing the exporters with the lowest quality to switch from direct exporting to using intermediaries, it raises the expected quality of the direct exporters. This, in turn, increases demand when quality is not revealed, benefitting the incumbent direct exporters. In a sense, producers signal that their variety has high quality by *not* using intermediaries.

3.4 Dynamics

Even with two periods, the model generates non-trivial dynamics. In the second period, we are in a full information world. How the price and sales of the exporters in period one vary depends on their mode of export.

Price : In period two, producer q charges a price $\sigma + cq$. In period one, the In exporter with quality q charges a final price of $\sigma + \tau + cq$. Assuming that the intermediation cost is added in the importing country, the FOB price for In exporters continue to be $\sigma + cq$ in period one. At the same time, the expected price for a D exporter with quality q in period one is

$\alpha(q)(\sigma + cq) + [1 - \alpha(q)]\bar{p}$. Observe that

$$\begin{aligned} \sigma + \tau + cq_I^{**} &\geq \sigma + cq_I^{**}, \\ &> \bar{p}, \end{aligned}$$

where the second inequality follows from incentive compatibility. Hence, there is a discontinuity in the pricing schedule at q_I^{**}. Furthermore, the expected price for direct exporters is increasing in quality. The entire price schedule is displayed in Figure 4.

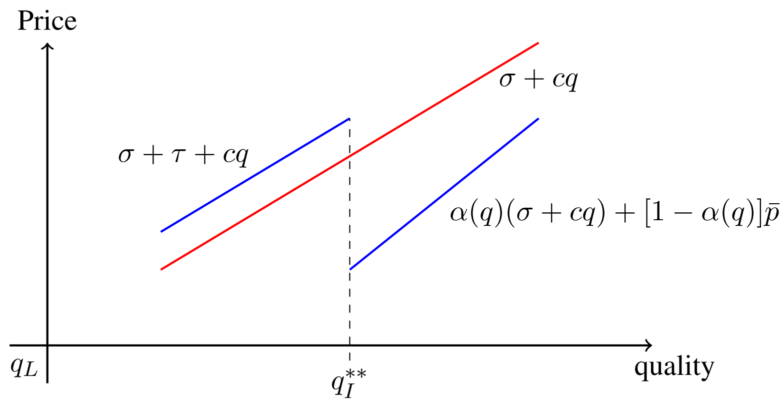


Figure 4: *Expected price of exporters*

By using an intermediary, a producer ensures that he does not have to export at a price that is too low in the event his quality is not revealed. Therefore, intermediaries provide some sort of insurance to the exporters. A variety sold through an intermediary has a higher final price in period one relative to period two, when its quality is revealed. Note, however, that in terms of the FOB price, there is no change in the price between periods one and two. In contrast, a variety that is sold directly has a price (both final and FOB) that rises over time. We summarize as follows:

PROPERTY B5: Between periods one and two, the FOB price of varieties
(i) remains unchanged for indirect exporters,
(ii) rises for direct exporters.

Quantity. The quantity sold by the In exporters, $x_I^{In}(q)$, is given by

$$x_I^{In}(q) = \alpha(q) \exp\left\{\frac{1}{\sigma}(1-c)q - 1 - \frac{\tau}{\sigma}\right\}.$$

It is clear that x_I^{In} rises over time, as these exporters stop using the services of intermediaries in period two. The quantity sold by the D exporters is given by

$$x_I^D(q) = \alpha(q)\exp\left\{\frac{1}{\sigma}(1-c)q - 1\right\} + [1-\alpha(q)]\exp\left\{\frac{1}{\sigma}(\bar{q}_I - \bar{p})\right\}.$$

Observe that for the q_I^{**} producer, $\bar{q}_I > q_I^{**}$ and $\sigma + cq^{**} > \bar{p}$. Hence, $\frac{1}{\sigma}(1-c)q_I^{**} - 1 < \frac{1}{\sigma}(\bar{q}_I - \bar{p})$. Replacing in the above equation, we have

$$\begin{aligned} x_I^D(q_I^{**}) &> \exp\left\{\frac{1}{\sigma}(1-c)q_I^{**} - 1\right\} \\ &> x_I^{In}(q_I^{**}). \end{aligned}$$

In spite of the intermediaries revealing the true quality of the producers, the double marginalization (due to τ) has a negative effect on demand (relative to direct exporting), with this effect becoming stronger as quality increases. For producers with quality less than q_I^{**}, the expected quantity sold when exporting directly is still relatively low. Accordingly, these producers find it optimal to use intermediaries. But for high levels of quality, selling less through intermediaries is too costly. The discontinuity in quantity exported at q_I^{**} suggests that there is a positive measure of producers selling less quantity using intermediaries than if they had exported directly. This is consistent with the predictions of a model where producers using intermediaries have a higher marginal cost. Finally, the following lemma derives a key relationship between $x_I^D(q)$ and the full information quantity, $x_F(q)$.

Lemma 1. *If* $\exp\{\frac{1}{\sigma}(1-c)q_H - 1\} > \exp\{\frac{1}{\sigma}(\bar{q}_I - \bar{p})\}$, *the* $x_F(q)$ *schedule intersects the* $x_I^D(q)$ *schedule only once from below.*

Observe that $x_I^D(q) \to x_F(q)$ as $q \to q_H$. Unlike at $q = q_I^{**}$, it is harder to sign the difference between $x_I^D(q)$ and $x_F(q)$ in the neighbourhood of q_H. This is because on the one hand, $q_H > \bar{q}_I$ which tends to raise demand under full information. On the other hand, $\sigma + cq_H < \bar{p}$ which tends to reduce demand under full information. In Lemma 1, we assume that the former effect dominates. This would be more likely if, for example, $\bar{p}$ is small. The equilibrium quantity as a function of quality is shown in Figure 5.

The dynamics of quantity for the producers that export through intermediaries is straightforward. Because of the double marginalization in period one, the quantity sold increases over time. The behaviour of quantity for the direct exporters is a bit more complicated. If incomplete information tends to depress the expected quantity of the producers with high quality, we get heterogenous quantity dynamics – the lowest quality direct exporters always experience a

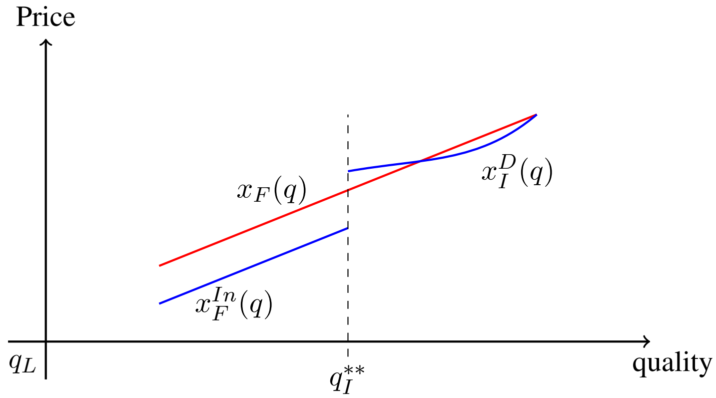


Figure 5: *Expected quantity of exporters*

decline in demand over time because they benefit from information frictions, while the opposite is the case for the highest quality exporters. We summarize as follows:

PROPERTY B6: Between periods one and two, the quantity of varieties
(i) rises for indirect exporters,
(ii) declines for low quality direct exporters, and rises for high quality direct exporters.

3.5 Comparative statics

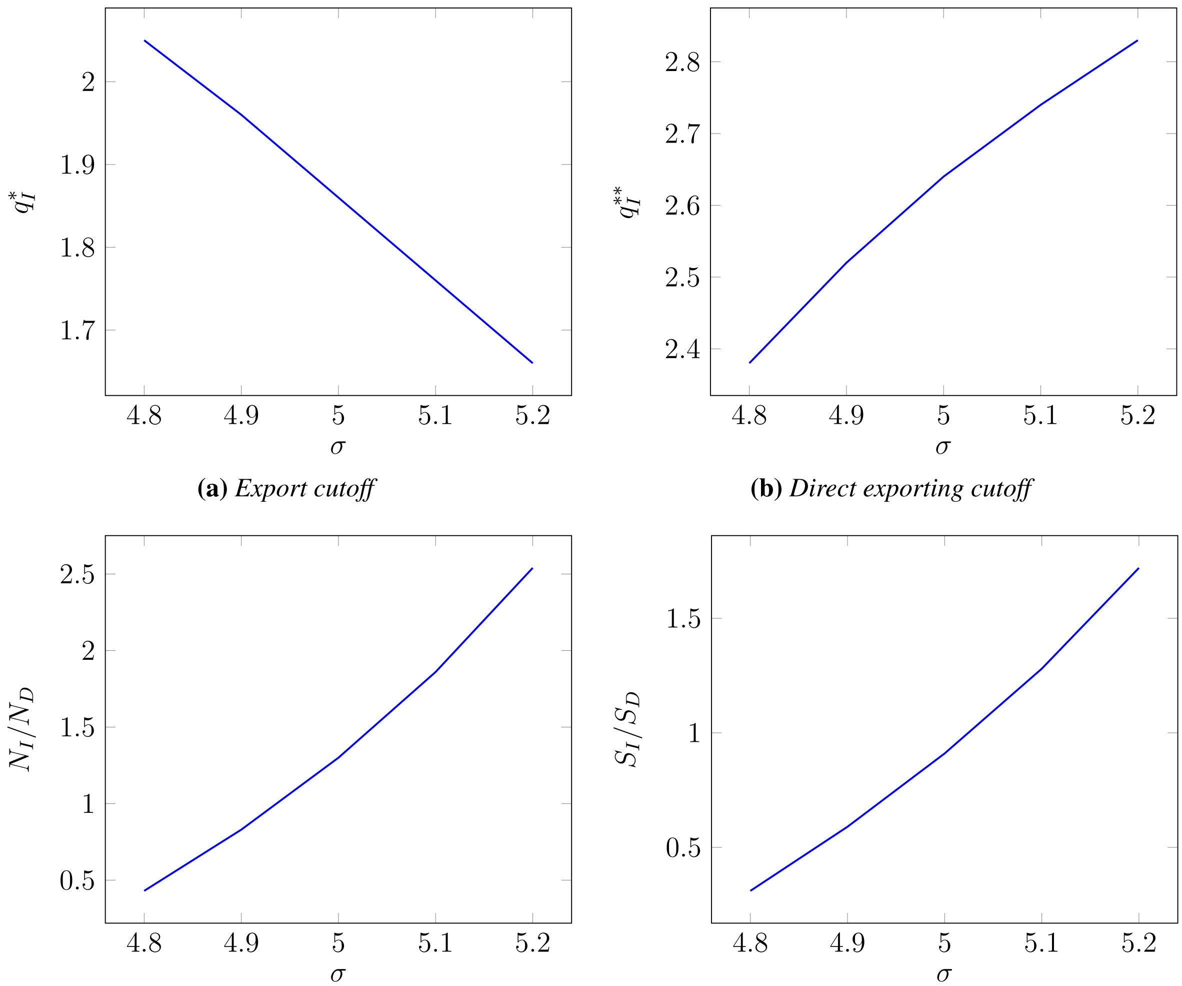
Having characterized the equilibrium, we proceed to perform comparative statics exercises with respect to the following variables: σ and α. The results in this section are derived numerically.[16]

3.5.1 A change in σ

Parameter σ captures the heterogeneity in the consumers' tastes. A higher value of σ corresponds to more heterogeneity. We consider the effect of a change in σ on the two thresholds, q_I^* and q_I^{**}, and the relative importance of intermediaries in exporting. We measure the latter using both the ratio of the number of indirect to direct exporters, as well as the ratio of their sales.

An increase in σ causes q_I^{**} to rise, as shown in Figure 6b. A higher value of σ corresponds to a lower elasticity of substitution for the varieties (Anderson et al., 1992) – goods with higher σ are more differentiated. As discussed earlier, the preferences that give rise to the multinomial logit formulation of demand in Equation 1 have two dimensions: a vertical dimension captured

[16]The parameter values used for this exercise are $c = 0.2, \bar{p} = 1.5, F = 4.5$. The distribution for q is a truncated exponential with $q_L = 1, q_H = 5$ and shape parameter equal to 1. Finally, $\alpha(q) = \left(\frac{q(i)-q_L}{q_H-q_L}\right)^\theta$ where $\theta > 0$. Our comparative static exercise with respect to α involves changing the parameter θ.



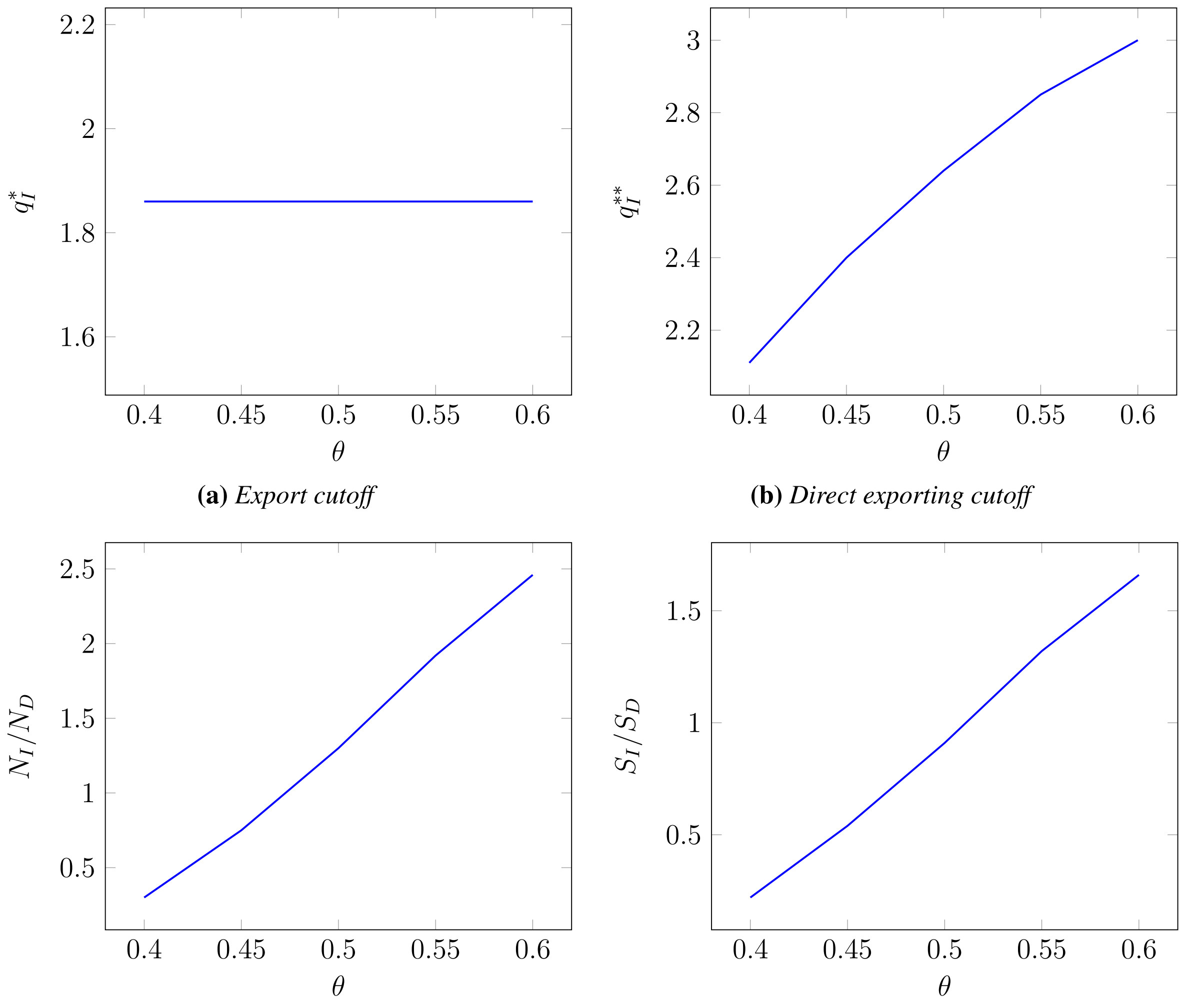
(a) *Export cutoff* **(b)** *Direct exporting cutoff*

(c) *Relative measure of indirect exporters* **(d)** *Relative sales of indirect exporters*

Figure 6: *Comparative statics with respect to σ*

by quality and a horizontal dimension captured by variety. When σ is small, agents' preferences are closely aligned. As a result, variety matters less and small differences in quality can lead to large differences in demand. Things are different when σ is large. Because of consumers' love for variety, a firm selling a high quality variety may not face a demand that is too high. Accordingly, exporters have lower incentive to signal their quality. Because high quality producers signal their quality by exporting directly, a high σ lowers their incentive to signal, causing some of them to switch to using intermediaries.

Our model's explanation of the relationship displayed in Figure 6b is different from the one that is usually offered in the context of models of quality uncertainty (Ahn et al., 2011). The explanation in the alternative models is the following: differentiated goods are those for which



(a) *Export cutoff* **(b)** *Direct exporting cutoff*

(c) *Relative measure of indirect exporters* **(d)** *Relative sales of indirect exporters*

Figure 7: *Comparative statics with respect to* α

quality matters more. Because producers can reveal their quality by exporting through intermediaries, producers in more differentiated goods sectors are more likely to use intermediaries. As a result, the marginal direct exporter has higher quality in sectors with higher σ.

As σ increases, the measure of direct exporters, N_D, falls. At the same, the measure of indirect exporters, N_I, rises. This is because of two reasons: on the one hand, some direct exporters switch to exporting through intermediaries. On the other hand, some of the non-exporters switch to exporting through intermediaries (see Figure 6a). As a result, $\frac{N_I}{N_D}$, which captures the importance of intermediaries in facilitating exports, goes up, as shown in Figure 6c. The same conclusion is obtained when instead, we look at relative sales of indirect exporters, $\frac{S_I}{S_D}$ (see Figure 6d).

3.5.2 A change in α

Next we examine the effect of a change in $\alpha(q)$ on producers' decision to export and the relative importance of intermediaries. Recall that $\alpha(q)$ measures the visibility of a q producer, in other words, the probability that the quality of a q producer is revealed if he exports directly.

In this exercise, we increase θ, the parameter of the $\alpha(q)$ function. An increase in θ corresponds to a reduction in $\alpha(q)$ across producers. This can be interpreted as lower levels of information about the home products in the foreign market. With less information, direct exporting becomes a less attractive alternative. This causes the marginal direct exporter to switch into exporting using intermediaries as displayed in Figure 7b. Because a change in visibility has no effect on the export cut-off, q_I^*, it leads to an increase in N_I and a decrease in N_D, thereby increasing $\frac{N_I}{N_D}$ (see Figure 7c) and relative sales of indirect exporters (see Figure 7d).

4 Empirics

Our model of intermediation presented above generates a number of predictions regarding the relative importance of intermediaries in certain markets, the difference in price and quantity of firms using different modes of export and the difference across these firms in terms of the dynamics of the same variables. In this section, we examine the empirical relevance of these predictions. We start by discussing how some of the predictions of our model are consistent with evidence provided by others. We then test, what we believe, is a hypothesis that is unique to our model.

4.1 Relation to literature

In our model, we assume that once consumers purchase a product, its quality is revealed. So, if a firm exports through an import intermediary in period one, it should export directly in period two. If our model is correct, we should then expect the firms that use intermediaries to be younger, on average, than direct exporters. Evidence consistent with this hypothesis has been provided by Abel-Koch (2013) and Davies and Jeppesen (2015). Of course, part of the explanation could be that firms sort into exporting mode based on their size and younger firms, on average, tend to be smaller – a result that we exploit below.

Intermediaries in our model have a technology that allows them to credibly reveal the quality of the products they carry. This ability to assure quality makes them especially attractive to firms whose products are not well known in foreign markets. There is not much direct evidence on the quality assurance role of intermediaries. Macchiavello (2010) looks at how Chilean wineries establish reputation for reliability in UK. He shows that these wineries are initially matched with intermediaries who specialize in discovering new wineries that have not yet established a good name. Abel-Koch (2013), using survey data from Turkey, reports that 27 percent of indirect exporters used an intermediary for the latter's "quality control services".

Feenstra and Hanson (2004) and Utar (2017) try to indirectly infer whether import intermediaries perform a quality assurance role by examining price data. Looking at Hong Kong re-exporters of Chinese goods, Feenstra and Hanson find that products sold through intermediaries had higher mark-ups, from which they conclude that goods purchased by intermediaries were of higher quality. On the other hand, using data from Denmark, Utar finds that the price paid by an import intermediary is not significantly different from that paid by a direct importer, suggesting that import intermediaries do not necessarily sell goods of higher quality.

Our model suggests some caution in interpreting the above evidence. First, although import intermediaries perform a quality assurance role, the firms selling through them are actually the ones whose product quality is in the intermediate range. For these firms, the cost of paying an intermediation fee and revealing their true quality is less than the expected cost of being treated as an average quality firm. Therefore, even if import intermediaries are able to reveal the quality of products that they carry, the firms with the highest quality products in an industry may not use their services.[17] Second, the average price charged by direct exporters is not necessarily higher than that charged by their indirect counterparts, at least in the first period. Although the direct exporters have a full information price that is higher, owing to the higher quality of their product, than that of the indirect exporters, their expected price under incomplete information could very well be lower due to the low signalling price $\bar{p}$ (see Figure 4). Therefore, the price charged by an intermediary vis-à-vis a direct exporter may not reflect the true difference in the quality of their products.

Our model also generates a number of comparative statics predictions that are consistent with existing evidence. First, the model predicts that the share of firms exporting through intermediaries is higher for more differentiated sectors. This is consistent with the findings of Feenstra and Hanson (2004), Blum et al. (2012) and Tang and Zhang (2011).[18] Second, the model predicts that the share of firms exporting through intermediaries is decreasing in $\alpha(q)$,

[17] Crozet et al. (2013) and Poncet et al. (2015) provide evidence that export intermediaries carry goods of lower quality than direct exporters, using data from France and China respectively. To the extent that export intermediaries perform some quality assurance role, the evidence provided by these papers is consistent with our predictions.

[18] In Blum et al. and Tang and Zhang, however, a higher degree of product differentiation raises the profits of the producers with lower quality. The result follows from these producers being the ones who tend to export through intermediaries.

the visibility of a firm. One could think of the inverse of distance as a proxy for $\alpha(q)$. If the foreign country is farther away, the foreign consumers might have less information about home products. In such a case, when a home producer starts to export, the probability of its quality being revealed is lower. Going by this interpretation, our model suggests a positive relation between distance and the relative importance of intermediaries. This is consistent with the findings of Ahn et al. (2011), Tang and Zhang (2011) and Akerman (2012).

4.2 Empirical strategy

Our model generates predictions with respect to the evolution of price and quantity at the firm level. These are novel predictions of our model as most models of trade intermediaries are static. In this section, we test the following hypothesis : Between periods one and two, the FOB price of varieties that are exported through intermediaries remains unchanged, while those exported directly rises (Property B5). To test this prediction, we use a version of the Chilean customs data. Each observation in this dataset corresponds to the annual export (sales and quantity) of a given HS6 product to a given destination by a Chilean firm.

Table 1: *Chilean export data: Some descriptive statistics*

	1992	2006	Average
Number of exporters	5,284	6,711	5,858
Number of products	2,850	3,213	3,102
Number of destinations	153	182	171
Number of product-destinations	14,280	23,628	19,223

Note: Product refers to HS6 product classification. The average is taken over the period 1992-2006.
Source: Chilean customs.

Table 1 provides an overview of the data. The number of exporters rose from 5,284 in 1992 to 6,711 in 2006, with an average of 5,858 exporters per year. On average, these firms exported 3,102 HS6 products to 171 destinations. Of course, not all products were exported to every destination. For example, in 1992, out of a possible 436,050 product-destination combinations or markets, Chilean exporters served only 14,280 – there are lots of trade zeros.

A drawback of this data set is that it does not have information on whether Chilean exporters sell through intermediaries or sell directly. To make headway with our analysis, we make use of the following stylized fact: smaller firms are more likely to use intermediaries while larger firms are more likely to sell directly (Blum et al., 2012). Accordingly, we test the following *modified* hypothesis: Between periods one and two, the FOB price of varieties exported by smaller firms, on average, increases by less relative to the price of varieties exported by larger firms.[19]

Observing that the price of larger firms evolves in a different way relative to smaller firms in a given market is not enough, however. Our model assumes that the only change between periods one and two occurs in the consumer's information set. Specifically, the quality of a variety that is sold directly is unobserved in period one; in period two, quality is fully revealed. But other parameters might change over time as well, which might differentially affect the price charged by direct exporters (the large firms) and firms exporting through intermediaries (the small firms). In particular, the demand for products sold by the large firms might increase more than the corresponding demand for small firms. Under a number of demand systems (linear demand, for example), such an exogenous increase in demand will lead to an increase in the profit-maximizing price. Accordingly, we need to control for any change in demand.

The estimating equation that we run is as follows:

$$\Delta p_{hcit} = \mu + \beta_1 s_{hcit} + \beta_2 \Delta x_{hcit} + \epsilon_{hcit}, \tag{5}$$

where Δp_{hcit} is the *change* in price between periods two and one (i.e., between periods $t+1$ and t) of a firm i selling product h that starts to export to country c in period t, s_{hcit} is a measure of the size of the firm and Δx_{hcit} is the corresponding change in quantity sold. ϵ_{hcit} captures the effect of all other factors that are orthogonal to the variables of interest. The null hypothesis is that $\beta_1 > 0$.

Our export data does not have price information. Instead, it has information on revenue and quantity (both physical units, as well as weight). We define price or unit value as revenue divided by physical units. We have information on physical units for 99 percent of observations.[20] Because of the possibility of outliers, we also winserize the price data at 5 and 95 percents, by destination-product-year. Finally, we use the total sales of a firm in product h and period t

[19]Observe that our model generates price dynamics for the producers, not the intermediaries. Most of the other data sets that have been used in the literature on trade and intermediation do not have matched data between firms and intermediaries. As a result, none of these data sets are useful for the analysis in this section.

[20]The correlation between the logarithms of physical unit based price and weight based price is close to 0.9.

across all destinations as a measure of its size when it enters destination c in period t.

Table 2: *Export spells: Some summary statistics*

	Mean	Median	75th percentile	95th percentile
Spell length	1.64	1	2	5
Spells per firm	1.38	1	2	3

Note: Because the export spells of firms that export in 2006, the last year in our sample, are truncated, the mean for spell length reported here is a lower bound. Spells per firm is for a given destination-product.

Our prediction is about the first two periods of a firm's export spell. Accordingly, we drop export spells that include 1992 (the first year in our sample) as we do not know whether these firms started exporting in 1992 or earlier. We are left with 399,165 export spells. The distribution for the length of export spells is highly skewed, as displayed in Table 2. Although more than half of all export spells last for only a year, about 25 percent last for at least 2 years. On average, export spells last for 1.64 years. For the purpose of our analysis, only export spells with a length of at least two years are considered. There are 108,709 such spells (0.27 of all spells).

A firm in a given market could also have multiple spells. As shown in Table 2, on average, a firm has 1.38 export spells in a market, while more than half of all firms have only one export spell. In our benchmark analysis, we treat every export spell of a firm as a new export spell (i.e., belonging to a new exporter). We perform robustness checks with respect to this assumption. Furthermore, our theoretical results compare the behaviour of firms using different modes of export in the same market. To facilitate this comparison, we consider only those markets with two or more export spells of length at least two years. About 20 percent of all markets, accounting for 24 percent of all export spells, fall in this category. That leaves us with 95,663 export spells.

4.3 Results

Table 3 contains the results for our baseline specification. The dependant variable is the change in log price between the first and second period of an export spell. We regress this on the log

Table 3: *Relation between price change and firm size: baseline specification*

	Dependant variable: Δp_{hcit}			
	(1)	(2)	(3)	(4)
s_{hcit}	0.04***	0.04***	0.01***	0.01***
	(0.002)	(0.003)	(0.001)	(0.003)
Δx_{hcit}			-0.23***	-0.21***
			(0.004)	(0.007)
constant	-0.33***	-0.32***	-0.02	-0.03
	(0.019)	(0.030)	(0.017)	(0.026)
N	95663	95663	95663	95663
R^2	0.17	0.65	0.31	0.70
Fixed effects				
Year	yes	no	yes	no
Destination-product	yes	no	yes	no
Destination-product-year	no	yes	no	yes

Note: Robust standard errors in paranthesis. *, ** and *** refer to significance at the 10%, 5% and 1% levels respectively. Δp_{hcit} is the (log) change in price between periods $t+1$ and t, where an export spell starts at t. Similarly, Δx_{hcit} is the (log) change in quantity between periods $t+1$ and t. s_{hcit} is the (log) total sales of firm i in product h and year t across destinations.

size of the firm, as measured by its total sales in other destinations. Column 1 presents the results when we do not control for the corresponding change in quantity. The coefficient on the size dummy is positive and significant at the one percent level. In this specification, we use year and destination-product fixed effects. The results hardly change once we introduce destination-product-year fixed effects (in Column 2).

In Columns 3 and 4, we include the log change in quantity between periods one and two. The coefficient on the change in quantity is negative. Because quantity shows up in the denominator of the dependant variable, however, this negative relationship could be purely mechanical. But our object of interest is the coefficient on firm size, which continues to be positive and significant at the one percent level. This confirms our hypothesis that larger firms are more likely to raise their prices in the period following their entry into an export market.

Table 4: *Relation between price change and firm size: alternate specifications*

	Dependant variable: Δp_{hcit}					
	(1)	(2)	(3)	(4)	(5)	(6)
s_{hcit}	0.01***	0.01***	0.01***	0.01***	0.02***	0.01**
	(0.002)	(0.003)	(0.002)	(0.004)	(0.002)	(0.005)
Δx_{hcit}	-0.22***	-0.20***	-0.22***	-0.19***	-0.25***	-0.22***
	(0.004)	(0.008)	(0.005)	(0.009)	(0.006)	(0.011)
Constant	-0.00	-0.02	-0.02	-0.03	-0.07***	-0.03
	(0.018)	(0.03)	(0.02)	(0.04)	(0.025)	(0.04)
Observations	76604	76604	61683	61683	44605	44605
R^2	0.34	0.72	0.37	0.77	0.37	0.75
Fixed effects						
Year	yes	no	yes	no	yes	no
Destination-product	yes	no	yes	no	yes	no
Destination-product-year	no	yes	no	yes	no	yes

Note: Robust standard errors in paranthesis. *, ** and *** refer to significance at the 10%, 5% and 1% levels respectively. Δp_{hcit} is the (log) change in price between periods $t+1$ and t, where an export spell starts at t. Similarly, Δx_{hcit} is the (log) change in quantity between periods $t+1$ and t. s_{hcit} is the (log) total sales of firm i in product h and year t across destinations. Columns 1 and 2 report results for a specification where only the first spells of multiple-spell exporter are considered. Columns 3 and 4 report results for a specification where only single-spell exporters are considered. Columns 5 and 6 report results for a specification where a new export spell is defined as one where the exporter has not exported for the previous 5 years.

In our baseline specification, we treat every export spell as belonging to a new exporter. But there are multiple-spell exporters in many markets. The second or third spells of these exporters might look quite different from their first spells. For example, consumers might remember the quality of a firm's product, even if it temporarily stops to export. In that case, a firm, if it chooses to export directly, may not need to signal its quality through price. Accordingly, price dynamics for such firms would be very different. To address this issue, we examione only the first export spells of multiple-spell exporters.

Another challenge posed by multiple-spell exporters is that it is hard to be sure when they actually started to export. If it enters and exits the export market multiple times during our sample period, it is quite likely that they were exporting before the start of the sample period. In this case, we face the same problem mentioned above. Even if we focus on the first export spells of these exporters, those may not, in fact, be their first spells. To address this issue, we examine only single-spell exporters.

In fact, we can never really be sure when a firm starts to export for the *first* time. But to better identify the first time exporters, we can make the definition for such exporters stronger. In our baseline analysis, every time a firm starts to export after a gap of one year, we treat that as a new export spell. As discussed above, this definition creates a problem when we have multiple-spell exporters. To address this issue, we treat an export spell as a new export spell if the firm has not exported for the five preceding years. The underlying assumption is that if a firm returns to a market after a gap of five years, it is essentially a new firm from the consumers' perspective.

In Table 4, we present results for these alternate specifications. Columns 1 and 2 report results for the specification where only the first spells of multiple-spell exporters are considered. Columns 3 and 4 report results for the specification where only single-spell exporters are considered. Columns 5 and 6 report results for the specification where a new export spell is defined as one where the exporter has not exported for the previous 5 years. Results are qualitatively as well as quantitatively very similar to the benchmark scenario.

To examine the robustness of our results, we also use alternate measures of firm size. First, we use the quantity sold by a firm in the third period of its spell (recall that we consider price change between periods one and two). Our model suggests that once quality is revealed, the quantity sold by a firm will converge to its long-run quantity. Second, we use the length of the export spell. Our usage is motivated by the well established empirical result that in any market, the bigger firms are also older (Dunne et al., 1988). This measure is unlikely to be affected by how firms change their price over time. The results, which we do not report here, are qualitatively very similar.

To summarize, compared to small exporters, big exporters experience larger increases in export prices following entry into export markets, even after controlling for changes in demand. This relation holds even when we focus only on first spells, or on firms with only one spell in the sample period. The relation is also robust to using alternate measures of firm size.

5 Conclusion

In this paper, we analyze the role of intermediaries in facilitating trade in the presence of incomplete information about product quality. We develop a framework to examine the role played by intermediaries in alleviating quality uncertainty. Intermediaries are firms located in the foreign country that buy goods from the home producers and sell them to foreign consumers. They allow some exporters to signal the true quality of their goods to foreign consumers. These exporters do not have to incur the information cost of exporting. However, selling through intermediaries also raises the final price of the goods, partly due to the fee charged by intermediaries, resulting in lower sales for some exporters.

These are the main findings of the paper: (i) An intermediation technology, as the one exogenously assumed in the literature, involving higher marginal cost but lower fixed cost arises endogenously in our model. (ii) There is sorting of exporters into different exporting modes: direct exporting and intermediaries. We show that in the presence of intermediaries, there exists a semi-separating equilibrium where every exporter above a threshold level of quality exports directly. Direct exporters are high quality producers that signal their quality by not using intermediaries. (iii) We uncover an externality of using intermediaries. The entry of intermediaries creates a positive externality for the direct exporters: in the presence of intermediaries, the low quality exporters choose to export through intermediaries, thereby raising the average quality of direct exporters. Because foreign consumers have rational expectations, they correctly anticipate this increase in average quality, resulting in higher demand for the goods sold by direct exporters.

The model is consistent with a number of empirical regularities that have been uncovered recently. First, producers in more differentiated goods sectors are more likely to use intermediaries. Second, there is a positive relation between information asymmetries (proxied by distance) and importance of intermediaries. We also provide evidence supportive of a novel prediction of our model: the FOB price of indirect exporters does not change over time while that of direct exporters increases over time.

Given that a large fraction of world trade is being carried out through intermediaries, it is important that we develop a good understanding of the intermediation sector. This will not only help us better understand the choices individual exporting firms make, but also the pattern of trade at a more aggregate level. By affecting price and quantity, intermediaries could also have a large impact on welfare. Clearly, more work needs to be done.

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Appendix

Proof of Proposition 1. We need to prove that there exists parameter values such that charging $\bar{p}$ is incentive compatible. When a firm charges $\bar{p}$, its profit is given by

$$\bar{\pi}(q) = (\bar{p} - cq)\exp\left\{\frac{1}{\sigma}(\bar{q}_{NI} - \bar{p})\right\}.$$

Note that if a firm chooses $p > \bar{p}$, it will choose $p = \sigma + cq$ irrespective of the quality that consumers believe it has. Let us denote the profit from this deviation by $\pi'(q)$. We must have,

$$\pi'(q) = \sigma\exp\left\{\frac{1}{\sigma}(q' - \sigma - cq)\right\}.$$

Deviating to a $p > \bar{p}$ is not profitable when $\bar{\pi}(q) \geq \pi'(q)$. This give us

$$\frac{\bar{p} - cq}{\sigma}\exp\left\{\frac{cq}{\sigma}\right\} > \exp\left\{\frac{1}{\sigma}(q' - \bar{q}) + \frac{1}{\sigma}(\bar{p} - \sigma)\right\}.$$

It can be shown that

$$\exp\left\{\frac{1}{\sigma}(q' - \bar{q}) + \frac{1}{\sigma}(\bar{p} - \sigma)\right\} < \exp\left\{\frac{1}{\sigma}(q' - \bar{q})\right\}\exp\left\{\frac{cq}{\sigma}\right\}$$

Hence, the required condition for incentive-compatibility is

$$\frac{\bar{p} - cq}{\sigma} > \exp\left\{\frac{1}{\sigma}(q' - \bar{q})\right\}.$$

Note that the smallest value for the LHS of the above inequality is obtained when $q = q_H$. Manipulating the above inequality, the sufficient condition is then given by

$$\bar{q} + \sigma\ln\left(\frac{\bar{p} - cq_H}{\sigma}\right) > q'.$$

If the LHS of the above equation is greater than q_L, we can always find a $q' \geq q_L$ that satisfies the above condition. Note that we require $\bar{q}$ to be high enough, which imposes some restriction on the shape of $G(q)$. □

Proof of Lemma 1. Suppose the two demand schedules, $x_F(q)$ and $x_I^D(q)$ intersect at $q = \hat{q}$.

Then we must have

$$\exp\{\frac{1}{\sigma}(1-c)\hat{q}-1\} = \exp\{\frac{1}{\sigma}(\bar{q}-\bar{p})\}.$$

Now, the left-hand side of the above equation is increasing in q, while the right-hand side is not. Hence, there does not exist $q > \hat{q}$ but less than q_H, such that the two schedules intersect again.

We have shown above that $x_I^D(q_I^{**}) > x_F(q_I^{**})$. Then either $x_I^D(q) > x_F(q)$ for all $q \in [q_I^{**}, q_H]$ or, there exists a quality level $\hat{q}$ such that $x_I^D(q) > x_F(q)$ for $q \in [q_I^{**}, \hat{q}]$ and $x_I^D(q) < x_F(q)$ for $q \in [\hat{q}, q_H]$. If $\exp\{\frac{1}{\sigma}(1-c)q_H - 1\} > \exp\{\frac{1}{\sigma}(\bar{q}_I - \bar{p})\}$, we are in the second scenario, i.e., the two schedules must intersect once. $\square$