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Quality Differentiation and Trade Intermediation

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Abstract

Existing studies show that intermediaries can help verify or screen product quality for buyers. This paper examines this claim both theoretically and empirically in the context of international trade. We develop a heterogeneous-firm model that features vertical and horizontal differentiation of products, a coexistence of direct exporting and indirect exporting through intermediaries, and firms' investment in quality signaling. When complete contracts are not available, intermediaries underinvest in quality signaling from the perspective of the producer. For products that are more horizontally differentiated, competition is less intense and even low-quality firms export via intermediaries. These two mechanisms yield a negative (positive) cross-product relation between vertical (horizontal) differentiation and the prevalence of trade intermediation. Intermediation is more prevalent in the more (both physically and culturally) distant destinations, more so for the more vertically and horizontally differentiated products. Using detailed product-level data from China, we find supporting evidence for these predictions.

Key Words Trade intermediation, vertical differentiation, product differentiation

JEL Classification Numbers: F12, L15

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"The idea is that maybe foreigners don't know which factory to go to, so you perform an introductory role, maybe a quality-control role and there it stops," says managing director of Li & Fung's, a multinational trading company that has offices in more than 40 countries.

"I was fed up with middlemen and poorly run factories distorting pricing, failing to control quality and allowing intellectual property (IP) to be knocked off, so I decided to do something about it," says the founder of Passage Maker, a third-party assembly, inspection and packaging company.

1 Introduction

Recalls of foreign-produced products frequently make headlines.[1] Subject to potentially more information asymmetry, buyers are generally more concerned about product quality when importing goods from abroad than buying them locally. An extensive theoretical literature proposes that intermediaries, such as wholesalers, trading companies, and import-export companies, can alleviate the "quality" problem by screening or verifying product quality for buyers.[2] Recent literature has examined the pattern of intermediation in international trade, but the focus has been mainly on destination-country characteristics.[3] To the best of our knowledge, little work has been done about a specific role played by trade intermediaries. This paper aims to fill this void by examining both theoretically and empirically how trade intermediaries can help mitigate the "quality" problem and thus exhibit varying prevalence across products.

In theory, a middleman can help alleviate the "quality" problem due to her prior investments in inspection technology or incentives to protect her reputation as a quality seller.[4] Given that both buyers and sellers are more vulnerable to information asymmetry in international commerce than

[1] For examples, New York Times (2007) "Lead Paint Prompts Mattel to Recall 967,000 Toys" and New York Times (2009) "Thousands of Homeowners Cite Drywall for Ills".

[2] Spulber (1996) reviews an extensive literature that have examined different roles of a middleman, including product quality assurance, matching, brokering, provision of liquidity and immediacy, and sometimes even contract enforcement.

[3] For instance, wholesalers and retailers accounted for 21 (31) percents of non-service exports (imports) in the U.S. (Bernard et al., 2010b). In Germany, 28% of exports in 1993 went through intermediaries. In Japan, Sogo Shosha (general trading companies) intermediated over 40% exports and over 70% imports in the 90s. The largest 10 trading companies accounted for 30% of Japan's GDP in the 80s. See Yoshihahra and Lifson (1986) for a classic description of Sogo Shoshas in Japan. Aiming to promote export-led growth, many developing countries since the 1980s followed the successful example of Japan and implemented policies to encourage the development of trading companies. In South Korea and Turkey for example, 51% and 38% of exports respectively were intermediated by middlemen (Peng and Ilinitch, 1998). Hong Kong intermediated 50% of the exports from mainland China (Feenstra et al. (2003)).

[4] For instance, see Biglaiser (1993) and Biglaiser and Friedman (1994), and Li (1998).

in domestic exchanges, intermediaries have a larger role to play as a quality assurer in the former. This conventional view suggests a *higher* prevalence of trade intermediation in differentiated-good exports. Empirical evidence about this hypothesis is scant. To our understanding, the few exceptions that indirectly verify the quality-verification hypothesis are Feenstra and Hanson (2004) and Feenstra et al. (2004), who find that entrepot exports through Hong Kong account for a larger share of Chinese exports for differentiated products than homogeneous products. They also find higher estimated welfare gains for foreign buyers when products are more differentiated.

However, business practitioners and scholars do not always agree with the quality-verification hypothesis. They argue that when costly investments are needed for quality verification, trade intermediaries' misaligned incentives may undermine their ability to verify product quality. When complete and self-enforcing contracts are unavailable in practice to specify the terms of investments and contingencies, trade intermediaries may underinvest in quality verification from the perspective of the producer.[5] In a seminal book on this topic, Yoshino and Lifson (1986) provide many anecdotes arguing that intermediation is more prevalent in the trade of homogeneous or less sophisticated goods in Japan. Other studies in international business also find confirming evidence.[6] The common hypothesis of these studies predicts a *lower* prevalence of trade intermediation in differentiated-good exports.

In sum, whether trade intermediaries can better facilitate exports of quality-differentiated products and prevail in those sectors remains an empirical question. To guide our empirical exploration, we build a heterogeneous-firm model (Melitz, 2003 and Chaney, 2008) that incorporates the roles of a trade intermediary proposed in the two literatures. In the model, there are multiple product categories that differ in the degree of horizontal differentiation (i.e., the elasticity of substitution between different varieties). Within each product category, a firm draws a vertical attribute of the product before entering an export market. Firms can produce and organize exports by themselves or produce but outsource the exporting tasks to an intermediary, who then controls the goods when they cross international border.[7] Under direct exporting, the producer has to undertake in-house

[5] Peng and Ilinitch (1998) point out that middlemen need to undertake costly investments in specialized physical and human capital to intermediate exports, especially for exports of highly differentiated products. Peng and York (2001) emphasize the agency costs involved in trade intermediation, and discuss the misaligned incentives between the producer and the export intermediary.

[6] See, for example, Trabold (2002) and Peng et al. (2006).

[7] In the theoretical framework, we assume that intermediaries do not take possession of the goods. They simply represent the producers to sell the goods in a foreign market. The case that involves selling the goods directly to

investment in quality signaling for foreign buyers. Under indirect exporting, the producer simply outsources the quality-signaling tasks to an intermediary.

Crucially, our model assumes that under indirect exporting, firms cannot write complete contracts ex ante to specify the division of surplus between the producer and the intermediary. The rationale we have in mind is that the quality of services provided by the intermediary is difficult to verify ex post. Without complete contracts, the exporter and the intermediary undertake investments non-cooperatively, expecting ex-post Nash bargaining. Since both the intermediary and the exporter anticipate only a fraction of the joint surplus from investments, the intermediary will underinvest in quality signaling, while the producer will underinvest in production (i.e., quantity exported), relative to the first best under direct exporting. Buyers' perceived product quality will be lower under indirect exporting.

Even when trading through intermediaries is associated with a lower fixed export cost, the hold-up effects can drive up the effective variable export cost. A combination of lower fixed costs and higher variable costs under indirect exporting renders a productivity sorting of firms into different trading modes – exporters with the highest product quality export directly, while those with lower quality export through intermediaries. Since for the more vertically differentiated products, sales are more sensitive to quality differences, underinvestment in quality signaling by the intermediary is more detrimental to sales for these products. As such, the share of intermediated exports is negatively correlated with the degree of vertical differentiation across products.

While this theoretical prediction appears to contrast the existing quality-verification view of trade intermediation, our model predicts a *positive* relation between the share of intermediated exports and horizontal differentiation, consistent with the existing literature (e.g. Feenstra and Hanson, 2004). The rationale is that for products that are more horizontally differentiated and thus less substitutable, exporters with lower quality can still capture a sufficiently large market share to justify exporting. Since the low-quality exporters tend to choose indirect exporting due to its lower fixed export cost, a larger share of intermediated trade is expected in more horizontally-differentiated product markets.

We then use Chinese transaction-level data to empirically examine these theoretical predic-

intermediaries is considered by Rauch and Watson (2004).

tions.[8] Our data set covers the universe of direct and indirect exports from China in 2005. In addition to the extensive coverage, the choice of the country fits the purpose of the study as there have been rising concerns about the quality of Chinese exported products.[9] Following the recent empirical literature on quality and trade, we use different measures of quality differentiation for our empirical analysis, which include R&D intensity, advertising intensity (Verhoogen, 2008), and our own constructed measure of quality dispersion. For horizontal differentiation, we use Broda and Weinstein's (2006) estimates of elasticity of substitution between varieties within each product and the Gallop-Monahan index (Kugler and Verhoogen, 2012) that measures the dissimilarity of inputs across firms. Our regression results show a negative (positive) and significant relation between the prevalence of intermediated trade and the degree of vertical (horizontal) differentiation, contrasting the quality-verification view. The empirical results are robust to the use of different measures of vertical and horizontal differentiation, as well as controlling for other determinants of the prevalence of trade intermediation, such as search costs. Figures 1 and 2 highlight the main message of the empirical results. As is shown, across industries (HS2), the share of intermediated exports is negatively correlated with advertising plus R&D intensity; while there is a weakly positive correlation between the share of intermediated exports and the inverse of the elasticity of substitution between varieties. These relations will become stronger at the more disaggregated levels.

We also find a higher share of intermediated exports to more distant (culturally and physically) markets, confirming a common finding in the literature. The distance effects are stronger for more vertically differentiated or horizontally differentiated products. These results are consistent with the hypothesis that marketing costs are an essential part of firms' fixed export costs (Arkolakis, 2010).

Our paper relates to and builds on a growing literature on trade intermediation using firm-level data (Ahn et al., 2011; Akerman, 2012; Bernard et al., 2010a, 2010b).[10] We use the same data set as Ahn et al. (2011), who find that intermediated exports are more prevalent for destination

[8] In this paper, we focus primarily on export intermediaries located in China, and abstract from the discussion on exports to import intermediaries located in foreign countries.

[9] See P. Midler (2009) *Poorly Made in China* for many first-hand anedotes about how foreign buyers suffer from product quality issues in importing goods from China.

[10] Building on another extension of Melitz (2003), Akerman (2012) studies how economies of scale together with double marginalization shape the pattern of intermediated trade. Using Swedish firm-level data, he finds a positive correlation between the share of intermediated exports and various proxies for fixed export costs. Supporting these findings, Bernard et al. (2010a) also find evidence that the prevalence of intermediated exports is positively correlated with country-specific fixed trade costs, but not variable trade costs.

markets that are harder to penetrate. Similar to their explanations, we also rationalize our findings based on productivity-sorting of heterogeneous firms into different trading modes. Bernard et al. (2010b) also find a greater penetration of US intermediate exports into smaller markets and a larger dominance of wholesalers in agriculture-related trade. Based on matched importer-exporter data, Blum et al. (2010) find that within a trade relationship between Chile and Colombia, at least one of the firms is large. They reconcile their findings with a model that features search costs and an option to use trade intermediaries. Our work is distinct from all this work as we focus primarily on how product characteristics shape the sectoral pattern of trade intermediation. We also provide further evidence about how product characteristics affect the previously documented cross-country pattern.

Earlier theoretical work includes Rauch and Watson (2004) and Petropoulou (2010) who model the emergence of trade intermediaries as an outcome of search frictions and network in international trade. Recent theoretical work include Antras and Costinot (2011) and Dasgupta and Mondria (2012). Antras and Costinot introduce matching between producers and intermediaries into an otherwise standard Ricardian trade model, studying the welfare impact of trade liberalization in the form of a reduction in search frictions with the help of intermediaries. Dasgupta and Mondria (2012) focus instead on the reputation concerns of intermediaries and how they handle exports of an intermediate range of quality. Of note, our paper is closely related to Felbermayr and Jung (2011), who also adopt a Nash bargaining framework to study the effects of hold-up in trade intermediation. First, we focus on quality differentiation and signaling, while they emphasize the relationship specificity of the products. Second, we study hold-up by the intermediaries located in the exporting country, instead of the destination country as in their study.

The paper is organized as follows. Section 2 develops the theoretical framework. Section 3 describes our data source and construction of the variables of interest. Section 4 presents the empirical results. The last section concludes.

2 Theoretical Model

2.1 Preferences

The structure of the model follows Melitz (2003) and Chaney (2008). We model quality differentiation in the fashion similar to Mandel (2009), Crozet et al. (2010), Johnson (2012), and Hallak and Schott (2011), among others. We draw ideas from Antras and Helpman (2004) to introduce Nash bargaining between the producer and the trade intermediary under indirect exporting.

Consider a global economy with J countries. Each country has a mass of L_j consumers who supply labor inelastically. Consumers in each country have quasi-linear preferences over $J+1$ products as follows:

$$U = Q_0 + \frac{1}{\mu}\sum_{j=1}^{J} Q_j^{\frac{\mu}{\alpha_j}},$$

where Q_0 is the consumption of the homogeneous good, which is the numeraire traded freely across countries. Q_j is the consumption index of product j, which takes the following constant-elasticity-of-substitution aggregate over varieties:

$$Q_j = \int_{\omega \in \Omega_j} \left(a_j\left(\omega\right) q\left(\omega\right)\right)^{\alpha_j} d\omega,$$

where ω is a variety within product j. The demand shifter $a_j(\omega)$ captures quality of variety ω *perceived* by consumers, while $q(\omega)$ is its quantity consumed.[11] Note that the degree of quality differentiation can vary across products. $\alpha_j = (\sigma_j - 1)/\sigma_j$, where $\sigma_j > 1$ is the elasticity of substitution between varieties within product j.[12] In addition to the vertical attribute, $a_j(\omega)$, products differ in the degree of horizontal differentiation, which is captured by $1/\sigma_j$. μ is the elasticity of substitution between products, which is assumed to be smaller than α_j and identical for all products for simplicity.

Each firm produces only one variety. Without ambiguity, ω is used interchangeably to represent the firm or its variety. Varieties are differentiated vertically and horizontally across firms (brands). To simplify notation, we focus on one product category and suppress product index j for the

[11] Product quality is just an obvious example of many other subjective characteristics that can influence consumers' valuation of a product. For example, Felbermayr and Jung (2011) call this term brand reputation. Bernard et al. (2010c) call it "consumer taste."

[12] For example, one can think of product categories as sports utility vehicles (SUVs) and brands as different classes of SUVs produced by different automobile companeis.

moment.

Denote the consumer price of brand ω by $p(\omega)$. The inverse demand for a destination with demand factor of D is[13]

$$p(\omega) = q(\omega)^{-\frac{1}{\sigma}} a(\omega)^{1-\frac{1}{\sigma}} D. \tag{1}$$

Revenue from exporting to country c is

$$x_c(\omega) = p_c(\omega) q_c(\omega) = [a(\omega) q_c(\omega)]^{\alpha} D_c,$$

In this paper, consumers' perception of product quality is affected by the objective product attribute, ρ, and quality signalling, A. Similar to Crozet et al. (2010), firms draw ρ from a common distribution.[14] Consumers' perception of product quality is also affected by firms' marketing, advertising, quality assurance, and quality verification activities. To fix ideas, we refer to all these activities collectively as quality signaling, with the understanding that the types of activities involved can vary across firms and sectors. For convenience, we assume that the perceived quality of a product takes the following form:

$$a_j(A, \rho) = (A\rho)^{\beta_j} \tag{2}$$

where A represents the level of quality-signaling activities undertaken by the firm or the matched intermediary.[15] Following Hallak (2006) and Crozet et al. (2010), we use a product-specific parameter, β_j, to capture the degree of consumers' sensitivity to quality differences.[16] Without loss of generality, products are ranked so that β_j is increasing in j. Raising a_j is costly, either through quality production or signaling. The unit labor requirement to produce products with quality ρ is assumed to be ρ^{ϕ}, with $\phi > 0$. The cost of quality signaling, on the other hand, is assumed to be linear, with its unit labor requirement normalized to 1.

[13] $D = P^{1-\frac{1}{\sigma}} (yL)^{\frac{1}{\sigma}}$. y is the consumer's labor income plus dividend income, similar to Chaney (2008) and Arkolakis (2010). L is the total labor supply and $P = \left[\int_{\omega\in\Omega} \left(\frac{p(\omega)}{a(\omega)}\right)^{1-\sigma} d\omega\right]^{\frac{1}{1-\sigma}}$ is the ideal price index for a given product group in the destination. The inverse demand function is $q_j(\omega) = (p_j(\omega))^{-\sigma} a(\omega)^{\sigma-1} D_j^{\sigma}$. Quality adjusted demand function: $\widetilde{q}_j(\omega) = D_j^{\sigma} \widetilde{p}_j(\omega)^{-\sigma}$.

[14] Endogenizing the choice of quality as in Hallak and Sivadasan (2009) and Johnson (2012) will deliver quality as a power function of ρ. Importantly, our theoretical results are robust to this extension.

[15] The model is general enough to allow other functional forms of $a(A, \rho)$, such as $\left(A^{\xi}\rho^{1-\xi}\right)^{\beta}$ or $[(1 + A)\rho]^{\beta}$.

[16] Fajgelbaum, Grossman and Helpman (2011) also consider vertical and horizontal differentiation in a discrete-choice model framework. They postulate that perceived differences in quality among brands are larger if individuals' demand is less sensitive to price changes.

We will now derive firm-level equilibrium under direct exporting. Section 2.3 will solve for the firm-level equilibrium under indirect exporting. We will then solve for the aggregate export values and the share of intermediated exports in total exports of a product.

2.2 Production and Quality Signaling under Direct Exporting

For the moment, let us focus on a firm that exports directly to a foreign country. Firm, product, and foreign country subscripts are suppressed for simplicity. Upon choosing direct exporting, the exporter chooses quantity and the level of quality signaling (given ρ) to maximize profits as follows:

$$\max_{q,A}\left\{[a(A,\rho)q]^{\alpha}D - w\rho^{\phi-1}q - wA - wf_D\right\} \tag{3}$$

where q stands for quantity supplied; f_D is the fixed export cost for direct exporting, measured in terms of labor. Without loss of generality, we assume no variable trade cost. Solving (3) yields the optimal levels of quality signaling, quantity, and price as

$$A(\rho) = \left[\left(\frac{\alpha D}{w}\right)\beta^{1-\alpha}\rho^{(1+\beta-\phi)\alpha}\right]^{\frac{1}{1-\alpha(\beta+1)}}; \tag{4}$$

$$q(\rho) = \left[\left(\frac{\alpha D}{w}\right)\beta^{\alpha\beta}\rho^{1-(1-\alpha\beta)\phi}\right]^{\frac{1}{1-\alpha(\beta+1)}}; \tag{5}$$

$$p(\rho) = \frac{w\rho^{\phi-1}}{\alpha}. \tag{6}$$

The quality-unadjusted price (p) is increasing (decreasing) in ρ if $\phi > (<)\, 1$.[17] However, it is independent of the level of quality signaling because of the linear-cost assumption (wA).

We can then derive firm export sales $x(\rho) = p(\rho)\,q(\rho)$ as

$$x(\rho) = \left[D\left(\frac{\alpha}{w}\right)^{\alpha(1+\beta)}\beta^{\alpha\beta}\right]^{\frac{1}{1-\alpha(\beta+1)}}\rho^{\eta(\alpha,\beta)}, \tag{7}$$

[17] The quality-adjusted price is

$$\widetilde{p} \equiv \frac{p}{a} = \left[\left(\left(\frac{w}{\alpha}\right)^{(1+\beta)(1-\alpha)}\left(D\beta^{1-\alpha}\right)^{-\beta}\right)\right]^{\frac{1}{1-\alpha(\beta+1)}}\rho^{-\frac{(\beta-(\phi-1))(1-\alpha)}{1-\alpha(\beta+1)}}$$

Under Assumption 1 below (if the marginal utility of quality consumption is sufficiently high, relative to the marginal cost of quality production), $\widetilde{p}$ is decreasing in ρ.

The elasticity of revenue to quality, $\frac{\partial \ln x(\rho)}{\partial \ln \rho} = \eta(\alpha, \beta) = \frac{\alpha(\beta+1-\phi)}{1-\alpha(\beta+1)}$, is increasing in β. A higher consumers' demand sensitivity to product quality raises the market share of high-quality firms. In addition, $\frac{\partial \ln x(\rho)}{\partial \ln \rho}$ is increasing in $\sigma = (1-\alpha)^{-1}$, the elasticity of substitution between product varieties. Higher substitutability between varieties raises goods market competition, which in turn magnifies the competitive advantage of high-quality firms. These elasticities will be the drivers of the main theoretical results below. If the marginal cost of quality production is independent of quality (i.e., $\phi = 0$), revenue is then unambiguously increasing in ρ. If there is no vertical differentiation (i.e., $\beta = 0$ and $\phi = 0$), we are back to the standard equation $x(\rho) = \left[D\left(\frac{\alpha\rho}{w}\right)^{\alpha}\right]^{\frac{1}{1-\alpha}}$ as in Melitz (2003).

We make the following assumption regarding the parameters:

Assumption 1: $\phi - 1 < \beta < \frac{1-\alpha}{\alpha}$

This assumption guarantees the conventional expectations about the correlation between export sales, firm quality, and destination market size. The first inequality assumes that the marginal cost of production is increasing in quality (i.e., $\phi > 0$), but not excessively.[18] Without the first inequality, export sales will be decreasing in productivity. The second inequality ensures that export sales is increasing in aggregate demand in the destination country, a reasonable assumption.

Finally, by plugging (4), (5), and (7) into (3), we can solve for firm profit as:

$$\pi(\rho) = Bx(\rho) - wf_D,$$

where $B = 1 - \alpha(1+\beta)$.

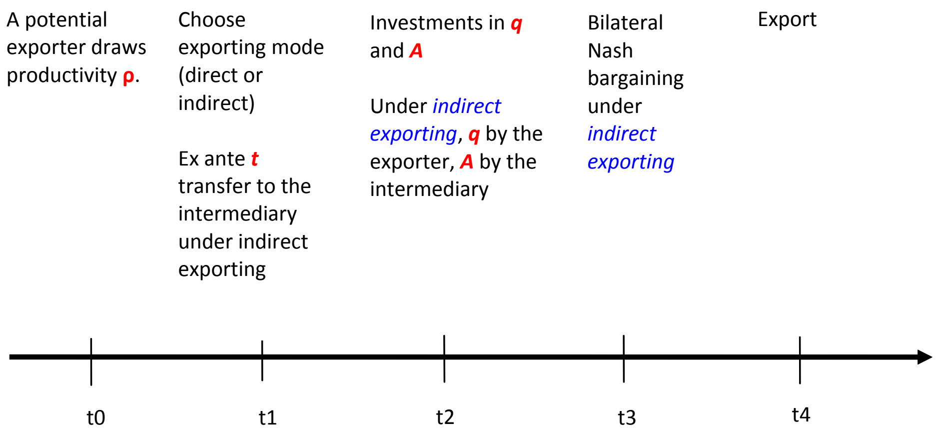
2.3 Production and Quality Signaling under Indirect Exporting

We now turn to the case of exporting through intermediaries. We focus on the role of quality signaling played by intermediaries, abstracting away from other functions of intermediaries, such as matching and brokering.[19] These other functions, which are admittedly important, will be carefully

[18] Hallak and Sivadasan (2009) assume that $\phi - 1$ is lower than unity, in their single-sector model without varying degrees of quality differentiation across products.

[19] See Spulber (1996) and Feenstra and Hanson (2004) for details.

Figure 1: Timing of Events



controlled for in our empirical analysis below.

The timing of events is as follows. There are five periods – t_0 to t_4. At t_0, each firm randomly draws quality ρ. The firm stays in the market if ρ is above a certain quality threshold. At t_1, the firm chooses an exporting mode. It can choose *direct exporting*, under which it organizes export activities and undertakes investments in quality signaling. Alternatively, it can choose *indirect exporting*, under which *both* exporting and quality signaling tasks are outsourced to an intermediary. If the firm chooses indirect exporting, it will be matched randomly with a homogeneous intermediary, to whom it makes a take-it-or-leave-it offer bundled with an ex-ante transfer. Similar to Antras and Costinot (2011), we assume an infinitely elastic supply of ex-ante identical intermediaries. Ex-ante transfers adjust such that the expected profits of all intermediaries equal ex-ante outside options, which are driven to 0 by free entry of intermediaries.

Once the intermediary accepts the offer, at t_2 it then chooses the level of quality signaling, while the producer chooses quantity non-cooperatively. Under incomplete contracting, the two parties undertake investments, anticipating ex-post Nash bargaining over the surplus from the relationship at t_3. If both parties agree to the terms of bargaining, they export the products at t_4 and split the joint surplus according to their primitive bargaining powers. Figure 1 summarizes the timing of events.

Let us now solve for the firm's equilibrium under indirect exporting. For simplicity, we assume that the intermediary's investment is entirely relationship-specific, so that it *cannot* recycle previous investment in quality signaling for other producers. Relaxing this assumption to allow for partial relationship-specificity of investment will not change the results qualitatively.[20] We also normalize the producer's outside option to 0 at the stage of bargaining. In other words, the producer cannot sell the finished products locally or to a foreign buyer when bargaining fails.[21] With zero outside options for both parties, the ex-post surplus for bargaining exactly equals the export sales of the joint production unit.

Intermediaries specialize in trading rather than production, they enjoy economies of scale in quality signaling, which can arise from a pre-established network of foreign buyers or experience in marketing in a particular foreign market. These economies of scale in exporting are captured by a lower fixed exporting cost (i.e., $f_I < f_D$), admittedly in an abstract fashion.[22] Furthermore, mainly for convenience, intermediaries and producers are assumed to have an identical variable cost of quality signaling.[23]

As in Antras and Helpman (2004), we adopt the generalized Nash bargaining framework and denote the primitive bargaining power of the intermediary by γ. Anticipating ex-post bargaining, the intermediary chooses A to maximize $\gamma x(q, A) - wA + t$ upon matching, where t is the ex-ante transfer from the producer to the intermediary. The producer chooses q to maximize $(1-\gamma) x(q, A) - w\tau\rho^{\phi-1} q - t$. Solving the two problems simultaneously yields quality signaling (A_I), quantity (q_I), price (p_I), export sales (x_I) as:

$$A_I(\rho) = H_1(\alpha)^{\frac{1-\alpha}{1-\alpha(\beta+1)}} A(\rho); \tag{8}$$

$$q_I(\rho) = H_2(\alpha, \beta)^{\frac{\alpha\beta}{1-\alpha(\beta+1)}} q(\rho); \tag{9}$$

[20] A positive outside option for the intermediary will essentially lower the effective cost of verification, raising the intermediaries' absolute advantage in verification. Suppose the degree of recoverability of investment costs varies across products. As long as cost recoverability is non-increasing in vertical differentiation, an intuitive assumption, the main results will still hold.

[21] Alternatively, we can assume that the producer would lose only part of the sales without the intermediary. Our results are robust to this assumption, as long as the recoverability of sales is not increasing quality differentiation of the product.

[22] To the extent that trading companies specialize in trading but not production, a lower fixed cost can be endogenized in a network framework proposed by Chaney (2012).

[23] We can relax this assumption and instead assume all intermediaries to have a lower variable cost of quality verification. However, we need to limit such cost advantage. If intermediaires's cost advantage in verifying quality is so excessive that the negative hold-up effects are always dominated by intermediaries' efficiency in quality verification, direct exporting will never be an optimal trading mode for any products given $f_I < f_D$. This contrasts what we observe in the data.

$$p_I(\rho) = \frac{p(\rho)}{1-\gamma}; \tag{10}$$

$$x_I(\rho) = B_1 x(\rho). \tag{11}$$

where $H_1(\alpha) = (1-\gamma)^{\frac{\alpha}{1-\alpha}} \gamma < 1$, $H_2(\alpha, \beta) = (1-\gamma)^{(1/(\alpha\beta)-1)} \gamma < 1$, and $B_1 \equiv \left[(1-\gamma)^{\frac{1}{\beta}} \gamma\right]^{\frac{\alpha\beta}{1-\alpha(\beta+1)}}$. Since the intermediary can recoup only part of the investment costs due to ex-post bargaining, it would never obtain full incentives ex ante to undertake the first-best level of investment of a direct exporter. Similarly, the producer will underinvest in production compared to its direct-exporting counterpart (i.e., $q_I(\rho) < q(\rho)$). Due to the two-sided hold-up, production is suboptimal (i.e., $x_I(\rho) < x(\rho)$) and $p_I(\rho) > p(\rho)$.

Going back in time to t_1 when the producer makes a take-it-or-leave-it offer to a matched intermediary. Expected zero profits and the participation constraint of the intermediaries pin down the ex ante transfer to $t = -\gamma V(q, \lambda) + w f_I + w\theta_I A$. Solving out the producer's operating profits $\pi^o(\rho) = (1-\gamma) x(q, A) - w\rho^{\phi-1} q\tau - t$, using (8), (9), (10), and (11) yields the producer's profit as

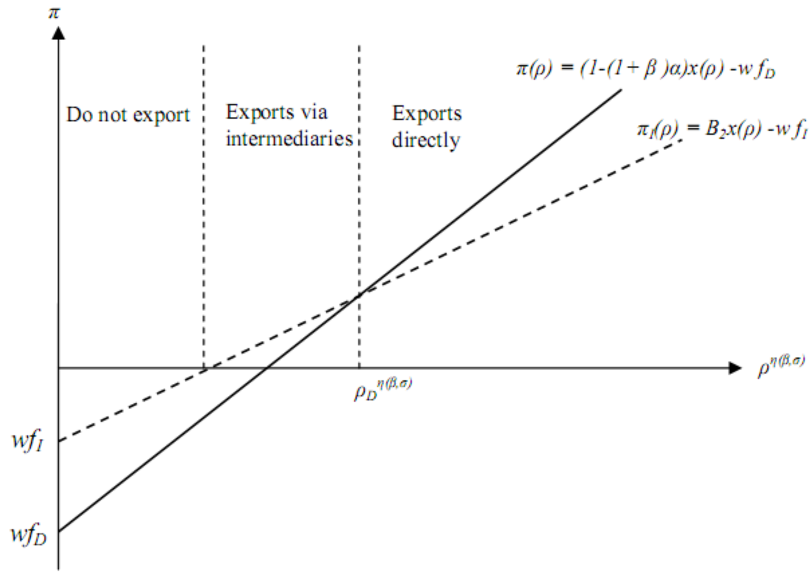
$$\pi_I(\rho) = B_2 x(\rho) - w f_I,$$

where $B_2 \equiv B_1 [1 - \alpha(1 - \gamma + \gamma\beta)] < 1$ and B_1 is defined as above. Notice that $\partial B_2 / \partial \beta < 0$ and $\partial B_2 / \partial \alpha < 0$. It can be readily shown that $B_2 < B \equiv 1 - \alpha(1+\beta)$.[24] The reason is that both quality signaling and quantity are lower than the first-best under direct exporting. While the operating profit is always lower under indirect exporting for a given ρ, as long as $f_I < f_D$, sufficiently low-ρ firms always find it profitable to export via intermediaries.

Figure 2 illustrates the profit function in terms of ρ under the two exporting modes. The only intersection between the two profit lines implies the existence of a productivity cutoff, above which firms optimally choose direct exporting.

[24] Mathematically, what we need to show is that $\left[(1-\gamma)^{\frac{1}{\beta}} \gamma\right]^{\frac{\alpha\beta}{1-\alpha(\beta+1)}} < \frac{1-\alpha(1+\beta)}{1-\alpha(1-\gamma+\gamma\beta)}$. Notice that (i) both terms are decreasing in α; (ii) the left hand side always declines faster than the right hand side when $\alpha \to 1$; and (iii) both terms attain their maximum values when $\alpha = 0$. Thus, the inequality always holds $\forall \alpha \in [0, 1]$.

Figure 2: Exporter profits under different trading modes for a product



2.4 Share of Intermediated Exports in Total Exports

We now solve for the productivity thresholds corresponding to the marginal firms that are indifferent between exporting and non-exporting, and between exporting directly and exporting through intermediaries. The following zero-profit condition pins down the productivity cutoff, above which firms choose to export through intermediaries (ρ_I):

$$\pi_I(\rho_I) = 0 \Rightarrow \rho_I^{\eta(\alpha,\beta)} = \frac{wf_I}{B_2}\left[\beta^{\alpha\beta} D \left(\frac{\alpha}{w}\right)^{\alpha(\beta+1)}\right]^{-\frac{1}{1-\alpha(\beta+1)}}, \tag{12}$$

where $\eta(\alpha,\beta) = \frac{\alpha(\beta+1-\phi)}{1-\alpha(1+\beta)}$ as defined above. The marginal exporter should be indifferent between direct exporting and indirect exporting. Thus, the following condition pins down the productivity threshold for direct exporting (ρ_D):

$$\pi_I(\rho_D) = \pi_D(\rho_D) \Rightarrow \rho_D^{\eta(\alpha,\beta)} = \frac{w(f_D - f_I)}{B - B_2}\left[\beta^{\alpha\beta} D \left(\frac{\alpha}{w}\right)^{\alpha(\beta+1)}\right]^{-\frac{1}{1-\alpha(\beta+1)}} \tag{13}$$

In order to have $\rho_D > \rho_I$ so that both direct and indirect exporters co-exist, we need $\frac{B}{B_2} < \frac{f_D}{f_I}$.[25]

To obtain closed-form solutions, we assume that ρ is Pareto-distributed (Helpman et al., 2004

[25] Ahn et al. (2011) assume zero fixed cost for indirect exporting, implying that ρ_D is always larger than ρ_I in our model.

and Chaney, 2008). The cumulative distribution function $G(\rho) = 1 - (\rho_{\min}/\rho)^{\kappa}$, where $\rho \geq \rho_{\min} > 0$ and the shape parameter equals $\kappa > \eta(\alpha, \beta)$.[26]

For a given product, summing up exports of all firms with $\rho \in [\rho^I, \rho^D]$ gives the value of total intermediated exports, X_I; while summing up exports of all firms with $\rho \in [\rho^D, \infty]$ gives total direct exports X_D. X_I and X_D are:

$$\begin{aligned} X_I &= B_1 \left[\beta^{\alpha\beta} D \left(\frac{\alpha}{w}\right)^{\alpha(\beta+1)}\right]^{\frac{1}{1-\alpha(\beta+1)}} \Theta(\rho_I, \rho_D) \\ X_D &= \left[\beta^{\alpha\beta} D \left(\frac{\alpha}{w}\right)^{\alpha(\beta+1)}\right]^{\frac{1}{1-\alpha(\beta+1)}} \Theta(\rho_D, \infty) \end{aligned}$$

where $\Theta(z_0, z_1) = \int_{z_0}^{z_1} \rho^{\eta} dG(\rho) = \frac{\kappa \rho_{\min}^{\kappa}}{\kappa - \eta} \left[z_0^{\eta-\kappa} - z_1^{\eta-\kappa}\right]$.

For each product, the ratio of intermediated exports to direct exports becomes:[27]

$$\begin{aligned} \frac{X_I}{X_D} &= B_1 \left[\left(\frac{\rho_D}{\rho_I}\right)^{\kappa-\eta(\alpha,\beta)} - 1\right] \\ &= B_1 \left\{\left(\frac{B}{B_2} - 1\right)^{1-\frac{\kappa}{\eta(\alpha,\beta)}} \left(\frac{f_D}{f_I} - 1\right)^{\frac{\kappa}{\eta(\alpha,\beta)}-1} - 1\right\} \end{aligned} \quad (14)$$

In the appendix, we show that $\frac{d\left(\frac{X_I}{X_D}\right)}{d\beta} < 0$ and $\frac{d\left(\frac{X_I}{X_D}\right)}{d\alpha} > 0$, assuming that $\frac{f_D}{f_I}$ is constant across products (an assumption that we will relax later). In the empirical section below, we will focus on examining the following claim:

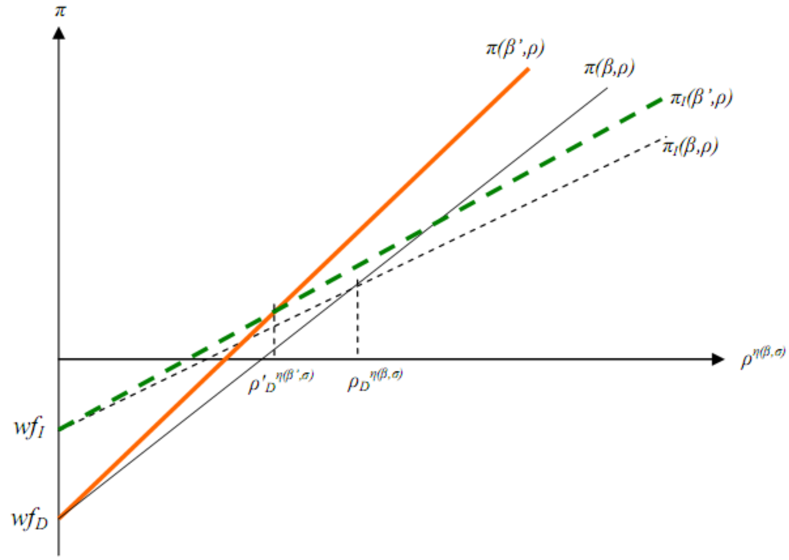
Claim 1 All else being equal, the share of intermediated exports in total exports is lower for the more vertically differentiated products (higher β), but is higher for the more horizontally differentiated products (higher $1/\sigma$).

Proof: See Appendix 1.

[26] In existing research on heterogeneous firms in international trade, the shape paramemter, κ, is commonly assumed to be larger than σ. In our case, when there is no quality differentiation across firms ($\beta = 0$ and $\phi = 0$), our assumption is essentially the standard one in the literature.

[27] Alternatively, as it is done in Antras and Helpman (2004), one can analysize the fractions of firms using different trading modes. The ratio of the mass of indirect exporters to direct exporters equals $\left(\frac{f_D - f_I}{f_I} \frac{B_2}{B - B_2}\right)^{\frac{\kappa}{\eta(\alpha,\beta)}} - 1$.

Figure 3: Exporter profits under different trading modes ($\beta' > \beta$)



The intuition is that a lower level of quality signaling provided by the intermediary reduces the perceived quality and thus the firm's quantity supplied in equilibrium. The hold-up effects on exports are stronger for more vertically differentiated products, for which demand is more sensitive to quality and its signaling. Figure 3 graphically depicts the comparative static analysis of an increase in β. Notice that the profit schedules for both direct and indirect exports pivot upward, because a higher demand elasticity to quality implies higher profits for all exporters. However, because of the hold-up effects associated with indirect exporting, the extent of the increase in profits is smaller under indirect exporting. As such, the productivity cutoff for direct exporting ρ_D moves toward the origin, implying a larger fraction of firms engaging in direct exporting.

By focusing on hold-up, our model provides insights that appear to contrast with the claim that trading companies act as quality screeners or guarantors. On the contrary, Claim 1 provides support to the common view in the business literature that trading companies tend to intermediate simple products in practice (Trabold, 2002; Yoshino and Lifson, 1986). Importantly, the positive correlation between horizontal differentiation of the product and the prevalence of trade intermediation is consistent with Feenstra and Hanson (2004). They show that trade intermediaries in Hong Kong re-export a larger share of more differentiated products from China. According to our model, the reason is not due to intermediaries' competitive advantage in screening or signaling product quality. Instead, it is because of a standard feature of Melitz's model (2003). The rationale is that for products that are more horizontally differentiated and thus less substitutable, exporters with lower quality can still capture a sufficiently large market share to justify exporting. Since the low-quality exporters tend to choose indirect exporting due to its lower fixed export cost, a larger share of intermediated trade is expected in the more horizontally-differentiated product markets.

Recent studies focus on the cross-country pattern of trade intermediation. One of the main results in these studies is that trade intermediation prevails in exports to countries that are harder to penetrate (e.g. more distant or smaller markets). Our model also shows that an increase in the fixed direct export cost relative to the fixed indirect export cost would raise the share of intermediated exports.

More importantly, our model sheds light on how the "distance" effects may vary across products. Suppose fixed trade costs, for both direct and indirect trading, are invariant to product characteristics, simple comparative static exercises show that the positive "distance effects" would be alleviated for products that are more vertically differentiated or less horizontally differentiated (see Appendix A.1.2). The reason is that for products that are characterized with a higher degree of quality differentiation or elasticity of substitution between varieties, firm product quality is associated with a larger cost advantage. Thus, in markets that are already populated by high-quality direct exporters (the most vertically differentiated or the most competitive ones), the distribution of direct and indirect exporters is less sensitive to a change in the relative fixed direct export cost (e.g. distance). This mitigation in fact resonates well with the main message of Chaney (2008), who shows a lower distance elasticity of trade flows in sectors that feature lower horizontal differentiation.

However, if fixed trade costs differ across products, the relation between product vertical and horizontal differentiation would be ambiguous. In particular, if f_D encompasses marketing costs as in Arkolakis (2010), the "distance" effects, due to exporting to a more distant or a less familiar country, could be magnified for more vertically or horizontally differentiated products. We will empirically examine both possibilities as stated in the following claim.

Claim 2 The share of intermediated exports in total exports is increasing in the relative fixed cost of direct exporting (f_D/f_I) to a given destination. If f_D/f_I is invariant across products, the positive effect of higher direct export costs is *mitigated* for products that are more quality differentiated (higher β) or less horizontally differentiated (lower $1/\sigma$). If f_D/f_I is increasing in β and $1/\sigma$, respectively, the positive effects of higher direct export costs can be exacerbated.

Proof: See Appendix 1.

3 Data and Variables

3.1 Customs Data and the Pattern of Intermediated Exports

The main data set for this study covers the universe of all Chinese export and import transactions in 2005, which have been used by Ahn et al. (2011) and Manova and Zhang (2011). For each export (import) transaction, we know the value, the quantity, the destination (source) country, and the trade regime type (e.g., ordinary trade or processing trade) at the HS 8-digit (2002 version) level. Since the last 2 digits of an HS8 are country-specific and may change over time, we aggregate the data up to the HS6 level for which we define as a product. For each exporter and intermediary, we know the ownership type (e.g., state-owned, domestic private, foreign invested).[28] We exploit the richness of the data to examine our hypotheses across industries, product categories, destination countries, and ownership types of firms.

Firms in China for which the main business line is importing, exporting, or trade intermediation are legally required to register as a specialized trading company. These companies will have names that include phrases such as "trading", "importing", and "exporting". Similar to Ahn et al. (2011), we identify trade intermediaries by finding the presence of these phrases in their firm names.[29] It is possible that a trading company's name does not include these phrases, as long as the company can prove to the authority its sufficient engagement in manufacturing. This is particularly relevant after China's accession to the WTO in December 2001, after which many trading intermediaries tried to diversify their businesses. Our current matching method is admittedly imperfect and captures

[28] The data also report quantity, quantity units, customs offices (ports) where the transaction was processed (97 in total), and transportation modes.

[29] Specifically, we search "mao yi", "wai mao", "wai jing", "jin chu kou", "jing mao", "gong mao", and "ke mao" in firm names.

only a subset of the actual share of intermediated trade.

With this caveat in mind, Table 1 shows the intermediaries' share in total exports and total number of exporters. Between 2000 and 2006, the export share of intermediaries gradually declined from 33 percent to 21 percent, while the fraction of intermediaries in total number of trading firms remains stable until 2005. This is consistent with the Chinese government commitment to fully liberalizing trading rights by the end of 2004, in accordance with the WTO agreements that the government.[30] To circumvent any potential estimation biases due to the regulation of trading rights, we use data from 2005.[31] In the empirical analysis, we further exclude products that are permitted by the WTO agreements to remain under state trading monopoly (e.g., crude oil and silver).[32]

Table 2 provides summary statistics of the number of destination countries served and the number of products exported by both direct exporters and intermediaries. Trade intermediaries on average have wider product- and country scopes. They serve 14.5 countries and export 43 (HS6) products on average, compared to 6.9 countries and 10.6 for direct exporters. The median numbers also exhibit the same pattern. Compared to direct exporters, trade intermediaries tend to have a country focus. Trade intermediaries export 7.1 products per destination, compared to 3.7 by direct exporters. Intermediaries' average export sales per destination or per product are both larger than those of direct exporters. This is not surprising, as intermediaries usually do not invest in production and probably incur a much lower cost to diversify their product scope.

3.2 Measuring Vertical Differentiation

We use the following measures for the degree of quality differentiation of each product (HS6).

1. Research and development intensity ($R\&D$);

2. Advertising and R&D intensity (ARD);

3. Quality dispersion (QD).

[30] Source: "China relaxes trading rights controls," China Daily, Aug 27, 2003

[31] Our results are robust to using data from 2006.

[32] The data are obtained from China's WTO entry agreement legal documents. See Annex 2A2 (http://www.lawbook.com.cn/zdtj/wto/flwj/law06.doc) and Annex 2B (http://www.lawbook.com.cn/zdtj/wto/flwj/law07.doc).

Corresponding measures at more aggregate level – industry (HS4) or sector (HS2) are calculated as weighted averages of the HS6-based measures, with weights equal to the export share of each HS6.

Following the existing literature (e.g., Sutton 1991, Sutton 1998, Verhoogen, 2008), we use R&D intensity and advertising plus R&D intensity to proxy for quality differentiation The theoretical underpinning is that equilibrium expenditure on R&D or advertising (as a share in total sales) is increasing in the sensitivity of sales to these expenditures. We use firm-level data for the core OECD countries from ORBIS to construct the measures of R&D intensity. Data from 2006/2007 are used. There are several advantages of using the measures from all OECD countries. First, it enlarges the sample size of firms to compute the measures for as many sectors as possible. Second, as is pointed out by Ciccone and Papaioannou (2011), using a single country's measure in regressions for other countries can result in substantial estimation biases. By using firm data from multiple countries, we hope to average out country-specific measurement errors and any systematic biases they pointed out.

Partly because of this reason, we use a second measure of quality differentiation - ARD intensity, constructed based on manufacturing firm data from the 2005 industrial firm survey, conducted by China's National Bureau of Statistics (CNBS).[33] For each Chinese firm, we compute ARD intensity as the ratio of R&D plus advertising expenditures to sales in 2005.[34] An advantage of using Chinese data to construct these measures is that the data better reflect the marketing and R&D investment practices in China. See Appendix A.2 for details of these variables.

Despite the widespread use of R&D or ARD intensity to proxy for quality differentiation in the literature, we propose a third quality differentiation measure - quality dispersion - which is constructed based on our model.[35] Similar to Khandelwal et al. (2011), by taking log over the inverse demand function as specified in (1) we obtain the following estimation equation:

$$\ln q_{jc}(\omega) + \sigma_j \ln p_{jc}(\omega) = \sigma_j \ln D_{cj} + \epsilon_{jc}(\omega) . \tag{15}$$

[33] This survey includes all private enterprises that have over 5 million RMB (about 60,000 USD) would be included in the survey. All state-owned enterprises are already included in the survey. See Brandt, Van Biesebroeck and Zhang (2012) for detailed data description.

[34] We also use firm value added as the denominator. Results are quantitatively similar.

[35] We thank Amit Khandelwal for suggesting this measure.

By imposing σ_j the elasticity of substitution for product j, we estimate eq. (15) over a large sample of firms to obtain firm-product-level quality, $\epsilon_{jc}(\omega)$. $\sigma_j \ln D_{cj}$ is absorbed by a product-destination fixed effect. We divide the estimated $\widehat{\epsilon}_{jc}(\omega)$ by $\sigma_j - 1$ to obtain the model-based estimate of firm-product quality, $\widehat{\ln a(\omega)}$. Data for q's and p's are from the transaction-level trade data, while data for σ's are taken from Broda and Weinstein (2006) for the US. To maximize the coverage of sectors, instead of imposing σ_j at the HS6 level, we impose σ_j at the HS2 level (98 categories).[36] We then compute the variance of estimated $\ln \widehat{a}(\omega)$ across all transactions for each HS6.

Alternatively, we can also use a similar, more transparent, but less structural-based measure of quality differentiation – the coefficient of variation in prices (unit values). To the extent that prices are positively correlated with product quality, price dispersion reflects the variation in quality in an industry or product. There are well-know drawbacks of using unit values to proxy for quality.[37] Results based on this measure are similar to those based on the measure of quality dispersion and are reported in Appendix Table A5.

The top and bottom 10 vertically-differentiated industries based on the R&D intensity and quality dispersion measures are reported in Appendix Table A8. According to the R&D intensity measure, the top three vertically-differentiated industries (SIC (87) 4-digit) are Chewing and smoking tobacco (2131), Electric housewares and fans (3634) and Biological products, except diagnostic (2836). The bottom three vertically-differentiated industries are Canvas and related products (2394), Lace and warp knit fabrics mills (2258), and Reconstituted wood products (2493).

3.3 Measuring Horizontal Differentiation

Our main measure of horizontal differentiation is the (inverse) elasticity of substitution between varieties ($1/\sigma$) from Broda and Weinstein (2006). Based on a nested constant-elasticity-substitution utility function, the authors estimate product-specific elasticities of substitution between varieties imported into the US. [38] The measures are available at the HS 10-digit category. We take the

[36] Broda and Weinstein (2006) data on elasticity are at the HS 10 level. We take the median value to obtain the measures at the HS2 and HS6 levels.

[37] Recent studies argue that unit value does not fully reflect product quality (e.g., Khandelwal, 2009; Hallak and Schott, 2010). For instance, markups that are sensitive to market power, distribution costs, and search costs are embedded in unit values. The dispersion of prices may also reflect information asymmetry and search costs that vary across products.

[38] The data are downloaded from Weinstein's website.
http://www.columbia.edu/~dew35/TradeElasticities/TradeElasticities.html

median of the value among HS10 to be the measure for HS6 level. Importantly, the measure of horizontal differentiation is weakly correlated with all measures of vertical differentiation, including the measure of quality dispersion that relies on σ in the estimation (see Appendix Table A1). The lack of association suggests that the the horizontal and vertical differentiation can potentially represent two very different attributes of a product. It also ensures that collinearity is not an important concern for our regression results.

Our alternative measure of horizontal differentiation is the Gallop-Monahan index, which measures the dissimilarity of input mixes across firms in an industry. The idea is that products become less substitutable if the underlying inputs are more different. The same measure has been used by Syverson (2004) and Kugler and Verhoogen (2012). Since we do not have data on inputs for Chinese firms, we obtain the measures from Kugler and Verhoogen (2012) for Colombian firms. See Appendix A.2 for details.

Notice that we do not use the well-known Rauch's (1999) classification for simple and complex goods for either vertical or horizontal differentiation, because it is unclear which specific dimension that it proxies for. In the appendix, we report baseline results using Rauch's "differentiated good" dummy. See Appendix A.2 for details.

In our regression analysis, we also use a wide range of variables for destination country characteristics. See the appendix.

4 Empirical Analysis

4.1 Regression Specification

To examine Claim 1, we estimate the following reduced-form specifications separately:

$$\begin{aligned}\left(\frac{X_I}{X_I+X_D}\right)_j &= \beta V_j + Z_{\mathbf{j}}\gamma + F_i + \epsilon_j; \qquad (16)\\ \left(\frac{X_I}{X_I+X_D}\right)_j &= \mu H_j + Z_{\mathbf{j}}\gamma' + I_i + \epsilon_j.\end{aligned}$$

where j and i stand for product and industry respectively. $\left(\frac{X_I}{X_I+X_D}\right)_j$ is the share of exports via intermediaries in total exports of product j from China to the rest of the world.[39] An industry (i) is defined as an HS2 category (N = 98), while a product ($j \in i$) is a HS6 category. V_j is one of the measures of product j's vertical differentiation, while H_j is a measure of horizontal differentiation. $Z_{\mathbf{j}}$ includes a host of product characteristics that could affect the prevalence of intermediation, including proxies for buyers' search cost and intermediaries' bargaining power. These variables will be discussed in more detail in the next section. Some of our variables of interest vary across SIC or ISIC 4-digit categories (e.g., R&D intensity). To address any potential biases due to different levels of aggregation, we always cluster standard errors at the most aggregated level of the independent variables. Furthermore, we also repeat the main regression analyses at the HS4 level to check the robustness of the results.

Before we systematically control for other potential determinants, we include industry fixed effects (F_i or I_i) to control for all industry-specific characteristics that affect the prevalence of intermediated exports. The coefficients β and μ are then interpreted as the within-industry effects of vertical and horizontal differentiation of a product, respectively. The within-industry variation in V_j or H_j is deemed to be small but any significant effects would provide stronger evidence. Notice that there are limitations of this approach because within an industry, there could still be differences in product characteristics that contribute to the variation in the share of intermediated exports. We will address those omitted variables one by one below.

To examine Claim 2 about the effects of fixed costs of direct exporters, we estimate the following specification:

$$\left(\frac{X_I}{X_I+X_D}\right)_{jc} = (\delta_1 V_j + \delta_2 H_j) \times \ln(f_{cD}) + [K_j + K_c] + \epsilon_{jc} \tag{17}$$

where j stands for product and c stands for country. $\ln(f_{cD})$ is a proxy for the fixed export cost incurred by direct exporters selling to country c. K_j and K_c are product (HS6) and country fixed effects, respectively. The focus of this regression is on the interactive effects between the fixed direct export costs and product characteristics (vertical or horizontal differentiation). According to Claim

[39] Alternatively, we can take log over eq (11) to obtain a structural counterpart of.(16). The resulting specification would become (approximately) $\ln\left(\frac{X_I}{X_D}\right) \approx \ln B_1 + \left(1 - \frac{\kappa}{\eta(\alpha,\beta)}\right)\ln\left(\frac{B}{B_2} - 1\right) + \left(\frac{\kappa}{\eta(\alpha,\beta)} - 1\right)\ln\left(\frac{f_D}{f_I} - 1\right)$. Since this equation is an approximation and our measures of vertical, horizontal differentiation, fixed cost for intermediation are not exact, we opt for a reduced-form approach.

2, if f_{cD}/f_{cI} is invariant across products, the effects of f_{cD}/f_{cI} on $X_I/(X_I+X_D)$ are alleviated (magnified) for more vertically (horizontally) differentiated products (i.e., $\delta_1<0$ and $\delta_2>0$). If f_{cD}/f_{cI} increases significantly with the product's vertical and horizontal differentiation, we may have $\delta_1>0$ and $\delta_2>0$. The model specifies a relation between the share of intermediated exports and the *relative* fixed export costs, f_{cD}/f_{cI}, rather than the absolute one. Assuming that f_{cI} is relatively stable across countries compared to f_{cD} (i.e., $\ln(f_{cI})\approx\ln(f_I)\,\forall c$), $(\delta_1V_j+\delta_2H_j)\times\ln(f_{cI})$ can be readily absorbed by the product fixed effects, K_j, leaving f_{cD} to have a differential effect on $X_I/(X_I+X_D)$ across products.[40] Following the literature, we use log distance and other destination-specific trade barriers to proxy for $\ln(f_{cD})$.

4.2 Regression Results

4.2.1 Product-level Analysis

We first aggregate exports across countries to the HS4 or HS6 level. Table 3 reports the results of estimating eq. (16). The upper part reports results at the HS6 level. Standard errors are always clustered at the level of the most aggregated regressor.[41] In columns (1)-(2), we use R&D intensity to proxy for vertical differentiation. Beta coefficients are reported. When HS2 fixed effects are not included, the point estimate in column (1) suggests that a one standard-deviation increase in the R&D intensity of the product is associated with a 0.11 standard-deviation decline in the share of intermediated exports, $X_I/(X_I+X_D)$. Based on the statistics reported in Table A1, this implies a 2.4 percentage-point decline. When HS2 fixed effects are included in column (2), the magnitude and significance of R&D intensity drop but remain statistically negative (at the 5% level).

Similarly, we find a negative and significant (at the 1% level) correlation between the product's advertising plus R&D (ARD) intensity and $X_I/(X_I+X_D)$ (columns (3)-(4)). Columns (5) and (6) also report significant and negative correlation when our constructed measure of quality dispersion (QD) is used, regardless of whether HS2 fixed effects are included or not. Repeating the same regression using the coefficient of price variance to proxy for vertical differentiation confirms these results (see Appendix Table A5). In sum, regardless of the measure, a product's vertical differentiation is associated with a lower share of intermediated exports.

[40] Ahn et al. (2011) assume that $f_I=0$ for all countries.

[41] Results always become more significant when we use robust standard errors instead.

One may be concerned that the significance of the results is boosted up since $R\&D$ and ARD are measured at the SIC level (between HS2 and HS4), a level more aggregated than HS6. In addition to clustering standard errors appropriately, in the lower part of Table 3, we aggregate trade data to the HS4 level, and compute the share of intermediated exports accordingly. The measures of quality differentiation are computed as weighted averages of the corresponding measures at the HS6 level, with weights equal to the export shares of HS6's in each HS4. Odd-numbered columns continue to show negative and significant correlation between any vertical differentiation measure and $X_I / (X_I + X_D)$. Since some HS2 only have a few HS4, instead of including HS2 fixed effects in even-numbered columns, we include fixed effects for industry sections, based on United Nations industrial groupings of HS2.[42] As expected, after the inclusion of industry-section fixed effects, the magnitude and significance decline but remain statistically significant when ARD intensity and QD are used to proxy for quality differentiation.

In Table 4, we use the same samples and correlate $X_I / (X_I + X_D)$ with the product's horizontal differentiation. When the inverse of the elasticity of substitution ($1/\sigma$) between varieties within a product is used to measure horizontal differentiation (columns (1)-(2)), we find a positive but not significant correlation. When the Gollop-Monahan (GM) index is used, the correlation is positive and significant, even when HS2 fixed effects are included. As is shown in the lower part of Table 4, using the share of intermediation and horizontal differentiation measured at the HS4 level confirms these findings. In sum, our findings based on the GM measure is consistent with our model predictions, and lend support to the existing literature that finds a positive relation between product differentiation and the share of intermediated exports (e.g. Feenstra and Hanson, 2004).

Given that most papers have used Rauch's (1999) measures to proxy for either horizontal or vertical differentiation, our paper would be incomplete if we do not show the corresponding results. In Appendix Table A5, we show that the coefficient on the Rauch index is negative, but only significant at the HS4 level. Since it is unclear whether the Rauch index measures vertical or horizontal differentiation of a product, we cannot conclude whether these results support our model or not.[43]

[42] See http://unstats.un.org/unsd/tradekb/Knowledgebase/HS-Classification-by-Section.

[43] Bastos and Silva (2010) find a positive correlation between the Rauch (1999) index and export unit values across firms, arguing that the Rauch index is well-suited to represent quality differentiation. Our findings are entirely consistent with their claim.

4.2.2 Controlling for Other Determinants of Trade Intermediation

In Table 5, we include more controls to our baseline estimation. The main goal is to control for, even approximately, other factors that would shape the prevalence of trade intermediation according to the existing literature. Roughly speaking, these factors capture the cost of using intermediaries, search costs for buyers, and the prevalence of state-owned enterprises and foreign firms in the product market. HS2 fixed effects are always included. We continue to use all three measures of vertical differentiation – R&D intensity (columns (1)-(3)), ARD intensity (columns (4)-(6)), and quality dispersion (columns (7)-(9)). We use the Gallop-Monahan index as the measure of horizontal differentiation, mainly for its more comprehensive coverage of products. See Table 6 for the results using $1/\sigma$ as the measure instead.

In column (1), in addition to HS2 fixed effects, we include the shares of exports from state-owned enterprises (SOE) and from foreign invested enterprises (FIE) as controls, respectively. SOEs tend to have their own affiliated state-owned intermediaries to export and are generally less restricted to export directly than private firms. On the other hand, many FIEs produce primarily for their parents in the destination countries and do not need to invest in quality signaling. This is particular true for processing firms, which are mostly foreign-owned and produce primarily for their foreign headquarters. The negative coefficients on both SOE and FIE export shares in column (1) show that the propensity to use intermediaries is indeed lower for products that are more dominated by SOEs and FIEs.

In column (2), we include the Herfindahl (concentration) indices of direct exporters and intermediaries, respectively. We include the Herfindahl index of direct exporters to capture, among other things, the dominance of large firms in the product market. In particular, including this measure addresses the concern that our empirically identified relation is simply a reflection of the underlying dispersion of sales, which would also affect the share of intermediation due to quality (productivity) sorting of firms according to our model. In addition, we include the Herfindahl index of intermediaries to control for the monopoly power of intermediaries and thus markups they charge for their services. While a higher markup implies a lower share of intermediated trade, a higher Herfindahl index of intermediaries could be associated with a higher $X_I/(X_I + X_D)$ if intermediaries have developed a natural monopoly to handle exports, due to for example the intangible assets (e.g., relationship with customers) accumulated before the trading-rights liberalization. We also control for the ratio of the number of exporters to intermediaries to proxy for the (relative) cost for buyers to search for a producer. The point estimates on all these controls are significant and take the signs that confirm the conventional predictions. Importantly, the coefficient on R&D intensity remains negative and significant (at the 1% level), with the magnitude of the coefficient increasing slightly.

In column (3), we add Nunn's (2007) measure of contract dependence of the product to capture the main theoretical underpinning of the model – contracting frictions and hold-up.[44] If the exchange of a product requires more contract enforcement, hold-up would be more severe, all else equal. As such, a contract-dependent product should be associated with a lower share of intermediated exports, according to our model. Column (3) shows a significant and negative coefficient on the contract dependence measure, supporting this hypothesis and our model assumptions.

Similar results are obtained when ARD intensity (columns (4)-(6)) and QD (columns (7)-(9)) are used to proxy for vertical differentiation. The negative correlation with vertical differentiation remains consistently significant when $1/\sigma$ is used to measure horizontal differentiation.

4.2.3 Sensitivity Analysis

After confirming the robustness of the main results, in Table 6 we conduct a host of sensitivity analyses, using the specification from column (3) in Table 5. To conserve space, we use only R&D intensity as the measure of quality differentiation, but both measures of horizontal differentiation. Results based on other measures are reported in Appendix Table A6.

In Panel A, we exclude processing exports from the calculation of the dependent variable, $X_I/(X_I + X_D)$.[45] Processing exporters consistently accounted for over half of Chinese exports in recent years and directly receive orders from foreign buyers. They may not need to invest as much in quality signalling and other export facilitation activities compared to regular exporters. In Panel B, foreign exports are excluded in the calculation of $X_I/(X_I + X_D)$. As is discussed before, FIEs often export directly back to foreign headquarters; and thus may not need to invest as much in export

[44] The measure is defined as one minus the share of inputs that are either reference-priced or can be found in exchange markets. The raw data are originally from Rauch (1999). Nunn (2009) uses a US I/O table to compute the weighted average of the "thickness" of the upstream sectors.

[45] Notice that from taking a certain type of exports from X_D, the intermediated export share would necessarily decline, but the extent of the decline may differ across products.

facilitation activities, similar to processing exporters. Panel C excludes SOEs from the calculation, as some SOEs have their own trading companies and have been granted special trading rights even before China's WTO accession. Panel D excludes exports to Hong Kong in the calculation. Feenstra and Hanson (2004) show that between 1988 and 1998, Hong Kong intermediated 50% of Chinese exports, and that the share is higher for products that are more differentiated based on Rauch (1999) index. Across all four panels, the coefficient on R&D intensity remains negative and significant (at the 1% level), while the coefficient on both the horizontal differentiation measures are positive, and is always significant when the Gollop-Monahan index is used.

In Panel E, we confirm that our results are not driven by outliers, by excluding products at the top 5% and bottom 5% in terms of R&D intensity. Finally, in Panel F, we show that our results remain completely robust when data from 2006 are used.

4.2.4 The Impact of Fixed Direct Export Costs

Claim 2 hypothesizes that a higher fixed export cost for direct relative to indirect exporting is associated with a higher share of intermediated exports to a country. This result resonates well with the main findings of Ahn et al. (2011). In Table 7 we examine the effects of a number of proxies for fixed trade cost on $X_I/(X_I + X_D)$. Panel A reports results at the country level, while Panel B reports those at country-HS6 level.

Let us focus on the cross-country evidence. In the first column, we find that exports to more distant markets are associated with more trade through intermediaries (column (2)). Columns (2) through (3) use import regulations to proxy for fixed direct export costs. More restrictive import regulations are also found to be associated with a higher $X_I/(X_I + X_D)$.

In addition to physical and institutional trade barriers, it has been argued that language and cultural barriers can be important determinants of the extensive margin of trade. The idea is that exporters would find it more costly to sell to a foreign market, if foreign consumers are more culturally different from the exporting country (Guiso et al., 2009). In that situation, trade intermediaries can play an important role in reducing the informational and cultural barriers, by providing matching services for both Chinese producers and foreign buyers.

We use the share of Chinese in the importing country's population as a proxy for cultural barriers to trade. The idea is that if the importing country has a proportionally larger Chinese population, the chance that the buyer is a Chinese or is connected to a Chinese network is higher. To make the measure consistent with the other distance measures, we take the inverse of the share and then take log to represent the information barrier to trade.[46] We find that a country with a proportionally larger Chinese diaspora is associated with a lower share of intermediated exports from China. Furthermore, we use the genetic distance measure from Spolaore and Warziarg (2009) as an exogenous measure of the cultural dissimilarity between the sellers and the buyers to examine how it could shape the pattern of intermediated trade (column (5)).[47] We find that exports to destination countries that are more genetically different from the Chinese are more likely to be handled by intermediaries.

In the lower part of the table, we repeat the analysis at the country-HS6 level. We always control for HS6 fixed effects to make sure that the pattern does not arise due to different compositions of products. As expected, all coefficients become even more significant and have the same signs.

4.2.5 The Effects of Vertical and Horizontal Differentiation on the "Distance" Effects

Table 8 examines Claim 2 by estimating equation (17). Country and HS6 fixed effects are always included. Standard errors are clustered at the HS6 level. According to Claim 2, if f_D/f_I is invariant across products, $\delta_1 < 0$ and $\delta_2 > 0$ are expected. If f_D/f_I is increasing in β and/ or $1/\sigma$, $\delta_1 > 0$ and $\delta_2 > 0$ are expected.

We focus on three proxies for fixed export costs – physical distance, genetic distance, and the inverse share of the Chinese population in the destination country.[48] To conserve space, we only report results using the Gallop-Monahan (GM) index as the measure of horizontal differentiation. Results based on $1/\sigma$ are reported in Appendix Table A7.

In Panel A when (log) physical distance is used, we find negative but insignificant coefficients on the interaction term between distance and R&D and ARD intensities, respectively. The coefficients on the interactions with the GM index and the quality dispersion (QD) measure are positive and significant. These results support the hypothesis that fixed trade costs, measured by physical

[46] Rauch and Trinadad (2002) find that bilateral trade flows are higher between China and countries with a larger share of Chinese population.

[47] Genetic distance is a measure based on differences in the distribution of gene variants across populations between two countries. It has been used in existing literature to study the impact of cultural differences on exchanges (Guiso, Sapienza, and Zingales, 2009) and technology diffusion (Spolaore and Warziarg, 2009).

[48] Using importing regulations as a proxy for fixed trade costs yield consistent but less precise estimates. These alternative measures should be less likely to increase in both vertical and horizontal differentiation.

distance, increase in quality differentiation and may offset the hold-up effects on trade intermediation.[49] Notice that the positive coefficient on the interaction with horizontal differentiation is expected, regardless of whether the fixed trade cost is increasing in horizontal differentiation or not.

In Panel B, when genetic distance is used to proxy for cultural dissimilarity, we obtain positive coefficients on all differentiation-distance interaction terms. While the coefficient on the R&D intensity remains insignificant, all other interactions become significant (barely significant for ARD). These results provide stronger evidence in the sense that cultural distance can potentially capture a sharper rise in marketing costs for vertically and horizontally differentiated exports. Finally in Panel C, when the (log) inverse share of Chinese population is used to proxy for cultural distance, we find positive and significant coefficients on all interaction terms (barely significant for QD). Together with the results based on genetic distance, these results support Claim 2 that fixed marketing cost is probably increasing vertical differentiation, large enough to offset the hold-up effects observed at the aggregate.

5 Conclusion

This paper theoretically and empirically examines the relations between the prevalence of intermediation in exports and the degree of vertical and horizontal differentiation of the product. Our model features heterogeneous product quality and investment in quality signaling across firms. A producer can export directly or indirectly through an intermediary. When complete contracts are not available, intermediaries underinvest in quality signaling from the perspective of the producer. The underinvestment problem intensifies for the exports of the more vertically differentiated products. On the other hand, in product markets that are more horizontally differentiated, there is less competition and thus more low-quality (small) exporters, which tend to use intermediaries to export.

Using detailed product-level data on Chinese intermediated and direct exports, we find a negative (positive) cross-product relation between vertical (horizontal) differentiation and the prevalence

[49] Notice that if there is selection issue due to firms with higher quality tend to ship over longer distance (Hummels and Skiba, 2004), we would have a larger share of quality-differentiated products exported more distant market. Based on our baseline results and the Hummels-Skiba theory, the weighted average of the share of intermediated exports should be lower. Thus, our interaction effects could be downward biased, due to selection.

of trade intermediation, supporting the model predictions. While our findings contrast the quality-verification view in the literature, they support the existing findings of a positive relation between product differentiation and the prevalence of trade intermediation.

Complementing the existing studies, we also find a larger role for intermediaries to help exporters penetrate the more (physically or culturally) distant markets. The "distance" effects appear to be stronger for the more differentiated products. In sum, our paper shows that while intermediaries do not have an absolute advantage in selling the more quality-differentiated products, they do have a relative advantage in selling those products in the distant and less familiar markets.

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A Appendix

A.1 Theoretical Appendix

A.1.1 Proof of Claim 1

Recall that the ratio of intermediated exports to direct exports is

$$\begin{aligned}\frac{X_I}{X_D} &= B_1\left[\left(\frac{\rho_D}{\rho_I}\right)^{\kappa-\eta(\alpha,\beta)}-1\right]\\ &= B_1\left\{\left(\frac{B}{B_2}-1\right)^{1-\frac{\kappa}{\eta(\alpha,\beta)}}\left(\frac{f_D}{f_I}-1\right)^{\frac{\kappa}{\eta(\alpha,\beta)}-1}-1\right\},\end{aligned}$$

where

$$\begin{aligned}B &\equiv (1-(1+\beta)\alpha)\,;\quad B_1\equiv\left[(1-\gamma)^{\frac{1}{\beta}}\gamma\right]^{\frac{\alpha\beta}{1-\alpha(\beta+1)}};\\ B_2 &\equiv [1-\alpha(1-\gamma+\gamma\beta)]\left[(1-\gamma)^{\frac{1}{\beta}}\gamma\right]^{\frac{\alpha\beta}{1-\alpha(\beta+1)}};\quad \eta(\alpha,\beta)=\frac{\alpha(\beta+1-\phi)}{1-\alpha(1+\beta)}.\end{aligned}$$

Notice that in order to have $\frac{X_I}{X_D}\geq 0$, we need $\frac{B}{B_2}\frac{f_I}{f_D}<1$. For a clearer illustration, re-express $\frac{X_I}{X_D}$ as

$$\frac{X_I}{X_D}=B_1\left\{(a-b)^c-1\right\}, \tag{A-1}$$

where

$$a=\frac{B}{B_2}\left(\frac{f_D}{f_I}-1\right)^{-1};b=\left(\frac{f_D}{f_I}-1\right)^{-1};c=1-\frac{\kappa}{\eta(\alpha,\beta)}.$$

Notice that $\frac{dB_1}{d\beta}<0$. Thus, to show that $\frac{X_I}{X_D}$ is decreasing in β, it is sufficient (though not necessary) to show that the following holds:

$$\frac{d\left[c\ln(a-b)\right]}{d\beta}=\frac{c}{a-b}\frac{da}{d\beta}+\ln(a-b)\frac{dc}{d\beta}<0. \tag{A-2}$$

Notice that $\frac{c}{a-b}<0$; $\ln(a-b)<0$; $\frac{dc}{d\beta}>0$, and

$$\frac{d\ln a}{d\beta}=\frac{a\alpha}{\left[1-\alpha(1+\beta)\right]^2}\left\{-K\left[\alpha\gamma+(1-\gamma)(1-\alpha)\right]-\left[(1-\alpha)\ln(\gamma)+\alpha\ln(1-\gamma)\right]\right\}, \tag{A-3}$$

where $K=\frac{1-\alpha(1+\beta)}{1-\alpha(1-\gamma(1-\beta))}<1$. Using the fact that $-\ln(\gamma)-(1-\gamma)>0$ and $-\ln(1-\gamma)-\gamma>0$, we can readily show that $\frac{d\ln a}{d\beta}>0$. Together with $\frac{c}{a-b}<0$, $\ln(a-b)<0$, and $\frac{dc}{d\beta}>0$, it can be proved that $\frac{d[c\ln(a-b)]}{d\beta}<0$ and $\frac{d\left(\frac{X_I}{X_D}\right)}{d\beta}<0$.

Similarly, to show that $\frac{X_I}{X_D}$ is *decreasing* (increasing) in α ($\frac{1}{\sigma}$), it is sufficient (though not necessary) to show that

$$\frac{d\left[c\ln(a-b)\right]}{d\alpha}=\frac{c}{a-b}\frac{da}{d\alpha}+\ln(a-b)\frac{dc}{d\alpha}<0.$$

Notice that $\frac{c}{a-b} < 0$; $\ln(a-b) < 0$; $\frac{dc}{d\alpha} > 0$, and

$$\frac{d\ln a}{d\alpha} = \frac{a(1+\beta)}{1-\alpha(\beta+1)}\left\{1-\beta\ln(\gamma)-\ln(1-\gamma)+\frac{K(1-\gamma+\gamma\beta)}{1+\beta}\right\} > 0 \tag{A-4}$$

where K is defined as above. Together with $\frac{c}{a-b} < 0$, $\ln(a-b) < 0$, and $\frac{dc}{d\alpha} > 0$, we can show that $\frac{d[c\ln(a-b)]}{d\alpha} < 0$ and thus $\frac{d\left(\frac{X_I}{X_D}\right)}{d\alpha} < 0$. $\frac{X_I}{X_D}$ is decreasing (increasing) in α ($\frac{1}{\sigma}$).■

A.1.2 Proof of Claim 2

According to eq. $(A-1)$, the impact of an increase in (f_D/f_I) on X_I/X_D ultimately depends on the sign of $\frac{d[c\ln(a-b)]}{d(f_D/f_I)}$, which equals

$$\begin{aligned}\frac{d[c\ln(a-b)]}{d(f_D/f_I)} &= \frac{c}{a-b}\frac{d(a-b)}{d(f_D/f_I)}\\ &= \left(\frac{\kappa}{\eta(\alpha,\beta)}-1\right)\left(\frac{f_D}{f_I}-1\right)^{-1} > 0.\end{aligned}$$

This proves the first part of the claim. Suppose the fixed trade costs (f_D and f_I) are invariant for different products. Since.$\frac{d\frac{\kappa}{\eta(\beta,\alpha)}}{d\beta} < 0$ and $\frac{d\frac{\kappa}{\eta(\beta,\alpha)}}{d\alpha} < 0$, it can be shown that $\frac{d}{d\beta}\frac{d[c\ln(a-b)]}{d(f_D/f_I)} < 0$ and $\frac{d}{d\alpha}\frac{d[c\ln(a-b)]}{d(f_D/f_I)} < 0$, which prove the second part of the claim.

Let us now turn to the potential "exacerbation" effects. Suppose the direct fixed export costs encompass marketing costs, as in Arkolakis (2010). Assume intuitively that marketing costs are increasing in vertical and horizontal differentiation, then $\frac{d(f_D/f_I)}{d\beta} \geq 0$ and $\frac{d(f_D/f_I)}{d(1/\sigma)} \geq 0$. To examine the impact of an increase in vertical differentiation on the "distance" effects, we first derive the augmented sufficient condition $(A-2)$ as follows:

$$\frac{d[c\ln(a-b)]}{d\beta} = \frac{c}{a-b}\frac{d(a-b)}{d\beta} + \ln(a-b)\frac{dc}{d\beta}$$

Then differentiate this expression with respect to (f_D/f_I) :

$$\begin{aligned}\frac{d}{d(f_D/f_I)}\frac{d[c\ln(a-b)]}{d\beta} &= \frac{d\left(\frac{c}{a-b}\right)}{d(f_D/f_I)} \times \underset{-}{\frac{d(a-b)}{d\beta}} + \frac{c}{a-b} \times \left[\frac{d}{d(f_D/f_I)}\frac{d(a-b)}{d\beta}\right] \\ &= \frac{c}{a}\left(\frac{f_D}{f_I}-1\right)\frac{d(a-b)}{d\beta} + \frac{c}{a-b} \times \left[\frac{d}{d(f_D/f_I)}\frac{d(a-b)}{d\beta}\right].\end{aligned} \tag{A-5}$$

Notice that $\frac{d\ln(a-b)}{d\beta} = \frac{d\ln(a-1)}{d\beta} - \left(\frac{f_D}{f_I}-1\right)^{-1}\frac{d\left(\frac{f_D}{f_I}\right)}{d\beta}$, where the first term on the right hand side is positive as is shown above. For X_I/X_D to decrease in β, which we have shown so far, we need $\frac{d\ln(a-b)}{d\beta} < 0$. Assume that this is the case, then in eq. $(A-5)$, the first term is negative while the second term is positive. For sufficiently high $\frac{f_D}{f_I}$, it can be shown that $\frac{d}{d(f_D/f_I)}\frac{d[c\ln(a-b)]}{d\beta} > 0$, which rationalizes the exacerbation of the "distance "effects.■

A.2 Data Appendix

A.2.1 Product-level Variables

Measures of Vertical Differentiation

1. Research and Development (R&D) Intensity (based on firms from OECD countries). Definition: Average of the ratio (R&D Expenditure/ Sales) across firms. Source: ORBIS in 2006/7. The data are originally classified at the 4-digit US SIC code (451 categories). We use the concordance file from Schott's website to map each HS 10-digit code to 4-digit SIC, and then to HS 6-digit. If there multiple HS 6 matched with SIC, we take the match that has the highest number of HS 10 shared. If there are ties, we manually choose the SIC for each HS6 code.

2. Research and Development (R&D) Intensity (based on Chinese firms). Same definition as (1). Source: China's National Bureau of Statistics (CNBS) in 2005. The data are classified at the 4-digit China industry code (480 categories). We first use a concordance file from CNBS to map each category to a US SIC 4-digit code. Then we repeat the procedure as described in (1) to map each measure to each HS6 code.

3. Advertising Intensity (based on Chinese firms). Same definition as 2. Source: China's National Bureau of Statistics (CNBS) in 2005. The data are classified at the 4-digit GB/T4754-2002 code (480 categories). China industry code (480 categories). We first use a concordance file from CNBS to map each category to a US SIC 4-digit code. Then we repeat the procedure as described in (1) to map each measure to each HS6 code.

4. Quality dispersion. Definition: see eq. (15) and the related text. Source: Chinese transaction-level trade data (2005).

Measures of Horizontal Differentiation

1. Elasticity of Substitution (σ). Source: Broad and Weinstein (2006). The data are originally classified at the 10-digit HS category based on the 1992 HS classification (4873 categories). We take the median value of σ for each HS 6-digit category. We first concord the 1992 HS code to the 2002 HS code using the concordance file from UN Comtrade. To calculate the measure at the HS4 level, we use the export share of the corresponding HS6 categories to calculate a weighted average of the measure for each HS4 category. We calculate export shares using export volume at the HS6 level from our transaction-level data.

2. Gallop-Monahan Index (based on US firms). Source: Kugler and Verhoogen (2012). Definition:
$$GM_p = \sum_{j,k} w_j \left(\sum_i \frac{|s_{ijp} - \overline{s}_{ijp}|}{2} \right)^{\frac{1}{2}}, \tag{A-6}$$
where i, j, and p stand for inputs, plants, products, respectively. w_{jt} stands for the revenue share of firm j in product p sales. This term inside the brackets measures how dissimilar input mix of plant j is from other firms that also produce product p. Since we do not have access to input data at the firm level, we use the measures already constructed by Kugler and Verhoogen (2012) using Colombian firm-level data. Their original data are available at the ISIC (Revision 2) 4-digit level. We use the concordance from the UN Comtrade to concord the measures first to HS6. To calculate the measure at the HS4 level, we use the export share

of the corresponding HS6 categories to calculate a weighted average of the measure for each HS4 category.

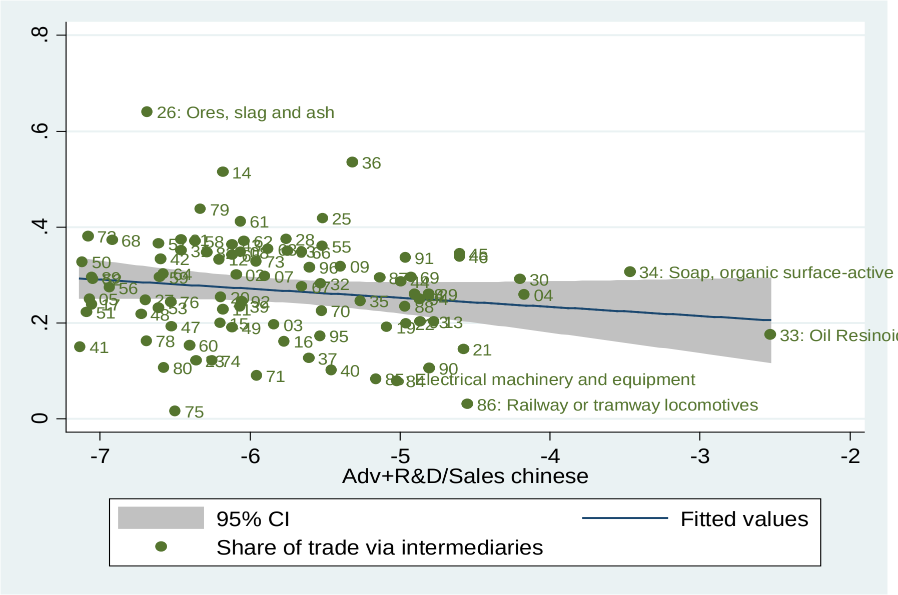
Other Measures

- Rauch's (1999) differentiated-good dummy. Source: Rauch (1999). Rauch categorizes industries into three categories: (1) goods that are mainly traded on organized exchanges; (2) goods that are reference priced; (3) goods that neither have reference prices nor are traded on organized exchanges. The dummy variable equals one if the product falls into category (3) and zero otherwise. The data are originally classified at the 4-digit SITC Revision 2 level (1189 categories). We concord the data into HS 6-digit level (2002 version) from SITC Rev.2 and Rev.3. All concordance tables are from the United Nations Statistics Division.
- Herfindahl index of direct exporters, Herfindahl index of intermediaries, export shares of state-owned enterprises, export shares of foreign invested firms, and the ratio of the number of direct exporters to intermediaries. All these are computed using China's transaction-level trade data (2005) at the HS4 or HS6 level. No weighted averages are ever used.

A.2.2 Country Variables

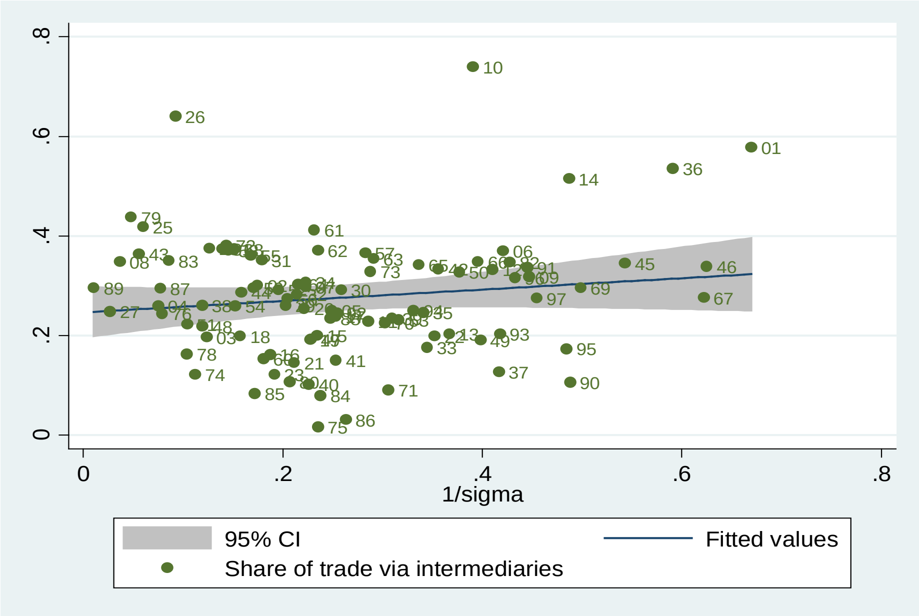
1. GDP: Source: World Bank World Development Indicators.
2. GDP per capita: Source: World Bank World Development Indicators.
3. Distance: Source: Centre d'Etudes Prospectives et d'Informations Internationales (CEPII).
4. Rule of law: Source: World Bank Governance Indicators.
5. Population: Source: World Bank World Development Indicators.
6. Chinese population around the World: Source: Ohio University Shao Center's Distribution of the Ethnic Chinese Population Around the World.
7. Genetic distance: Source: Spolaore and Warziarg (2009). Population-weighted average of the differences in the distribution of gene variants across populations between two countries.

Figure 4: Share of Intermediated Exports and Advertising and R&D Intensity



Share = 0.158 - 0.019x(Adv+R&D/Sales)
(2.48) (-1.71); N=90

Figure 5: Share of Intermediated Exports and 1/(Elasticity of Substitution)



Share = 0.247 + 0.114x(1/sigma)
(9.16) (1.16) N = 95

Table 1: Direct Exporters vs. Intermediaries in China's Exports (2000-2006)

This table reports the evolution of the shares of direct versus intermediated exports from 2000 to 2006.

Year	Direct Exporters' Export Value (billion USD)	Intermediaries' Export value (billion USD)	Share in Total Value (%)	Num. Direct Exports	Num. Intermediaries	Share in Total Num. (%)
2000	167.1	82.2	33	54,968	7,803	12.4
2001	184.8	81	30.5	59,500	8,572	12.6
2002	235.5	90.1	27.7	68,966	9,646	12.3
2003	328.5	109.8	25	82,959	12,670	13.2
2004	463.2	130.5	22	103,822	16,767	13.9
2005	610.2	151.4	19.9	128,064	19,866	13.4
2006	764.5	204	21.1	135,548	37,024	21.5

Source: Authors' calculations from China's transaction-level customs database.

Table 2: Number of Destination Countries and Products by Type of Exporters (2005)

This table reports the summary statistics of the number of destination countries and number of products served by direct exporters and trade intermediaries, respectively.

	Mean	Median	St. Dev.	Min	Max
Direct Exporters					
Nb. of destination countries	6.9	3	10.2	1	152
Nb. of products	10.6	3	37	1	2455
Nb. of products per destination	3.66	1	13.12	1	1732
Export value per destination (USD)	197609	21445.2	2543245	1	6.55E+08
Export value per product (HS6) (USD)	102115.8	5837.667	1852768	1	7.85E+08
Intermediaries					
Nb. of destination countries	14.5	6	19.7	1	169
Nb. of products	43	11	90.5	1	1454
Nb. of products per destination	7.09	2	18.53	1	1316
Export value per destination (USD)	88187.81	17452.8	1337737	1	4.28E+08
Export value per product (HS6) (USD)	52525.21	6566	720910.4	1	3.05E+08

Source: Authors' calculations from China's transaction-level customs database.

Table 3: Share of Intermediate Exports and Vertical Differentiation

This table explores the relationship between vertical differentiation and the share of intermediated exports across HS6 and HS4 product categories. Three measures of vertical differentiation are used. R&D intensity is the average of the ratio of R&D expenditure to sales, based on data of firms in OECD countries in 2006/ 2007 (Source: Orbis). Adv + R&D intensity is the average of the ratio of advertising plus R&D expenditure to sales, based on firm-level data from China (source: NBS). Quality dispersion is our structurally estimated measure of the standard deviation of product quality within a HS6 or HS4 (see eq. (15) for details).

Dependent Var = Share of Exports Through Intermediaries						
Vertical Diff (V)	**R&D Int. (OECD)**		**Adv + R&D Int. (China)**		**Quality Dispersion**	
Unit of Obs			**HS 6-digit category**			
Vertical Diff	-0.113***	-0.059**	-0.119***	-0.092***	-0.146***	-0.124***
	(-3.91)	(-2.22)	(-4.43)	(-3.16)	(-9.53)	(-5.80)
HS 2-digit FE	No	Yes	No	Yes	No	Yes
N	3781	3781	3581	3581	4198	4198
R-squared	.0128	.109	.0141	.112	.0213	.148
Unit of Obs			**HS 4-digit category**			
Vertical Diff	-0.115***	-0.057	-0.153***	-0.081*	-0.147***	-0.093**
	(-3.15)	(-1.26)	(-4.07)	(-1.84)	(-4.37)	(-2.46)
Industry (UN Code) FE	No	Yes	No	Yes	No	Yes
N	995	995	978	978	1109	1109
R-squared	.0132	.0939	.0234	0.126	.0215	.126

t statistics in parentheses; beta coefficients are reported;
standard errors are clustered at the HS 6-digit level; * $p<0.10$; ** $p<0.05$; *** $p<0.01$

Table 4: Share of Intermediated Exports and Horizontal Differentiation

This table explores the relationship between horizontal differentiation and the share of intermediated exports across product (HS6) categories. Two measures of horizontal differentiation are used. 1/σ is the inverse of the elasticity of substitution estimated by Broda and Weinstein (2006). The Gallop-Monahan Index measures the dissimilarity of inputs across firms in an industry. See Kugler and Verhoogen (2012) and eq. (A-6) in the appendix for details.

Dependent Var = Share of Exports Through Intermediaries				
Horizontal Diff. (H) Measure:	**1/σ**		**Gallop-Monahan Index**	
Unit of Obs	**HS 6-digit category**			
H	0.003	0.023	0.126***	0.028
	(0.19)	(1.37)	(3.79)	(0.92)
HS 2-digit FE	No	Yes	No	Yes
N	4037	4037	4259	4259
r2	0.000	0.104	0.016	0.100
Unit of Obs	**HS 4-digit category**			
H	-0.004	0.023	0.098***	0.067*
	(-0.13)	(0.67)	(3.12)	(1.78)
Industry (UN Code) FE	No	Yes	No	Yes
N	1081	1081	1034	1034
R-squared	0.000	0.123	0.010	.082

t statistics in parentheses; beta coefficients reported; robust standard errors are used in columns (1)-(2), while they are clustered at the ISIC 4-digit level in columns (3)-(4).
* p<0.10; ** p<0.05; *** p<0.01

Table 5: Share of Intermediated Exports, Vertical, and Horizontal Differentiation (by HS6)

This table includes measures of vertical and horizontal differentiation as regressors simultaneously. The dependent variable is the share of exports through intermediaries. The unit of observation is HS6. HS2 fixed effects are always included. Variables that could affect the prevalence of intermediated exports are included additively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Vertical Diff. (V)	R&D Intensity (OECD)			Adv + R&D Intensity (China)			Quality Ladder		
V	-0.068***	-0.097***	-0.076***	-0.064**	-0.087***	-0.104***	-0.029	-0.024	-0.039**
	(-2.87)	(-4.15)	(-3.51)	(-2.30)	(-3.24)	(-4.28)	(-1.53)	(-1.44)	(-2.11)
Gallop-Monahan Index	0.086***	0.072***	0.066***	0.099***	0.089***	0.076***	0.087***	0.087***	0.069***
	(3.30)	(2.86)	(2.80)	(3.68)	(3.40)	(3.32)	(3.10)	(3.36)	(3.02)
State Exp Share	-0.183***	-0.157***	-0.166***	-0.188***	-0.164***	-0.168***	-0.188***	-0.164***	-0.151***
	(-5.90)	(-6.25)	(-5.33)	(-5.97)	(-6.46)	(-5.19)	(-6.79)	(-6.78)	(-5.25)
Foreign Exp Share	-0.469***	-0.370***	-0.396***	-0.465***	-0.374***	-0.391***	-0.530***	-0.426***	-0.445***
	(-16.92)	(-13.37)	(-12.88)	(-15.72)	(-12.70)	(-12.36)	(-18.70)	(-15.09)	(-14.34)
Herf Intermediaries		0.389***	0.390***		0.392***	0.399***		0.341***	0.341***
		(10.31)	(9.95)		(10.24)	(10.24)		(11.42)	(10.59)
Herf Direct Exp.		-0.303***	-0.269***		-0.309***	-0.270***		-0.321***	-0.282***
		(-10.49)	(-8.77)		(-10.51)	(-9.21)		(-13.81)	(-10.61)
Nb. Direct Exp./		-0.401***	-0.414***		-0.390***	-0.407***		-0.363***	-0.378***
Nb. Intermed.		(-6.77)	(-6.16)		(-6.43)	(-5.82)		(-7.10)	(-6.23)
Contract Dependence			-0.083***			-0.108***			-0.090***
			(-2.94)			(-4.00)			(-3.08)
N	3247	3182	2509	3035	2971	2286	3545	3540	2761
r2	.163	.318	.313	.156	.31	.308	.216	.363	.361

t statistics in parentheses; beta coefficients reported. Standard errors clustered at the SIC level are reported in columns (1)-(6), while robust standard errors are in parentheses in columns (7)-(9). * p<0.10; ** p<0.05; *** p<0.01.

Table 6: Sensitivity Analysis

This table conducts the identical analysis of columns (3) in Table 5 over different samples. The sample for Panel A excludes processing trade in the calculation of the dependent variable; Panel B excludes exports from foreign-invested firms; Panel C excludes exports from state-owned enterprises; Panel D excludes exports from Hong Kong; Panel E excludes observations associated with the top 5% and the bottom 5% of R&D intensity; Panel F uses data from 2006. Column (1) in each panel uses the Gallop-Monahan (G-M) index, while column (2) uses the inverse of the elasticity of substitution (1/σ) as the measure of horizontal differentiation.

	A. Exclude Processing Exports		B. Exclude Foreign-invested Firms		C. Exclude State-owned Enterprises	
Horizontal diff. (H)	G-M	1/σ	G-M	1/σ	G-M	1/σ
R&D Intensity	-0.070***	-0.075***	-0.083***	-0.089***	-0.071***	-0.078***
	(-3.05)	(-3.08)	(-3.85)	(-3.84)	(-3.76)	(-4.03)
H	0.057**	0.015	0.049**	0.032	0.047**	0.028
	(2.52)	(0.64)	(2.05)	(1.41)	(2.38)	(1.37)
N	2848	2508	2850	2509	2850	2509
R-squared	.186	.188	.261	.274	.474	.464

	D. Exclude Exports to Hong Kong		E. Exclude top 5 and bottome 5 % RD intensity		F. Year = 2006	
Horizontal diff. (H)	G-M	1/σ	G-M	1/σ	G-M	1/σ
R&D Intensity	-0.070***	-0.072***	-0.068***	-0.067***	-0.104***	-0.110***
	(-3.11)	(-2.96)	(-2.69)	(-2.63)	(-4.35)	(-4.44)
H	0.047**	0.009	0.065***	0.025	0.063**	0.008
	(2.25)	(0.37)	(2.60)	(1.04)	(2.58)	(0.34)
N	2844	2506	2596	2292	2846	2500
R-squared	.177	.179	.309	.303	.306	.299

t statistics in parentheses; beta coefficients reported; standard errors clustered at HS 6-digit; * p<0.10; ** p<0.05; *** p<0.01

Table 7: Share of Intermediated Exports and Distance

This table explores the relationship between various fixed direct exporting costs and the share of intermediated exports across countries. Panel A explores the cross-country relationship while Panel B explores it at the country-product level. In Panel B, HS 6-digit fixed effects are always included.

Dependent Var. = Share of Exports Through Intermediaries					
	(1)	(2)	(3)	(4)	(5)
			Panel A		
Unit of Obs.			**Country**		
Country Measures	ln(Dist)	ln(Import Doc)	ln(Import Days)	ln(1/Chinese Pop. Share)	ln(Genetic Dist)
Dest. Country Var.	0.195**	0.183**	0.242***	0.182*	0.163*
	(2.52)	(2.52)	(3.14)	(1.96)	(1.96)
	157	168	168	113	142
R-squared	.0381	.0337	.0587	.0332	.0264
			Panel B		
Unit of Obs.			**Country-HS6**		
Dest. Country Var.	0.067***	0.052***	0.081***	0.054***	0.078***
	(29.16)	(22.15)	(30.00)	(20.72)	(34.39)
HS 6-digit FE	Yes	Yes	Yes	Yes	Yes
N	246684	249252	249252	203655	225283
R-squared	.128	.126	.13	.135	.128

t statistics in parentheses. Standard errors are clustered at the HS 6-digit level.
* p<0.10, ** p<0.05, *** p<0.01

Table 8: Share of Intermediated Exports, Distance, and Product Characteristics (by HS6 x country)

This table examines how vertical and horizontal differentiation affect the distance effects on trade intermediation explored in Table 6. HS6 and country fixed effects are always included

Dependent Var. = Share of exports through intermediaries in each HS6-country cell			
Vertical Diff Measure (V)	**R&D Int.**	**Adv+R&D Int.**	**Quality Disp.**
Horizontal Diff Measure (H)	G-M	G-M	G-M
Panel A			
Distance Measure (f_{CD})		**ln(dist)**	
Dist. X V	-0.008	-0.040	0.101***
	(-0.21)	(-0.94)	(2.70)
Dist. X H	0.086**	0.087**	0.111***
	(2.41)	(2.23)	(3.25)
Fixed Effects		HS6 and Country	
N	226290	193542	236267
R-squared	.149	.151	.146
Panel B			
Distance Measure (f_{CD})		**Genetic Distance**	
Dist. X V	0.032	0.053*	0.045**
	(1.44)	(1.90)	(2.21)
Dist. X H	0.071***	0.084***	0.075***
	(3.22)	(3.53)	(3.54)
Fixed Effects		HS6 and Country	
N	206507	176755	215471
R-squared	.153	.155	.149
Panel C			
Distance Measure (f_{CD})		**ln(1/china pop share)**	
Dist. X V	0.030***	0.098***	0.017*
	(2.65)	(4.72)	(1.74)
Dist. X H	0.026**	0.037***	0.020*
	(2.25)	(3.03)	(1.81)
Fixed Effects		HS6 and Country	
N	186648	159516	194781
R-squared	.155	.157	.152

t statistics in parentheses. Standard errors are clustered at the HS6 level. * p<0.10, ** p<0.05, *** p<0.01.

Appendix Tables

Table A1: Summary Statistics of Product-level Variables

Product	Num. Obs	Mean	Std. Dev.	10th	25th	50th	75th	90th	min	max
Share of Interm. Exp.	4704	0.309	0.223	0.040	0.138	0.282	0.428	0.594	0	1
Share of Interm. Exp. (non-SOE)	4689	0.367	0.252	0.056	0.170	0.338	0.517	0.725	0	1
Quality Dispersion	4466	1.282	0.614	0.596	0.867	1.188	1.588	2.054	0.149	5.039
R&D Intensity (OECD)	4405	-4.415	1.333	-6.461	-5.150	-4.138	-3.584	-3.020	-9.796	-0.353
R&D + Advertising Intensity (China)	3833	-5.737	0.933	-6.877	-6.468	-5.829	-5.006	-4.544	-8.189	-2.398
1/σ	4311	0.341	0.193	0.086	0.204	0.323	0.476	0.625	0.001	0.909
Gallop-Monahan Measure	4518	0.410	0.149	0.193	0.340	0.444	0.533	0.563	0.000	0.596

Table A2: Correlation of Product-level Variables

	Shr Int Exp	Shr Int (nSOE)	QD	RD	RDA	1/σ
Share of Interm. Exp.						
Share of Interm. Exp. (non-SOE)	0.910					
Quality Dispersion	-0.096	-0.099				
R&D Intensity (OECD)	-0.150	-0.120	0.164			
R&D + Advertising Intensity (China)	-0.109	-0.093	0.218	0.492		
1/σ	0.026	-0.004	0.241	0.113	0.061	
Gallop-Monahan Measure	0.129	0.096	-0.205	-0.260	-0.149	-0.003

Table A3: Summary Statistics of Country Variables

	Nb. Obs.	Mean	Std. Dev.	10th	25th	50th	75th	90th	min	max
ln(Dist.)	158	8.991	0.542	8.269	8.794	9.030	9.375	9.536	6.825	9.868
ln(Import Doc.)	169	2.061	0.404	1.609	1.792	2.079	2.303	2.565	0.000	2.944
ln(Import Days)	169	3.290	0.673	2.398	2.890	3.258	3.737	4.159	1.386	4.644
ln(1/Chinese Pop. Share)	114	8.297	3.347	3.731	6.037	7.589	10.800	12.835	1.521	15.037
ln(Gen. Dist.)	144	7.083	0.674	6.339	6.941	7.088	7.539	7.950	3.826	8.004
ln(GDP)	158	10.035	2.260	7.016	8.576	9.723	11.693	13.089	5.373	16.331

Table A4: Correlation of Country-level Variables

	ln(Dist)	ln(Imp Doc)	ln(Imp Days)	ln(1/Chn Shr)	ln(G-Dist)
ln(Dist.)					
ln(Import Doc.)	0.011				
ln(Import Days)	0.144	0.720			
ln(1/Chinese Pop. Share)	0.203	0.289	0.455		
ln(Gen. Dist.)	0.673	0.068	0.269	0.579	
ln(GDP)	-0.299	-0.440	-0.582	-0.283	-0.314

Table A5: Share of Intermediated Exports, Rauch Index and Coefficient of Price Variance

This table reports the cross-product (HS4 or HS6) relationship between

Dependent Var. = Share of Exports Through Intermediaries				
Unit of Obs		**HS 6-digit category**		
Rauch	-0.036	-0.003		
	(-1.57)	(-0.08)		
CV			-0.086***	-0.027**
			(-6.90)	(-2.22)
HS 2-digit FE	No	Yes	No	Yes
N	4484	4484	4617	4617
R-sq.	.001	.107	.00735	.116
Unit of Obs		**HS 4-digit category**		
Rauch	-0.107***	-0.061		
	(-2.71)	(-1.44)		
CV			-0.128***	-0.043
			(-4.16)	(-1.59)
HS 2-digit FE	No	Yes	No	Yes
N	1115	1115	1167	1167
R-sq.	.011	.117	.0165	.114

t statistics in parentheses; beta coefficients reported; robust standard errors are
* p<0.10; ** p<0.05; *** p<0.01

Table A6: Sensitivity Analysis

This table conducts the identical analysis of column (3) in Table 5 using different samples of firms and measures of vertical differentiation. The dependent variable is the share of exports via intermediaries in each HS6 cell. Panel A excludes processing exporters in the calculation of the dependent variable. Panel B excludes exports from foreign-invested firms. Panel C excludes exports from state-owned enterprises while Panel D excludes exports from Hong Kong. In each panel, columns (1) and (3) use quality dispersion (QD) as the measure of vertical differentiation. Columns (2) and (4) use Advertising and R&D intensity (ARD). Columns (1)-(2) use the inverse of the elasticity of substitution (1/σ) as the measure of horizontal differentiation while columns (3)-(4) use the Gallop-Monahan (G-M) index.

	A. Exclude Processing Exports				**B. Exclude Foreign-invested Firms**			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
Vertical diff. measure	QD	ARD	QD	ARD	QD	ARD	QD	ARD
Horizontal diff. measure	1/σ	1/σ	G-M	G-M	1/σ	1/σ	G-M	G-M
V	-0.037*	-0.113***	-0.031	-0.108***	-0.043*	-0.114***	-0.047**	-0.117***
	(-1.67)	(-4.10)	(-1.42)	(-4.32)	(-1.81)	(-4.26)	(-2.20)	(-4.66)
H	0.023	0.023	0.069***	0.064***	0.046**	0.041*	0.059**	0.055**
	(1.01)	(0.94)	(3.02)	(2.87)	(2.06)	(1.74)	(2.31)	(2.37)
N	2439	2285	2760	2627	2440	2286	2761	2629
R-squared	.191	.191	.194	.19	.256	.28	.253	.268

	C. Exclude State-owned Enterprises				**D. Exclude Exports to Hong Kong**			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
Vertical diff. measure	QD	ARD	QD	ARD	QD	ARD	QD	ARD
Horizontal diff. measure	1/σ	1/σ	G-M	G-M	1/σ	1/σ	G-M	G-M
V	-0.031*	-0.086***	-0.034**	-0.087***	-0.022	-0.107***	-0.023	-0.104***
	(-1.72)	(-3.87)	(-2.05)	(-4.06)	(-0.94)	(-3.79)	(-1.08)	(-4.16)
H	0.028	0.039*	0.061***	0.060***	0.018	0.015	0.067***	0.056***
	(1.40)	(1.92)	(2.96)	(3.16)	(0.79)	(0.60)	(3.16)	(2.83)
N	2440	2286	2761	2629	2439	2283	2758	2623
R-squared	.48	.46	.489	.476	.167	.181	.173	.181

t statistics in parentheses; beta coefficients reported; standard errors clustered at HS 6-digit; * p<0.10; ** p<0.05; **

Table A7: Share of Intermediated Exports, Distance, and Product Characteristics (by HS6 x country)

This table examines how vertical and horizontal differentiation affects the distance effects on

Dependent Var. = Share of exports through intermediaries in each HS6-country cell

Vertical Diff. Measure (V)	**R&D Int.**	**Adv+R&D Int.**	**Quality Disp.**
Horizontal Diff. Measure (H)	1/σ	1/σ	1/σ
Panel A			
Distance Measure (f_{CD})		**ln(dist)**	
Dist. X V	-0.034	-0.040	0.106***
	(-0.94)	(-0.88)	(2.86)
Dist. X H	0.108***	0.064	0.069*
	(2.94)	(1.58)	(1.88)
Fixed Effects		HS6 and Country	
N	201172	171383	214628
R-squared	.148	.149	.145
Panel B			
Distance Measure (f_{CD})		**Genetic Distance**	
Dist. X V	0.009	0.051*	0.038*
	(0.40)	(1.74)	(1.80)
Dist. X H	0.034	0.006	0.020
	(1.57)	(0.24)	(0.95)
Fixed Effects		HS6 and Country	
N	183647	156630	195908
R-squared	.152	.153	.148
Panel C			
Distance Measure (f_{CD})		**ln(1/china pop share)**	
Dist. X V	0.018	0.085***	0.005
	(1.60)	(3.88)	(0.50)
Dist. X H	0.007	-0.006	0.002
	(0.69)	(-0.57)	(0.18)
Fixed Effects		HS6 and Country	
N	166034	141419	177202
R-squared	.154	.156	.151

t statistics in parentheses. Standard errors are clustered at the HS 6 level. * p<0.10, ** p<0.05, *** p<0.01.

Table A8-A: Most and Least Vertically-differentiated Products (Based on R&D intensity (OECD))

SIC (87)	Industry	ln(R&D)
Top 10		
2131	Chewing and smoking tobacco	-0.353
3634	Electric housewares and fans	-1.117
2836	Biological products, except diagnostic	-1.378
2835	Diagnostic substances	-1.436
2834	Pharmaceutical preparations	-1.868
3674	Semiconductors and related devices	-1.920
3825	Instruments to measure electricity	-1.927
3769	Space vehicle equipment, n.e.c.	-1.968
2833	Medicinals and botanicals	-2.020
3572	Computer storage devices	-2.291
Bottom 10		
2426	Hardwood dimension and flooring mills	-7.712
2512	Upholstered household furniture	-7.867
3353	Aluminum sheet, plate, and foil	-7.882
3965	Fasteners, buttons, needles, and pins	-7.901
2259	Knitting mills, n.e.c.	-7.949
2311	Men’s and boys’ suits and coats	-7.979
3716	Motor homes	-8.133
2394	Canvas and related products	-8.408
2258	Lace and warp knit fabrics mills	-9.122
2493	Reconstituted wood products	-9.796

Table A8-B: Most and Least Vertically-differentiated Products (Based on Quality Dispersion)

HS6	Description	QCV
Top 10		
852453	Magnetic tapes (excl. of 8524.40), of a width >6.5mm	5.039
670300	Human hair, dressed/thinned/bleached/othw. wkd.; wool/oth. animal hair	4.853
911420	Jewels for clocks/watches	4.811
670490	Wigs, false beards, eyebrows & eyelashes, switches and the like, of animal	4.803
670419	Wigs other than complete wigs, false beards, eyebrows & eyelashes, switches	4.626
851730	Telephonic/telegraphic switching app.	4.409
852491	Recorded media for repr. phenomena other than sound/image, n.e.s.	4.325
670420	Wigs, false beards, eyebrows & eyelashes, switches and the like, of human	4.323
284440	Radioactive elements & isotopes & comps	4.295
852499	Recorded media for sound/oth. similarly recorded phenomena, incl. matrices	4.175
Bottom 10		
720110	Non-alloy pig iron cont. by wt. 0.5%/less of phosphorus, in pigs/blocks.	0.209
520528	Cotton yarn, single (excl. sewing thread), of combed fibres, cont. 85%/more	0.208
720270	Ferro-molybdenum, in granular/powder form	0.204
200949	Pineapple juice (excl. of 2009.41), unfermented & not cont. added spirit, w ...	0.201
440399	Wood, in the rough (excl. of 4403.10-4403.92)	0.198
20130	Meat of bovine animals, fresh/chilled, boneless	0.195
520521	Cotton yarn, single (excl. sewing thread), of combed fibres, cont. 85%/more	0.189
151521	Maize (corn) oil, crude	0.174
720711	Semi-finished prods. of iron/non-alloy steel, cont. by wt. <0.25% of carbon	0.162
20430	Carcasses/half-carcasses of lamb, frozen	0.149

Table A9: Most and Least Horizontally-differentiated Products (Based on 1/sigma)

HS6	Description	1/sigma
Top 10		
91030	Turmeric (curcuma)	0.909
853329	Fixed electrical resistors (excl. fixed carbon resistors, composition/film	0.909
920810	Musical boxes	0.909
853331	Wirewound variable electrical resistors, incl. rheostats & potentiometers	0.909
848049	Moulds (excl. ingot moulds) for metal/metal carbides, other than injection/	0.909
450200	Natural cork, debacked/roughly squared/in rect. (incl. square) blocks/plate	0.909
511300	Woven fabrics of coarse animal hair/horsehair	0.833
820590	Sets of arts. of 2/more of the SHs of 82.05	0.833
850300	Parts suit. for use solely/princ. with the machines of 85.01/85.02	0.833
852312	Magnetic tapes, prepd., unrecorded, for sound recording/sim	0.833
Bottom 10		
401490	Hygienic/pharmaceutical arts., incl. teats, of vulcanised rubber other than	0.008
270400	Coke & semi-coke of coal/lignite/peat, whether or not agglom.; retort carbo	0.008
521121	Woven fabrics of cotton, cont. <85% by wt. of cotton, mixed mainly or solel	0.008
190540	Rusks, toasted bread & sim. toasted prods.	0.006
30375	Dogfish & oth. sharks, frozen (excl. fillets/oth. fish meat of 03.04/livers ...	0.005
510310	Noils of wool/fine animal hair	0.005
870120	Road tractors for semi-trailers (excl. of 87.09)	0.004
290323	Tetrachloroethylene (perchloroethylene)	0.002
481092	Multiply paper & paperboard, coated on one/both sides with kaoli	0.002
520299	Cotton waste other than yarn waste (incl. thread waste) & garnetted stock	0.001