Export Prices and Market Access of Exporting Countries: Theories and Evidence

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A Dissertation presented to the Graduate Faculty
of the University of Virginia in Candidacy for the Degree of
Doctor of Philosophy

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University of Virginia
December, 2012

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Abstract

I investigate theoretically and empirically how bilateral and multilateral market access affects product-level FOB export prices. Bilateral market access is measured by product transport costs from a country to a particular destination market, while multilateral market access is measured by overall relative distance of a country from the rest of the world.

In the theory chapter, I model an open economy with four countries based on the quality heterogeneous-firms trade model and explain how market access affects export prices through a selection mechanism. The higher the transport costs from a country to a destination market, or the less remote a country with its higher wage, the more capable are the firms that select into the foreign market. The model yields opposite predictions for two types of industries. In price-competing industries, where the more capable firms have low marginal costs and sell at low prices, export prices decrease with transport costs, but do not vary with remoteness. In contrast, in quality-competing industries, where the more capable firms have high quality and high marginal cost, and sell at high prices, export prices increase with transport costs, but decrease with remoteness, and these effects are magnified as the scope for quality heterogeneity increases.

In the empirical chapter, I test the model's prediction by examining U.S. import data at a very narrowly-defined product level with remoteness and transport costs used as proxies for multilateral and bilateral market access, respectively. To address potential endogeneity issues, I use distance and import quantity as instruments for product-country level transport costs and find negative remoteness and positive transport costs effects on FOB unit values of imported products to the U.S., which support the model's prediction under quality competition. By using industry-specific proxies for the scope for quality heterogeneity, such as the quality ladder length and the quality industry indicator, I further explore cross-industry variations in the magnitude of these effects.

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1 Introduction

In international trade, firms are the players that make trade possible by participating in foreign markets through exporting or importing. Firms face many constraints when deciding whether to enter export markets, one of the most critical being the market access of the country in which they are located. In general, a country is considered to have good market access when it is near other countries and can thus more easily reach them.

This study focuses on two specific aspects of market access: bilateral and multilateral market access. Bilateral market access refers to how easy it is for a country to access one specific trading partner, while multilateral market access refers to how easy it is for a country to access all of its trading partners. For instance, bilateral market access can be measured by transport costs or distance between two trading partners. Alternatively, multilateral market access refers to a country's remoteness—in other words, the combined distances between that country and all of its trading partners or its location relative to the rest of the world.

While these two concepts may seem very similar, they differ significantly. For instance, suppose that the Netherlands and Australia export goods to a third country from which they are equidistant; in this situation, both exporting countries have equal access to the destination country. However, the Netherlands is closely surrounded by many other countries, unlike Australia, a remote country with no close neighbors. Therefore, though both countries may have the same level of bilateral market access to a particular destination country, Australia's multilateral market access is much poorer due to its remoteness.

As in previous literature, a country's multilateral market access will be measured by its remoteness, so that the more remote a country is, the poorer its multilateral market access. The importance of a country's remoteness with regard to its international trade is discussed in many prior studies. Wei (1996) introduces remoteness to represent the relative location of a country, and his method of measuring remoteness has been used by numerous empirical studies in trade. Also, Anderson and van Wincoop (2003) and Redding and Venables (2004) point out multilateral market access as a significant determinant of a country's economic performance.

This paper is particularly interested in analyzing how a country's market access, both bilateral and multilateral, affects its product-level export prices, and trade data regarding very narrowly-defined product categories makes this endeavor possible. Since export prices vary greatly even within product categories, it is important to understand the source of that variation. Previous work by Schott (2004) and Baldwin and Harrigan (2011) reveal that variations in export prices within product categories reflect product quality heterogeneity and are significantly influenced by the characteristics of exporting countries. Motivated by their work, this paper emphasizes that exporting countries' market access significantly influences their export prices and that the degree of influence differs depending on the degree of product quality heterogeneity across product categories.

The heterogeneous-firms trade (HFT) model is used as a theoretical framework in this study to analyze the mechanism through which market access affects export prices. Since Melitz (2003) pioneered the HFT model, it has been modified in many ways to explain a wide range of real world empirical findings. The quality heterogeneous-firms trade (QHFT) model proposed by Baldwin and Harrigan (2011), which incorporates quality as the source of firm heterogeneity, is one of the most successful modified versions of the HFT models. Kneller and Yu (2008) further modify the QHFT model by incorporating a linear demand system, and their framework is employed in this paper to address how different levels of market access across exporting countries affect export prices at the product level.

Based on the Kneller and Yu framework, I present a four-country open economy model, a setting in which the fewest possible countries can differ in terms of both bilateral and multilateral market access. The model explains the effects of market access on export prices through a selection mechanism whereby, when all firms in a given country are heterogeneous in terms of capability, the high capability firms producing high quality products are the ones selected to participate in export markets. The threshold of capability that divides exporters and non-exporters within a country differs across countries depending on their level of market access. The poorer a country's bilateral market access, the more difficult it is for its firms to export, due to high transport costs. On the other hand, the poorer a country's multilateral market access, the easier it is for its firms to export, due to low production costs.[1]

For an industry that exhibits quality heterogeneity, the model predicts that the poorer the exporting country's bilateral market access, the higher its average export price will be, but the poorer the country's multilateral market access, the lower its average export price will be. Moreover, these effects increase in magnitude as the degree of quality heterogeneity within an industry increases. In contrast, if the industry exhibits no quality heterogeneity, the model yields different predictions: the poorer the exporting country's bilateral market access, the lower its average export price will be; however, the country's multilateral market access does not significantly affect its average export price. The model, therefore, shows how the effects of market access on export prices differ depending on industry-specific scopes for quality differentiation.

[1] This issue will be more specifically discussed in the section which examines this paper's theoretical model; the model assumes that wages in remote countries are lower than in more centralized countries based on the findings of previous literature, including Redding and Venables (2004). According to their finding, remote countries with poorer multilateral market access must pay higher overall transport costs, both to export products and import production inputs, than more centralized countries, and thus can only afford to pay lower wages than more centralized countries.

Using U.S. import data, I empirically investigate the effects of multilateral and bilateral market access on export prices and test the prediction of the theoretical model. This data contains information on very narrowly defined product categories, which are based on the Harmonized System (HS) 10-digit codes, including the information required to calculate the free-on-board (f.o.b.) unit value of exports, a proxy for export prices. To measure each country's multilateral market access, its remoteness is constructed as its GDP-weighted average distance from the rest of the world. I use two measures for each country's bilateral market access: the distance between each exporting country and the U.S. and the transport costs by each exporting country in each product categories.

When distance is used as a measure of bilateral market access, negative remoteness effects are significantly captured, but distance effects are inconclusive and vary greatly across industries. However, when transport costs are used as a measure of bilateral market access, both negative remoteness effects and positive transport cost effects are reliably and significantly captured. In the estimation using transport cost data, I address a potential endogeneity problem between the unit value of exports and their transport costs by exploiting instrument variables, distance and export quantity, following Hummels and Skiba (2004).

Furthermore, I explore how the effects of market access on export prices vary depending on industry-specific quality heterogeneity. To gauge the degree of quality differentiation across industries, I use two proxies: the quality ladder length from Khandelwal (2010) and the quality industry indicator from Mandel (2010). By using these two proxies, my empirical investigation finds that cross-industry variations in the effects of market access on export prices is related to the degree of quality differentiation.

The remainder of the paper is organized as follows: Section 2 discusses related literature, Section 3 presents the theoretical model, Section 4 describes the data, Section 5 shows empirical specifications and results, and Section 6 reports the conclusion.

2 Literature Review

2.1 Theoretical Foundations

In international trade, market access is one of the most important factors in determining trade performance. In this paper, I discuss two aspects of market access: bilateral and multilateral trade barriers. A bilateral market barrier refers to how difficult it is for a country to access a specific trading partner, while a multilateral market trade barrier refers to how difficult it is for a country to access all of its trading partners. For instance, the former can be considered as the distance or transport costs between two specific trading countries, while the latter can be considered as the combined distances between a country and all of its trading partners, or as its location relative to all other countries in the world. While these two barriers may seem very similar, the following studies, which provide the foundation for this paper's definition of market access, elucidate the importance of trade barriers in trade performance, make important distinctions between the two types of trade barriers, and motivate this paper's research question.

Within an international market, market access can be conceptualized as the degree of trade barriers a country faces, so that the higher a country's trade barrier, the poorer its market access. Anderson (1979) and Anderson and van Wincoop (2003), among many others, assert that both multilateral trade barriers and bilateral trade barriers determine trade flows between two trading partners based on a gravity model framework. The intuitive rationale for their argument is that the more resistant a country is to trade with other countries, the more it is pushed to trade with a given bilateral trading partner.[2] In other words, if an exporter is highly resistant to multilateral trade, the demand for its goods as well as its supply prices decrease, causing the exporter to increase the volume of its trade with its bilateral trading partner.[3]

Redding and Venables (2004) provide another perspective for understanding the impact of multilateral market access on an exporting country's economy and its trade performance. Remote countries with limited market access face higher trade costs in importing production inputs and exporting their products. Consequently, firms in remote countries can only afford to pay wages that are relatively low in comparison to countries with better market access. Therefore, the market access and wage levels of trading countries is negatively related, a finding which Redding and Venables support with empirical evidence.

Though I assume the importance of market access asserted in the previous studies, I emphasize different aspects of trade performance than they do; I focus on how export prices, among many other trade performance measures, are affected by the market access of exporting countries. The primary question that will be attacked in the theoretical part of this paper is how a country's market access affects the trade activities of its firms and the participation of those firms in world markets in order to ultimately find how these firms' exporting activities determine their export prices. Recent literature on HFT models provide the theoretical framework I use to approach this question; the key studies are discussed below.

Melitz (2003) provides a great stepping stone for understanding the mechanism of

[2] In the model of Anderson and van Wincoop (2003), the multilateral resistance terms are represented by the price indices of trading countries. Since the price indices are treated as unobservables, they are solved endogenously in terms of the borders and income shares of the countries observed as well as their distance from their trading partners.

[3] Harrigan (2003) also documents the role of remoteness in trade flows based on the gravity model.

the export participation and aggregate performance of firms with different levels of productivity. Based on the assumption that high productivity firms produce goods at lower marginal costs, the Melitz model shows that high productivity firms charge lower prices for their products than low productivity firms. Also, the more selective a firm's export participation is, the lower its aggregate export price.

As in Melitz (2003), the standard HFT model is based on the assumption of a constant elasticity of substitution (CES) demand with a symmetric country setting in which all countries have the same characteristics. Consequently, the model does not address the case of an asymmetric country setting in which countries have different characteristics, which is the focus of this paper. I therefore turn to a modified model of Melitz (2003), Melitz and Ottaviano (2008), which extends Melitz (2003) by using a linear demand system to allow different market sizes across countries and thus provides a reasonable theoretical framework for analyzing asymmetric countries using a HFT model.

Since the question of this paper focuses on prices of exports among many other measures of trade performance, I consider the price determination mechanism in the HFT model. It is important to note that price determination in the HFT models can vary greatly depending on the relationship between firm productivity and product quality which the model assumes. In Melitz (2003) and Melitz and Ottaviano (2008), a high productivity firm produces goods at lower marginal costs and charges lower prices than a low productivity firm. Consequently, the source of heterogeneity among firms is production efficiency, and these models are called "efficiency-sorting models."

However, efficiency-sorting models do not consider quality differences between products which, in the real world, influence the price of products in many industries. Baldwin and Harrigan (2011) incorporate the fact that high quality products are usually produced by high productivity firms at higher prices into the Melitz model and propose a QHFT model that assumes that high productivity firms produce high quality products at higher marginal costs and charge higher prices than low productivity firms. Unlike the efficiency-sorting models based on Melitz, this quality-sorting model asserts that the source of firm heterogeneity is product quality. Therefore, the QHFT model predicts that the aggregate price of a firm's exports increases as its export participation becomes more selective, which contradicts Melitz (2003). However, since the Baldwin and Harrigan's model is also based on a CES demand system, it only explains a symmetric world.

Kneller and Yu (2008) modify the QHFT model in Baldwin and Harrigan (2011) by adding a linear demand system, an addition that enables their model to address countries that have asymmetric market sizes.[4] I therefore employ the basic setup of Kneller and Yu (2008) and develop a four-country open economy model to analyze how market access of exporting countries affects their firms' export participation and aggregate export prices.

The two different models are based on different assumptions regarding the relationship between firms' productivity and their export prices, and they yield contradictory predictions regarding the effects of market access on export prices. Most previous studies, including Manova and Zhang (2010) and Kneller and Yu (2008), dichotomize industries into either efficiency-sorting or quality-sorting industries depending on whether or not their production practices involve quality differentiation.

However, this study allows the degree of quality heterogeneity to vary across products because the degree of quality diversification may vary across products even within industries where quality-sorting model applies. Khandelwal (2010) and Mandel (2010), for instance, show that the scope for quality differentiation varies significantly

[4] Besides Kneller and Yu (2008), Antoniades (2010) also proposes a QHFT model with a linear demand system by incorporating the quality factor into the demand system with a different functional form.

across both products and industries. Reflecting this finding, my model shows how the effects of market access on export prices differ depending on the degree of quality heterogeneity.

2.2 Methods of Empirical Investigation

Recent empirical studies that utilize HFT models to investigate the relationship between export prices and the characteristics of importing countries provide a foundation for the empirical method used in this paper. Baldwin and Harrigan (2011), who use product-level U.S. export data in their examination of how the remoteness and distance of importing countries affects export prices, have been particularly important. Their robust finding of a positive relationship between distance and export unit values and a negative relationship between remoteness and export unit values consistently supports the prediction of the QHFT model. Manova and Zhang (2010), using Chinese firm-level data and a sample of rich destination markets, also examine how the remoteness and distance of importing countries affects export prices; their results also support the predictions of the quality-sorting model. These two previous studies focused on the destination countries' market access; in contrast, I explore the relationship between the exporting countries' market access and their export prices using product-level U.S. import data.

Schott (2004)—who employs U.S. product-level import data to explore how the characteristics of exporting countries, such as their per capita GDP, their capital abundance and their skill abundance, are related to export prices—has greatly influenced this current study. He finds that, within very narrowly defined product categories, countries with a higher per capita GDP and a higher level of skill abundance tend to export more expensive products and suggests that there are within-product quality specializations across countries.

Hummels and Klenow (2005), by examining product-level trade data from a wide range of sample countries, confirm the strong positive correlation within product categories between the wealth of exporting countries and their export prices.[5] Johnson (2011) investigates the relationship of the exporting country's per capita GDP to its export price by considering an export participation selection mechanism. He finds that his estimated threshold of export participation faced by firms tend to be lower in poorer countries than in richer countries, and the correlation between this threshold and the export prices is negative in some industries but positive in some other industries. Based on the variation of the correlation, he classifies industries into industries with heterogeneous product quality and homogenous product quality. Based on the suggestion of their findings, I examine the relationship between the market access of exporting countries and their product-level export prices using product-level U.S. import data.

To measure the market access of exporting countries, I turn to previous studies and employ remoteness as the measure of a country's multilateral market access. Baldwin and Harrigan (2011) incorporate the remoteness of different countries to theoretically analyze and empirically investigate their QHFT model. In their empirical analysis, they use the remoteness measure from Wei (1996), in which the remoteness of a country is measured as the GDP-weighted average of distances between that country and each of its trading partners. The remoteness of a country can also be interpreted as its relative location to all other countries or as its multilateral trade resistance, as in Anderson and van Wincoop (2003).

To assess a country's bilateral market access, I use two different measurements.

[5] Hummels and Klenow (2005) analyze both UNCTAD data for 1995 exports to 59 countries by 126 countries in 5,017 six-digit HS code product level and U.S. import data for 1995 with 124 exporting countries at ten-digit HS categories.

First, I use the distance between importing and exporting countries, the measurement employed by the majority of trade studies. Harrigan (2010), like many others in the field, finds a robust positive relationship between the unit value of HS 10-digit code products which the U.S. exports and the distance between the destination countries and the U.S.

Second, following Schott (2008), I use transport costs, which vary across countries and products. Using U.S. import data for HS 10-digit code products, Schott (2008) constructs ad valorem transport costs as the share of duties per import value at the product-country level. His analysis provides a good example of utilization of the transport charge information from the same source of the data. Thus, I utilize the same information except that I construct per-unit transport charges instead of ad valorem transport costs.

However, Harrigan (2010) suggests that using transport costs as a measure of bilateral market access may raise an endogenous problem, since transport costs may raise export prices. According to his finding, higher value-per-weight goods are more likely to be shipped by air, which implies that higher unit values increase transport costs. Using transport costs instead of exogenous distance data is problematic because there can be an endogenous problem between the unit value of exports and transport costs due to reverse causation.

Fortunately, Hummels and Skiba (2004) provide guidance for dealing with this endogenous problem of using transport cost data. They find that unit values increase with transport costs, which supports Alchian and Allen's (1964) conjecture that firms have an incentive to ship their higher quality goods to their furthest market because they face unit transport costs. In their empirical investigation, Hummels and Skiba (2004) consider the endogeneity problem between the unit value of exports and their transport costs and employ exogenous instrument variables, namely the distance between trading partner countries and the total quantity of exports traded between them. Following their method, I instrument for transport costs using the distance between each source country and the U.S. as well as the total quantity of their exports within each product category.

Furthermore, this paper is related to empirical trade literature that evaluates industry specific scopes for quality differentiation and classifies industries into quality-sorting or efficiency-sorting industries. Both Khandelwal (2010) and Mandel (2010) estimate measures to represent industry-specific scopes for quality differentiation. I utilize their measures for degrees of quality differentiation and evaluate variations of remoteness and distance effects on export prices between quality-sorting and efficiency-sorting industries.

This paper, like Manova and Zhang (2010) and Kneller and Yu (2008), investigates the correlation between a country's characteristics, such as its market size and distance, and its export prices and how the correlation differ depending on the quality heterogeneity across industries. However this paper goes further by additionally exploring the relationship between export prices and remoteness as another critical factor of country characteristics.

3 Model

In this section, I present a theoretical framework to explain how market access of exporting countries affect their export prices based on QHFT model. In the first subsection, I present a closed economy with heterogeneous firms, and then in the second sub-section, extend the closed economy to a four-country open economy, which is the most minimal setting that allows countries differ in both bilateral and multilateral market access. Based on the open economy framework, I find model's predictions on the effects of market access on export prices and how these effects vary across products depending on the industry-specific scope of quality heterogeneity.[6]

3.1 Closed Economy

3.1.1 Consumers

In a closed economy, there are L identical consumers and their preference over a continuum of vertically and horizontally differentiated varieties and a homogenous good is expressed in the following utility function:[7]

$$u = q_0 + \rho \int_{i\in\Omega} (z_i q_i) di - \frac{\gamma}{2} \int_{i\in\Omega} (z_i q_i)^2 di - \frac{\eta}{2} \left(\int_{i\in\Omega} (z_i q_i) di \right)^2 \tag{1}$$

where q_0 denotes consumption of the homogenous good, z_i represents the quality of variety i, and q_i stands for quantity of variety i. Consumers care about quality-adjusted quantity, $z_i q_i$. Demand parameters ρ, γ, and η are all positive.

The demand for the numeraire good is assumed to be positive ($q_0 > 0$). This utility function yields the inverse demand for each variety i as follows: $\frac{p_i}{z_i} = \rho - \gamma z_i q_i^c - \eta Z$ for all i, so that $q_i > 0$ where $Z = \int_{i\in\Omega} (z_i q_i) di$ denotes the aggregate (quality-adjusted) consumption. $\Omega^* \subset \Omega$ is defined as the subset of varieties that are consumed ($q_i > 0$). An increase in the quality of the variety (z_i) increases consumers' willingness-to-pay and decreases price elasticity. Therefore, firm i's residual demand becomes

$$q_i \equiv L q_i^c = \frac{L}{z_i \gamma} \left(\hat{P} - \frac{p_i}{z_i} \right) \tag{2}$$

Thus, the corresponding inverse demand for quality-adjusted price is $\frac{p_i}{z_i} = \hat{P} - q_i \frac{z_i \gamma}{L}$

[6] This model is a partial equilibrium model where wages are exogenously set while product prices are endogenously determined.

[7] Following Kneller and Yu (2008), quality is added in the utility function from Melitz and Ottaviano (2008).

where $\hat{P} \equiv \frac{\eta N\tilde{P}+\rho\gamma}{\eta N+\gamma}$ is the quality-adjusted choke price common to all varieties, above which the demand for an individual variety becomes zero, $\tilde{P} = \frac{1}{N}\int_{i\in\Omega^*}\left(\frac{p_i}{z_i}\right)di$ is the average quality-adjusted price of the varieties, and N is the number of varieties consumed.

3.1.2 Firms

Suppose there is a single industry in a closed economy in which N firms offer a single product. Production in this industry requires only one factor, labor, and all firms face the same wage rate, w. Firms and their products are indexed by i. Firm i produces its product with the quality level z_i. The firm needs c_i units of labor to produce one unit of product. In producing its quality level, the firm needs cost with the following form[8]:

$$z_i = c_i^{1+\theta} \tag{3}$$

$1+\theta$ is referred to as the quality elasticity that governs the extent to which higher unit labor requirement is related to higher quality. Depending on the value of θ, the industry exhibits different degrees of quality differentiation. If $\theta = -1$, all firms have the same product quality, $z_i = 1$ and there is no quality heterogeneity across products in the industry. If $\theta > -1$, there is quality differentiation across products and each firm produces its product quality $z_i = c_i^{1+\theta}$. More specifically, when $\theta > 0$, product quality increases elastically with respect to an increase in unit labor requirement, but when $-1 < \theta < 0$, product quality responds inelastically to an increase in unit labor requirement.

In this discussion, I emphasize only two cases: the case of $\theta = -1$, where product quality is homogeneous across firms, and the case of $\theta > 0$, where product quality

[8] This functional relationship between product quality and marginal cost is from Baldwin and Harrigan (2011).

is heterogeneous across firms, and quality increases elastically with respect to an increase in unit labor requirement. The case of $-1 < \theta < 0$, where product quality is heterogeneous across firms, but quality responds inelastically to an increase in unit labor requirement, will be discussed in appendix since it is relatively less relevant than the other two cases above in this discussion.[9]

First, when $\theta = -1$, all firms have the same $z_i = 1$ and firm i's cost for producing one unit of product is wc_i. Since all products have the identical quality, the only heterogeneity amongst firms stems from their efficiency levels represented by their unit labor requirement, c_i. In this type of industry, those firms with higher production efficiency with a smaller c_i producing at a lower marginal cost are capable. Since firms' capability is sorted by their efficiency level and there is no quality heterogeneity across varieties, this type of industry is called an 'efficiency-sorting industry' with homogeneous product quality.

Second, when $\theta > 0$, each firm produces its own product quality represented by $z_i = c_i^{1+\theta}$, and the product quality elastically respond to an increase in unit labor requirement c_i. The effective cost producing one unit of quality is $\frac{wc_i}{z_i} = \frac{wc_i}{c_i^{1+\theta}} = wc_i^{-\theta}$, and it decreases with c_i. Thus, for a given θ, those firms with a larger c_i, producing higher product quality at a lower effective cost, are more capable. Since the capability is sorted by their quality and there is product quality heterogeneity across varieties, this type of industry is called a 'quality-sorting industry' with heterogeneous product

[9] The third case with $-1 < \theta < 0$ is considered less relevant case because it is less consistent with empirical findings from previous literature. Empirical findings using micro-level data by Kugler and Verhoogen (2008) and Verhoogen (2008) show a robust positive relationship between product quality and input costs. Along with these empirical findings, the quality heterogeneous firms trade model literature, including the most influential one by Baldwin and Harrigan (2011) among others, argues that firms producing high product quality with high input costs earn higher operating profit, which is consistently explained by the case with $\theta > 0$. In contrast, the case with $-1 < \theta < 0$, as will be shown in appendix more in detail, yields that firms producing high product quality with high input costs earn lower operating profit, which is less consistent with the argument by previous literature. Thus, this case will be discussed as additional part in Model Appendix A.1.

quality.

In the next discussion, I focus on each of the two types of industries: the efficiency-sorting industry with homogeneous product quality and the quality-sorting industry with heterogeneous product quality. [10]

3.1.3 Efficiency-sorting Industry with Homogenous Product Quality

When the quality elasticity is zero, all firms produce the same product quality with $z_i = 1$, and there is no quality heterogeneity across products. Thus, this model collapses to the standard HFT model, and the source of firm heterogeneity only stems from its efficiency level, c_i. When a firm enters the industry, it randomly draws its c_i from a distribution function $G(c_i)$ on the support of $[0, c_M]$. For parametrization, Pareto distribution is assumed as in Melitz and Ottaivano (2008) such that $G(c_i) = \left(\frac{c_i}{c_M}\right)^{\alpha}$. When $\alpha = 1$, the distribution of c_i is uniform, but as α increases, the the distribution of c_i is more concentrated at higher levels of c_i. To learn their own level of unit labor requirement c_i, firms must pay a fixed sunk entry cost, f_e. Firms that can cover their marginal costs survive and maximize profits using their residual demand. All other firms exit the industry immediately.

Subsequently, firm i maximizes its profit $\pi_i = [p_i - wc_i]\, q_i$ using the residual demand function $q_i = \frac{L}{r}\left(\hat{P} - p_i\right)$. Let c_D represents the unit labor requirement of the firm that makes zero profit. As the price decreases to its cost, $p(c_D) = wc_D = \hat{P}$, this firm's demand $q(c_D)$ becomes zero. All firms with their c_i less than c_D earn non-negative profits and remain in the industry. Thus, $c_i \leq c_D$ becomes the survival condition. By solving the profit maximization problem of firm i, output, revenue, and profit functions can be obtained as follows:

[10] The third case with $-1 < \theta < 0$ is also discussed in depth in Model Appendix A.1.

$$q(c_i) = \frac{wL}{2\gamma}\left[c_D - c_i\right] \tag{4}$$

$$p(c_i) = \frac{w}{2}\left[c_D + c_i\right] \tag{5}$$

$$r(c_i) = \frac{w^2L}{4\gamma}\left[c_D^2 - c_i^2\right] \tag{6}$$

$$\pi(c_i) = \frac{w^2L}{4\gamma}\left[c_D - c_i\right]^2 \tag{7}$$

The optimal price increases with c_i, and the optimal revenue and profit decrease with c_i, implying that high capability firms with smaller c_i charging lower price earns greater revenue and profit. Thus, firms are heterogeneous in terms of their efficiency and they compete with their prices.

In the industry equilibrium, the free entry condition leads the expected profit to be equal to the fixed sunk entry cost as follows:

$$E(\pi) = \int_0^{c_D} \pi(c_i)dG(c_i) = \frac{w^2L}{4\gamma}\int_0^{c_D}\left[c_D - c_i\right]^2 dG(c_i) = f_e \tag{8}$$

With the survival condition, $c_i \leq c_D$, the free entry condition pins down the cut-off level of the c_D.[11] In the equilibrium, only firms with their c_i less than the endogenously determined c_D, survive and operate with non-negative profits.

In the industry equilibrium, the observed average price of products in the market is output-weighted average price of products of all operating firms. Let the share of quantity of products of a firm i, q_i, relative to the total of the industry, Q, be

[11] Refer to Model Appendix A.2.1 for solutions.

expressed as $\omega_i \equiv \frac{q_i}{\int q_i dG(c_i)} \equiv \frac{q_i}{Q}$. Then, the output-weighted average price can be formulated as the industry's total revenue divided by the industry's total quantity as follows:

$$\bar{P} = \int_0^{c_D} \omega_i p_i dG(c_i) = \frac{\int r_i dG(c_i)}{\int q_i dG(c_i)} \equiv \frac{R}{Q} \tag{9}$$

where R and Q are the industry total revenue and quantity respectively.

3.1.4 Quality-sorting Industry with Heterogeneous Product Quality

Quality-sorting industries with heterogeneous product quality is characterized with $\theta > 0$. In this case, $z_i = c_i^{1+\theta}$, quality increases elastically with respect to an increase in unit labor requirement. Thus, each variety has its own product quality depending on its unit labor requirement c_i such that the higher the c_i, the higher the product quality is. In this type of industry, high capability firms with high c_i produce high product quality.

When a firm enters the industry, it randomly draws its c_i from a distribution function $G(c_i)$ on the support of $[c_L, \infty)$. For parametrization, Pareto distribution is assumed such that $G(c_i) = 1 - \left(\frac{c_L}{c_i}\right)^{\alpha}$.[12] As α increases, the the distribution of c_i is more concentrated at lower levels of c_i.To learn their own unit labor requirement, firms must pay a fixed sunk entry cost, f_e. Firms that can cover their marginal costs survive and maximize profits using their residual demand. All other firms exit the industry immediately.

[12]Unlike the Pareto distribution function, $G(c_i) = \left(\frac{c_i}{c_M}\right)^{\alpha}$ assumed in the previous case, this Pareto distribution has its functional form, $G(c_i) = 1 - \left(\frac{c_L}{c_i}\right)^{\alpha}$. These two cases are just the inverse function from each other because the former functional form exhibits a Pareto distribution that are more concentrated at higher levels of c_i, which properly represents an efficiency-sorting industry, while the latter functional form exhibits a Pareto distribution that are more concentrated at lower level of c_i, which represents a quality-sorting industry.

Firm i maximizes its profit $\pi_i = [p_i - wc_i]\, q_i$ using the residual demand function $q_i = \frac{L}{z_i r}\left(\hat{P} - \frac{p_i}{z_i}\right)$. Let c_D represents the unit labor requirement of a zero-profit firm and any firms with their $c_i < c_D$ will not profitably operate in the industry. Thus, the zero-profit firms face their quality-adjusted price that is exactly the same as the quality-adjusted choke price, $\hat{P}$, such that $\frac{p}{z}(c_D) = \frac{wc_D}{z(c_D)} = \hat{P}$, and these firms' demand $q(c_D)$ becomes zero. All firms with their c_i greater than c_D earn non-negative profits and remain in the industry. Thus, $c_i \geq c_D$ becomes the survival condition. By solving the profit maximization problem of firm i, output, revenue, and profit functions can be obtained as follows:

$$q(c_i) = \frac{wL}{2\gamma z_i}\left[\frac{c_D}{z_D} - \frac{c_i}{z_i}\right] = \frac{wL}{2\gamma c_i^{1+\theta}}\left[c_D^{-\theta} - c_i^{-\theta}\right] \tag{10}$$

$$p(c_i) = \frac{wz_i}{2}\left[\frac{c_D}{z_D} + \frac{c_i}{z_i}\right] = \frac{wc_i^{1+\theta}}{2}\left[c_D^{-\theta} + c_i^{-\theta}\right] \tag{11}$$

$$r(c_i) = \frac{w^2 L}{4\gamma}\left[\left(\frac{c_D}{z_D}\right)^2 - \left(\frac{c_i}{z_i}\right)^2\right] = \frac{w^2 L}{4\gamma}\left[c_D^{-2\theta} - c_i^{-2\theta}\right] \tag{12}$$

$$\pi(c_i) = \frac{w^2 L}{4\gamma}\left[\frac{c_D}{z_D} - \frac{c_i}{z_i}\right]^2 = \frac{w^2 L}{4\gamma}\left[c_D^{-\theta} - c_i^{-\theta}\right]^2 \tag{13}$$

In this case, the quality-adjusted price, $\frac{p_i}{z_i} \equiv \frac{p_i}{c_i^{1+\theta}}$, decreases with c_i, and firms' revenue and profit increase with c_i as the revenue and profit functions show, $\frac{\partial r(c_i)}{\partial c_i} > 0$ and $\frac{\partial \pi(c_i)}{\partial c_i} > 0$. Thus, high capability firms producing high product quality gain greater operating revenue and profit.

In the industry equilibrium, the free entry condition leads the expected profit to be equal to the fixed sunk entry cost as follows:

$$E(\pi) = \int_{c_D}^{\infty} \pi(c_i) dG(c_i) = \frac{w^2 L}{4\gamma} \int_{c_D}^{\infty} \left[c_D^{-\theta} - c_i^{-\theta}\right]^2 dG(c_i) = f_e \tag{14}$$

With the survival condition, $c_i \geq c_D$, the free entry condition pins down the cut-off level of the c_D.[13] In the equilibrium, only those firms with their c_i greater than the endogenously determined c_D, survive and operate with non-negative profits.

In the industry equilibrium, the output-weighted average price can be formulated as the industry's total revenue divided by the industry's total quantity as follows:

$$\bar{P} = \int_{c_D}^{\infty} \omega_i p_i dG(c_i) = \frac{\int r_i dG(c_i)}{\int q_i dG(c_i)} \equiv \frac{R}{Q} \tag{15}$$

where R and Q are the industry total revenue and quantity respectively and ω_i denotes the share of quantity of products.

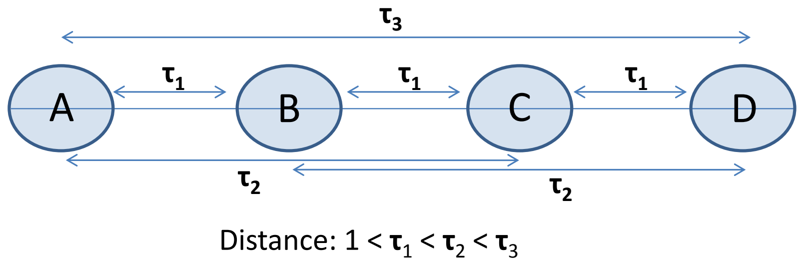
3.2 Four-country Open Economy

Suppose there are four countries that are same-sized and equidistant along a line as illustrated in Figure 1. Here, distance is assumed to represent transport costs between two countries and the same distance incurs the same transport costs.[14] The distance between two adjacent countries is τ_1, the distance between the first (A) and the third (C) countries or the second (B) and the fourth (D) countries is τ_2, and the distance between two peripheral countries (A and D) is τ_3. These distances and trade costs are assumed to be non-negligible and the relationship between these distances are

[13] Refer to Model Appendix A.2.2 for solutions.

[14] Transport costs and distance are assume to equally represent bilateral market access, so can be interchangeably used in the theoretical model. However, in empirical investigation, differences between transport costs and distance will be considered when they are used as proxies for bilateral market access.

Figure 1: Four-country open economy



assumed as follows: $1 < \tau_1 < \tau_2 < \tau_3$. All countries are trading to one another.

This geographical arrangement of countries makes country B and C to be central but country A and D to be remote from the rest of the world. The central countries B and C are assumed to face a higher level of wage than remote countries A and D due to the relative location.[15] The wage level in the remote countries A and D is set as one and the wage level in the central countries B and C is w, so $w > 1$, without loss of generality. Therefore, the wage difference stems from the difference in the market access condition across countries through the degree of centrality or remoteness of the countries.

This assumption is rationalized by findings from the following previous literature. According to Redding and Venables (2004), remote countries face higher transport costs or trade costs, relative to the central countries, in exporting their products and importing inputs. Due to the disadvantage of their relative location, firms in

[15] Melitz (2003) points out that HFT model can be extended to asymmetric countries by relying on an exogenously fixed relative wage between countries, and this assumption is also made in Bernard, Eaton, Jenson, and Kortum (2000). It is because modification of HFT model with asymmetric countries generates a general equilibrium problem that is difficult to solve for wages, export thresholds, and the mass of firms simultaneously. Helpman, Melitz and Yeaple (2004) and Melitz and Ottaviano (2008) address this problem by introducing a costlessly-traded, constant-return numeraire industry that determines wages globally. They assume that labor is inelastically supplied in a competitive market and the numeraire good is produced under constant returns to scale at unit cost and sold in a competitive market. This setting allows them to assume a unit wage. However, my model limits the discussion to a partial equilibrium model with exogenously fixed relative wage where central countries have relatively higher wages than in remote countries.

remote countries can only afford to pay relatively low wages in comparison to central countries. Also, their empirical finding verifies this negative causal relationship of market access of countries to their wage levels.[16]

In this model, therefore, the relative wage between central and remote countries represents the degree of remoteness. As relative location of countries becomes more polarized such that remoteness or centrality increases, the increased difference of market access between central and remote countries raises the wage difference. Thus, the relative wage in remote countries compared to that of central countries decreases with remoteness.

3.2.1 Consumers and Firms

In each country, there are L consumers, sharing the same preferences. Firms in an origin country o ($o = A, B, C, D$) can sell in the destination country d ($d \neq o$) incurring a per-unit transport cost, τ, as a form of ice-berg cost. The variable cost per unit of exports is $w^o \tau c_i$, and the effective cost per unit of quality is $\frac{w^o \tau c_i}{z_i} = w^o \tau^{od} c_i^{-\theta}$. A firm producing in a country o can export some output q_X^{od} to a destination country d at a delivered (c.i.f) price, p_X^{od}. The demand for this firm's exports in country d is given as $q_X^{od} = \frac{L}{z\gamma}\left[\hat{P}^d - \frac{p_X^{od}}{z}\right]$, and its exporting profit is given as $\pi_X^{od} = \left[p_X^{od} - w^o \tau^{od} c_i\right] q_X^{od}$.

3.2.2 Efficiency-sorting Industry with Homogenous Product Quality

In an efficiency-sorting industry with $\theta = -1$, product quality is homogeneous for all firms with $z = 1$. In this type of industry, the demand for a firm i's exports will be $q_X^{od} = \frac{L}{\gamma}\left[\hat{P}^d - p_X^{od}\right]$. Then, zero profit conditions yield the choke price faced by domestic and foreign firms competing in the same destination market, $\hat{P}^d = w^d c_D^d =$

[16] Also, the data that will be used in the empirical analysis of this paper shows a significant negative correlation between per capita GDP and remoteness across countries as Appendix Figure 2 shows.

$w^o\tau^{od}c_X^{od}$. Consequently, this condition defines the relationship between the origin country's exporting cut-off c_X^{od} and the destination country's domestic cut-off c_D^d. Thus, c_X^{od}, the cut-off above which firms in country o cannot profitably export to country d, can be expressed in terms of c_D^d, the cut-off above which domestic firms in country d cannot profitably operate in their domestic market d as follows: $c_X^{od} = \left[\frac{w^d}{w^o\tau^{od}}\right] c_D^d$.

These conditions further yield performance functions of a firm of country o exporting to destination market d. The profit maximizing export output, c.i.f. pricing rule, f.o.b pricing rule, exporting revenue, revenue based on the f.o.b price, and profit functions are as follows:

$$
\begin{array}{rclcrcl}
p_X^{od} &=& \frac{w^o\tau^{od}}{2}\left[c_X^{od}+c_i\right] & ; & p_{Xfob}^{od} &=& \frac{w^o}{2}\left[c_X^{od}+c_i\right] \\
q_X^{od} &=& \frac{w^o\tau^{od}L}{2\gamma}\left[c_X^{od}-c_i\right] & ; & r_X^{od} &=& \frac{\left(w^o\tau^{od}\right)^2L}{4\gamma}\left[\left(c_X^{od}\right)^2-c_i^2\right] \\
r_{Xfob}^{od} &=& \frac{(w^o)^2\tau^{od}L}{4\gamma}\left[\left(c_X^{od}\right)^2-c_i^2\right] & ; & \pi_X^{od} &=& \frac{\left(w^o\tau^{od}\right)^2L}{4\gamma}\left[c_X^{od}-c_i\right]^2
\end{array}
$$

A firm's total profit is the sum of its domestic profit, $\pi_D^o(c) = \frac{(w^o)^2L}{4\gamma}\left[c_D^o - c_i\right]^2$, and its exporting profit, $\pi_X^{od}(c) = \frac{\left(w^o\tau^{od}\right)^2L}{4\gamma}\left[c_X^{od}-c_i\right]^2$. Then, a free entry condition of the industry in each country will be the sum of total profits of all operating firms in the industry and is expressed in the following form: $\int_0^{c_D^o}\pi_D^o(c_i)dG(c_i) + \sum_{d\neq o}\int_0^{c_X^{od}}\pi_X^{od}(c_i)dG(c_i) = f_e$, where $o = A, B, C, D$ and $d \neq o$. By solving the free entry conditions for four countries using the cut-off conditions, c_D^A, c_D^B, c_D^C, and c_D^D, the domestic cut-offs above which firms cannot operate profitably in each of the four countries, can be found. Since all countries are identical except for their relative location, those countries that have the same relative location will have the same cut-off level. Thus, domestic cut-offs in the central countries are identical ,$c_D^B = c_D^C \equiv c_D^{central}$, and those in the remote countries are identical, $c_D^A = c_D^D \equiv c_D^{remote}$.[17]

[17]Refer to Model Appendix A.2.1 for solutions.

Let us focus on one case where a central country B imports from the other three exporting countries, A, C, and D. For a given domestic threshold c_D^B in B, the exporting countries face different exporting cut-offs as follows:

Table 1. Exporting Thresholds

The exporting cut-off of remote country A to B:	$c_X^{AB} = \frac{w}{\tau_1} c_D^B$
The exporting cut-off of central country C to B:	$c_X^{CB} = \frac{1}{\tau_1} c_D^B$
The exporting cut-off of remote country D to B:	$c_X^{DB} = \frac{w}{\tau_3} c_D^B$

A remote county A has an advantage of lower wage relative to its competing central country C in the same market B. Therefore, for the same central destination market, firms in the remote country face a relatively higher cut-off level of unit labor requirement c_i (less competition to export) than firms in the central country, $c_X^{AB} > c_X^{CB}$. On the other hand, the county A has an advantage of lower transport costs relative to its competing country D in the same market B. Therefore, for the same central destination market, firms in the proximate country face a relatively higher cut-off level of unit labor requirement c_i (less competition to export) than firms in the distant country, $c_X^{AB} > c_X^{DB}$.

Output-Weighted Average F.O.B. Export Prices In order to investigate how remoteness and distance determine the f.o.b. export prices, I formulate output-weighted average f.o.b. export prices. The share of exports quantity of an exporting firm relative to the total exports of the industry is expressed as $\omega_X^{od} \equiv \frac{q_X^{od}}{\int q_X^{od} g(k_i) dk_i} \equiv \frac{q_X^{od}}{Q_X^{od}}$. Then, the output-weighted average f.o.b. exports price can be calculated as the industry's total exporting revenue, calculated with f.o.b. export prices, divided by the industry's total exports as follows:

$$\bar{P}^{od}_{Xfob} = \int_0^{c^{od}_X} \omega^{od}_X p^{od}_{Xfob} dG(k_i) = \frac{\int r^{od}_{Xfob} dG(k_i)}{\int q^{od}_X dG(k_i)} \equiv \frac{R^{od}_X}{Q^{od}_X} \tag{16}$$

where R^{od}_X and Q^{od}_X are the total exporting revenue and quantity from an origin country o $(o = A, C, D)$ to the destination d $(d = B)$, respectively.

In the efficiency-sorting industry with homogenous product quality, the output-weighted average f.o.b. export price turns out to depend on the exporting cut-off (c^o_X) and the wage level (w^o) of the origin county and the shape parameter of the Pareto distribution (α) as follows:

$$\bar{P}^{od}_{Xfob} = \frac{R^{od}_X}{Q^{od}_X} = \frac{1+\alpha}{2+\alpha} w^o c^{od}_X \tag{17}$$

where w^o denotes the wage level in an exporting country o. Since the wages in remote countries are identical as 1, $w^A = w^D = 1$, and the wage in central countries are greater than 1, $w \equiv w^C = w^B > 1$, the output-weighted average f.o.b. export price of the exporting country A, C and D to the same central destination market B are as follows:

$$\bar{P}^{AB}_{Xfob} = \frac{1+\alpha}{2+\alpha} c^{AB}_X = \frac{1+\alpha}{2+\alpha} \underbrace{\left[\frac{w}{\tau_1} c^B_D\right]}_{selection\,effect}$$

$$\bar{P}^{CB}_{Xfob} = \frac{1+\alpha}{2+\alpha} w c^{CB}_X = \frac{1+\alpha}{2+\alpha} \underbrace{w}_{cost\,effect} \left[\frac{1}{\tau_1} c^B_D\right]$$

$$\bar{P}^{DB}_{Xfob} = \frac{1+\alpha}{2+\alpha}c^{DB}_X = \frac{1+\alpha}{2+\alpha}\underbrace{\left[\frac{w}{\tau_3}c^B_D\right]}_{selection\,effect}$$

A remoteness effect on the average export prices can be found by comparing $\bar{P}^{AB}_{Xfob}$ and $\bar{P}^{CB}_{Xfob}$, however, these export prices are identical meaning that there is no remoteness effect.

$$\bar{P}^{AB}_{Xfob} = \bar{P}^{CB}_{Xfob}$$

There are two forces that drive these prices to be indifferent. First, a selection effect: the weaker selection in country A raises the average export price by a factor of w through the threshold term c^{AB}_X. Second, a cost effect: country C suffers from higher costs of production with higher wages, thus the average export price increases by a factor of w, too. Therefore, these selection and cost effects cancel out the difference in average export prices between remote and central countries.

This result shows that when there is no quality differentiation, the remoteness effect on the output-weighted average f.o.b. export price will not be observed. It is because the wage difference favors a remote exporting country by allowing less capable firms with high c_i and high prices to export, resulting in a high average export price. On the other hand, due to the higher wage level, exporting firms in central countries set their price higher compared to the firms with the same level of c_i in remote countries, resulting in a high average export price.

Consequently, the selection effect raises average export price from a remote country, but the cost effect mitigates the price difference by raising average export price from a central country. As a result, the average export prices from remote and central counties are not different. Therefore, in those industries with no quality competition, the effect of relative locations of exporting countries on the average export prices is expected to be zero.

On the other hand, a distance effect on the average export prices can be found by comparing $\bar{P}^{AB}_{Xfob}$ and $\bar{P}^{DB}_{Xfob}$. The higher transport costs for country D ($\tau_3 > \tau_1$) causes the export threshold lower in country D than in A ($c^{AB}_X > c^{DB}_X$). Therefore,

$$\bar{P}^{AB}_{Xfob} > \bar{P}^{DB}_{Xfob}$$

That is, for an efficiency-sorting industry with no quality differentiation, the average export price decreases with distance.[18] It is because the higher the transport cost, the lower the exporting threshold is; then, it is more difficult for firms in a distant country to export than in a proximate country. Since a more capable firm produces with high efficiency charges a lower price, the average export price from the distant exporting country is lower than that of the proximate exporting country.

3.2.3 Quality-sorting Industry with Heterogeneous Product Quality

In a quality-sorting industry with $\theta > 0$, product quality is heterogeneous across firms with $z_i = c_i^{1+\theta}$. In this type of industry, the demand for a firm i's exports will be $q^{od}_X = \frac{L}{z\gamma}\left[\hat{P}^d - \frac{p^{od}_X}{z}\right]$, where $\hat{P}^d$ is the quality-adjusted choke price in the destination market d, and its exporting profit will be $\pi^{od}_X = \left[p^{od}_X - w^o\tau^{od}c_i\right] q^{od}_X$. From the zero profit conditions, the relationship between the choke price of the destination country, the origin country's exporting cut-off and the destination country's domestic cut-off is given as follows: $\hat{P}^d = w^d \frac{c^d_D}{z_D} = w^o\tau^{od}\frac{c^{od}_X}{z_X}$, which yields $\hat{P}^d = w^d\left(c^d_D\right)^{-\theta} =$

[18] This is also confirmed by the following comparative statics: $\frac{\partial \bar{P}^{od}_{Xfob}}{\partial \tau} = -\frac{1+\alpha}{2+\alpha}\frac{w}{\tau_1^2}c^B_D < 0$

$w^o\tau^{od}\left(c_X^{od}\right)^{-\theta}$. Then, c_X^{od}, the cut-off below which firms in country o cannot profitably export to country d, can be expressed in terms of c_D^d, the cut-off below which domestic firms in country d cannot profitably operate in their domestic market d as follows: $c_X^{od} = \left[\frac{w^o\tau^{od}}{w^d}\right]^{1/\theta} c_D^d$.

These conditions above yield performance functions of a firm of country o in export market d. The profit maximizing export output, c.i.f. pricing rule, f.o.b pricing rule, exporting revenue, revenue based on the f.o.b price, and profit functions are as follows:

$$
\begin{aligned}
p_X^{od} &= \tfrac{1}{2}w^o\tau^{od}c^{1+\theta}\left[\left(c_X^{od}\right)^{-\theta} + c_i^{-\theta}\right]; & p_{Xfob}^{od} &= \tfrac{1}{2}w^o c^{1+\theta}\left[\left(c_X^{od}\right)^{-\theta} + c_i^{-\theta}\right] \\
q_X^{od} &= \tfrac{L}{2\gamma c_i^{1+\theta}}w^o\tau^{od}\left[\left(c_X^{od}\right)^{-\theta} - c_i^{-\theta}\right]; & r_X^{od} &= \tfrac{L}{4\gamma}\left(w^o\tau^{od}\right)^2\left[\left(c_X^{od}\right)^{-2\theta} - c_i^{-2\theta}\right] \\
r_{Xfob}^{od} &= \tfrac{L}{4\gamma}(w^o)^2\tau^{od}\left[\left(c_X^{od}\right)^{-2\theta} - c_i^{-2\theta}\right]; & \pi_X^{od} &= \tfrac{L}{4\gamma}\left(w^o\tau^{od}\right)^2\left[\left(c_X^{od}\right)^{-\theta} - c_i^{-\theta}\right]^2
\end{aligned}
$$

For a firm in each country, its domestic profit is $\pi_D^o(k) = \frac{(w^o)^2L}{4\gamma}\left[\left(c_D^o\right)^{-\theta} - c_i^{-\theta}\right]^2$, and its exporting profit is $\pi_X^{od}(k) = \frac{L}{4\gamma}\left(w^o\tau^{od}\right)^2\left[\left(c_X^{od}\right)^{-\theta} - c_i^{-\theta}\right]^2$. Each country has its own free entry condition in a form of $\int_{c_D^o}^{\infty}\pi_D^o(c_i)dG(c_i) + \sum_{d\neq o}\int_{c_X^{od}}^{\infty}\pi_X^{od}(c_i)dG(c_i) = f_e$ where $o = A, B, C, D$ and $d \neq o$. Solving these four free entry conditions using the cut-off conditions yields the domestic cut-offs of the four countries, c_D^A, c_D^B, c_D^C, and c_D^D, below which firms cannot operate profitably in each country. Due to the symmetry, domestic cut-offs in the central countries are identical ,$c_D^{central} \equiv c_D^B = c_D^C$, and those in the remote countries are identical, $c_D^{remote} \equiv c_D^A = c_D^D$.[19]

Let us focus on one case where the central country B imports from the other three exporting countries, A, C, and D. For a given domestic threshold c_D^B in B, the exporting countries face different exporting cut-offs as follows:

[19] Refer to Model Appendix A.2.2 for solutions.

Table 2. Exporting Thresholds

The exporting cut-off of remote country A to B:	$c_X^{AB} = \left(\frac{\tau_1}{w}\right)^{1/\theta} c_D^B$
The exporting cut-off of central country C to B:	$c_X^{CB} = (\tau_1)^{1/\theta} c_D^B$
The exporting cut-off of remote country D to B:	$c_X^{DB} = \left(\frac{\tau_3}{w}\right)^{1/\theta} c_D^B$

When country A and C are compared to each other, the remote county A has an advantage of lower wage relative to its competing central country C in the same market B. Therefore, for the same central destination market, firms in the remote country A face a relatively lower cut-off level of unit labor requirement c_i (less competition to export) than firms in the central country, $c_X^{AB} < c_X^{CB}$. On the other hand, when comparing A and D, the county A has an advantage of lower transport costs relative to its competing country D in the same market B. Therefore, for the same central destination market, firms in the proximate country A face a relatively lower cut-off level of unit labor requirement c_i (less competition to export) than firms in the distant country, $c_X^{AB} < c_X^{DB}$.

Output-Weighted Average F.O.B. Export Prices

The output-weighted average f.o.b. exports price can be calculated as the industry's total exporting revenue, calculated with f.o.b. export prices, divided by the industry's total exports as follows:

$$\bar{P}_{Xfob}^{od} = \int_{c_X^{od}}^{\infty} \omega_X^{od} p_{Xfob}^{od} dG(k_i) = \frac{\int r_{Xfob}^{od} dG(k_i)}{\int q_X^{od} dG(k_i)} \equiv \frac{R_X^{od}}{Q_X^{od}} \tag{18}$$

where R_X^{od} and Q_X^{od} are the total exporting revenue and quantity from an origin country o $(o = A, C, D)$ to the destination d $(d = B)$, respectively, and $\omega_X^{od} \equiv \frac{q_X^{od}}{\int q_X^{od} g(k_i) dk_i} \equiv \frac{q_X^{od}}{Q_X^{od}}$ is the share of quantity of exports of an exporting firm relative to the total exports of the industry. In the quality-sorting industry with heterogeneous product quality, the output-weighted average f.o.b. export price depends on the quality elasticity (θ) as well as the exporting cut-off (c_X^{od}), the wage level (w^o) of the exporting county, and the shape parameter of the Pareto distribution (α) as follows.

$$\bar{P}_{Xfob}^{od} = \frac{R_X^{od}}{Q_X^{od}} = \xi(\alpha,\theta) w^o c_X^{od} \tag{19}$$

where $\xi(\alpha,\theta) \equiv \frac{(\alpha+\theta+1)(\alpha+2\theta+1)}{\alpha(\alpha+2\theta)}$. Using the export cut-off in each country, c_X^{AB}, c_X^{CB}, and c_X^{DB}, the output-weighted average f.o.b. export prices of country A, C and D to the central destination market B are expressed as follows:

$$\bar{P}_{Xfob}^{AB} = \xi(\alpha,\theta) c_X^{AB} = \xi(\alpha,\theta) \underbrace{\left(\frac{\tau_1}{w}\right)^{1/\theta} c_D^B}_{selection\,effect}$$

$$\bar{P}_{Xfob}^{CB} = \xi(\alpha,\theta) w c_X^{CB} = \xi(\alpha,\theta) \underbrace{w}_{cost\,effect} (\tau_1)^{1/\theta} c_D^B$$

$$\bar{P}_{Xfob}^{DB} = \xi(\alpha,\theta) c_X^{DB} = \xi(\alpha,\theta) \underbrace{\left(\frac{\tau_3}{w}\right)^{1/\theta} c_D^B}_{selection\,effect}$$

Unlike the previous case of the efficiency-sorting industry with no quality differentiation, the average export prices depend on quality elasticity, through the term θ in this quality-sorting industry with quality differentiation.

By comparing $\bar{P}^{AB}_{Xfob}$ and $\bar{P}^{CB}_{Xfob}$, we can find that average f.o.b. export price of the remote country A, $\bar{P}^{AB}_{Xfob}$, is lower than that of the central country C, $\bar{P}^{CB}_{Xfob}$:

$$\bar{P}^{AB}_{Xfob} < \bar{P}^{CB}_{Xfob}$$

Two forces drive this result: as shown in the lower exporting cut-off of country A, c^{AB}_{X}, due to the lower wage in the remote country, export participation is less selective than in the central country C, and this selection effect leads the export prices of remote country A in market B, $\bar{P}^{AB}_{Xfob}$ to be lower than the export prices of central country C in the same market B, $\bar{P}^{CB}_{Xfob}$. At the same time, since the country C faces a higher wage level by w, this cost effect additionally causes the export prices of central country C, $\bar{P}^{CB}_{Xfob}$ to be higher than the export prices of remote country $\bar{P}^{AB}_{Xfob}$. Therefore, these selection and cost effects result in a wider gap in export prices between central and remote countries.

This result tells us that the output-weighted average f.o.b. export price from a remote country is observed to be lower than that of a central country when the industry is engaged in quality differentiation and more capable firms produce higher product quality. The wage difference favors the remote exporting country by allowing less capable firms with low c_i and low prices to export, resulting in a low average export price. On the other hand, due to the higher wage level, exporting firms in the central country set their price higher compared to the firms with the same level of capability in the remote country, resulting in a high average export price in the central country. Consequently, the selection and cost effects cause the average export price of the remote country to be lower than that of the central country. Therefore, in the quality-sorting industry with heterogeneous product quality, the remoteness effect on the average export prices is expected to be negative.

On the other hand, a distance effect on the average export prices can be found by comparing $\bar{P}^{AB}_{Xfob}$ and $\bar{P}^{DB}_{Xfob}$. Higher transport costs for country D ($\tau_3 > \tau_1$) causes the export threshold to be higher in country D than in A ($c^{AB}_X < c^{DB}_X$). Therefore,

$$\bar{P}^{AB}_{Xfob} < \bar{P}^{DB}_{Xfob}$$

This result is driven by the selection channel since higher transport costs for the distant country D raises the exporting threshold. Thus, only high capability firms that produce high product quality and charge high prices are able to export for the same destination country, resulting in higher average export prices from the more distant country D.

3.2.4 Quality Elasticity and Effects of Market Access on Export Prices

In the previous analysis, the effect of remoteness on the export prices turns out to be negative while the effect of transport costs on the export prices turns out to be positive for a quality-sorting industry with quality differentiation. In this part, I further explore how the magnitude of these remoteness and transport costs effects vary depending on the quality elasticity parameter, θ. The comparative statics of the export prices with respect to wage and θ, $\frac{\partial \bar{P}^{od}_{Xfob}}{\partial w \partial \theta}$, tells us how remoteness effect varies depending on the quality elasticity parameter, θ, and the comparative statics of the export prices with respect to transport costs and θ, $\frac{\partial \bar{P}^{od}_{Xfob}}{\partial \tau \partial \theta}$, tells us how transport cost effect varies depending on the quality elasticity parameter, θ.

As shown in the average export price expression in (19), θ determines the export prices through two channels, the multiplier term, $\xi(\alpha, \theta)$, and the threshold term, c^{od}_X. The multiplier term, $\xi(\alpha, \theta)$, in the average export price equation (19) is given as follows:

$$\xi(\alpha,\theta) \equiv \frac{(\alpha+\theta+1)\,(\alpha+2\theta+1)}{\alpha\,(\alpha+2\theta)}, \quad for\,\theta > 0$$

In the case of $\theta > 0$ ($\epsilon_q > 1$), the industry exhibits a technology such that quality increases elastically to an increase in unit labor requirement, and the multiplier $\xi(\alpha,\theta)$ is greater than one and increases with quality elasticity, $\partial\xi(\alpha,\theta)/\partial\theta \equiv \xi_\theta(\alpha,\theta) > 0$.

First, the comparative statics of the export prices with respect to wage and θ is given as follows;

$$\frac{\partial \bar{P}^{od}_{Xfob}}{\partial w \partial \theta} = \xi_\theta(\alpha,\theta)\frac{\partial c^{od}_X}{\partial w} + \xi(\alpha,\theta)\frac{\partial c^{od}_X}{\partial w \partial \theta} \tag{20}$$

Based on this comparative statics, the export prices from the remote exporting country A yields the following result;

$$\frac{\partial \bar{P}^{AB}_{Xfob}}{\partial w \partial \theta} = \frac{1}{\alpha}\left(\frac{\tau_1}{w^{1+\theta}}\right)^{1/\theta}\left[\frac{(1+\alpha+\theta)(1+\alpha+2\theta)ln(\frac{\tau_1}{w})}{\theta^2(\alpha+\theta)} + \frac{2+\alpha}{(\alpha+2\theta)^2} - 1\right]c^B_D \tag{21}$$

Second, the comparative statics of the export prices with respect to transport costs and θ is given as follows;

$$\frac{\partial \bar{P}^{od}_{Xfob}}{\partial \tau \partial \theta} = \xi_\theta(\alpha,\theta)\frac{\partial c^{od}_X}{\partial \tau} + \xi(\alpha,\theta)\frac{\partial c^{od}_X}{\partial \tau \partial \theta} \tag{22}$$

Based on this comparative statics, the export prices from the remote exporting country A yields the following result;

$$\frac{\partial \bar{P}^{DB}_{Xfob}}{\partial \tau \partial \theta} = \frac{1}{\alpha\theta^2}\left(\frac{\tau_3^{\theta-1}}{w}\right)^{1/\theta}\left[\frac{(1+\alpha+\theta)(1+\alpha+2\theta)(\theta+ln(\frac{\tau_3}{w}))}{\alpha+2\theta} - \theta^2\left(1-\frac{2+\alpha}{(\alpha+2\theta)^2}\right)\right]c^B_D \tag{23}$$

Each of these two expressions may have either negative or positive values depending on the value of θ, α, and τ/w.

$$\frac{\partial \bar{P}^{AB}_{Xfob}}{\partial w \partial \theta} \begin{cases} > 0 \; if & ln(\frac{\tau_1}{w}) > \Theta \\ < 0 & otherwise \end{cases}$$

$$where\, \Theta \equiv \frac{\theta^2(4\theta^2+4\alpha\theta+\alpha(\alpha-1)-2)}{(1+\alpha+\theta)(\alpha+2\theta)(1+\alpha+2\theta)}$$

$$\frac{\partial \bar{P}^{DB}_{Xfob}}{\partial \tau \partial \theta} \begin{cases} < 0 \; if & ln(\frac{\tau_3}{w}) < \Lambda \\ > 0 & otherwise \end{cases}$$

$$where\, \Lambda \equiv \frac{\theta(-4\theta(\alpha+1)^2-2\theta^2(2\alpha+3)-\alpha(\alpha+1)^2)}{(1+\alpha+\theta)(\alpha+2\theta)(1+\alpha+2\theta)}$$

Based on the conditions that limit the potential rages of these parameters defined in the model, six different cases can be considered.[20] Among those six conditions in Table 3, most cases support that $\frac{\partial \bar{P}^{AB}_{Xfob}}{\partial w \partial \theta} < 0$ and $\frac{\partial \bar{P}^{DB}_{Xfob}}{\partial \tau \partial \theta} > 0$.

Table 3. Interaction Effects of Market Access and θ

		$\frac{\partial \bar{P}^{AB}_{Xfob}}{\partial w \partial \theta}$	$\frac{\partial \bar{P}^{DB}_{Xfob}}{\partial \tau \partial \theta}$
1	$ln(\frac{\tau_3}{w}) > ln(\frac{\tau_1}{w}) > \Theta > \Lambda$	+	+
2	$ln(\frac{\tau_3}{w}) > \Theta > ln(\frac{\tau_1}{w}) > \Lambda$	-	+
3	$\Theta > ln(\frac{\tau_3}{w}) > ln(\frac{\tau_1}{w}) > \Lambda$	-	+
4	$ln(\frac{\tau_3}{w}) > \Theta > \Lambda > ln(\frac{\tau_1}{w})$	-	+
5	$\Theta > ln(\frac{\tau_3}{w}) > \Lambda > ln(\frac{\tau_1}{w})$	-	+
6	$\Theta > \Lambda > ln(\frac{\tau_3}{w}) > ln(\frac{\tau_1}{w})$	-	-

[20] Refer to Model Appendix A.3 for more detail.

Two exceptional cases are these: Case 1 represents a case where even the lowest transport costs are dominantly larger than the wage.[21]Case 6 represents a case where the relative wage dominantly exceeds even the highest transports costs.[22]. These two cases can be considered as extreme cases. Thus, except for these two cases, the comparative statics show that the negative remoteness effect increases with θ, and the positive transport cost effect increases with θ, implying that the magnitude of remoteness effects and transport cost effects are expected to increase with the degree of quality differentiation, θ, in most cases.

[21]It is evident that $\Theta > 0$ and $\Lambda < 0$ because $\alpha \geq 1$ and $\theta > 0$. Thus, case1 represents a case where even the lowest transport costs are dominantly larger than the relative wage.

[22]Since $\Theta > 0$ and $\Lambda < 0$ due to $\alpha \geq 1$ and $\theta > 0$, case 6 represents a case where relative wage dominantly exceeds even the highest transports costs.

Table 4. Effects of Multilateral and Bilateral Market Access on Export Prices

	Quality elasticity ($\epsilon_q = 1 + \theta$)	Effect of Remoteness	Remoteness $\times\, \epsilon_q$	Effect of Transport cost	Transport cost $\times\, \epsilon_q$
Quality-sorting Industry with quality differentiation	$\epsilon_q > 1$	-	- [a]	$+$	$+$ [b]
Efficiency-sorting Industry with no quality differentiation	$\epsilon_q = 0$	0	0	-	0

[a]Except the case where $ln(\frac{\tau_1}{w}) > \Theta$
[b]Except the case where $\Lambda > ln(\frac{\tau_3}{w})$

4 Data

I use the product-level U.S. import data for the year 2005, which was compiled by Schott and obtained from the U.S. Census Bureau. In the data, the product categories, which will henceforth be referred to simply as "products," are narrowly defined by Harmonized System (HS) 10-digit codes.[23] Examples of these products include the following items:

- 6206303010 Women's cotton blouses with more than 2 color warps
- 9503490025 Toys that represent animal or non-human creatures

This data set provides information on the quantity and f.o.b. value of imports in each product category from each originating country. The import value represents the total payment for the imports excluding import charges and U.S. import duties. Using this information, I construct the f.o.b. unit value (U_{pc}) of product p shipped from country c by dividing the value of the imports by their quantity. The product's unit value, used as a proxy for its export price, is used as a dependent variable in my empirical analysis. For data cleaning purposes, I deleted all products that reported only one unit of quantity or had a total value of less than $1,000 dollars from the sample.

As proxies for bilateral market access, I make use of two different measures: distance and transport cost. The distance between an exporting country and the U.S. is sourced from the CEPII and defined as the distance in kilometers between the most important cities, or agglomerations of population, in each country. The transport cost data is obtained from the U.S. import data. The dataset provides information on import charges, which indicate the aggregate cost of all freight, insurance, and other charges, with the exception of U.S. import duties, incurred while transporting

[23] The Harmonized Tariff Schedule is the system used to classify U.S. import data, and its 10-digit classification codes indicate the most disaggregated level of product categories.

goods to the U.S.[24] Using this information, the transport cost per unit at the country-product level is calculated by dividing the import charges by the quantity of products shipped from an exporting country to the U.S.

As proxies for multilateral market access, I use the remoteness of a country, which is measured as a GDP-weighted average distance between the country and all of its trading partners, following Wei (1996): $R_c = \sum_d s_d D_{cd}$, where s_d denotes country d's share of GDP relative to the world's total GDP, figures obtained from the IMF World Economic Outlook Database, and D_{cd} denotes the distance between country c and d, figures sourced from the CEPII. The sum of this GDP-weighted distance over all other countries (d's) is defined as the remoteness of country c. This remoteness can be interpreted as country c's relative location with regard to all other countries in the world. According to this measure, the most central country is the Netherlands and the most remote country is New Zealand. Table A3 in the appendix lists countries in the sample classified by their remoteness.

In empirically specifying the effects of market access on the unit value of exports based on the theoretical model's prediction, I control for country-specific factors that can affect export price determination, such as whether a country is landlocked and whether the country shares a border or the same language with the U.S., because these factors affect the fixed costs of export market participation. The landlocked and language variables are obtained from the CEPII, and the data regarding the U.S. border is obtained from the CIA world fact book. Also, to control for the effects of demand, market size and income of exporting countries on their export prices, I include the exporting countries' GDP and their per capita GDP, figures obtained

[24] Import charges counts those costs from alongside the carrier at the exporting country's port and place them alongside the carrier at the first port of entry into the U.S. In the case of overland shipments originating in Canada or Mexico, such costs include freight, insurance, and all other charges and expenses incurred while taking the merchandise from its point of origin to the first port of entry into the U.S.

from the World Development Indicators of the World Bank.

In addition to these country-level control variables, I also consider product-country level tariff rates as another potential determinant of f.o.b. export prices because the linear demand is assumed in the theoretical model exhibits incomplete pass-through of the trade costs. U.S. import data reports the calculated duties that represent the estimated import duties collected.[25] Based on this information, I calculate the ad valorem tariff rates as the share of the duties per value at the country and product levels.

In addition to the set of control variables, in investigating the cross-industry variation of the effects of market access on the unit values of exports, I make use of two proxies for the scope for quality differentiation. The Khandelwal's (2010) quality ladder length and Mandel's (2010) quality industry indicator.[26]

Khandelwal (2010) estimates the quality ladder length as the width of the scope for quality differentiation within a HS 10-digit code product category using U.S. import data. He constructs the quality ladder length based on the nested logit framework suggested by Berry (1994) by defining HS product categories as nests, so that the longer the quality ladder is, the wider the range of quality differentiation within the product category. This continuous measure at the HS 10-digit product level varies from zero to a maximum of 5.8, with a mean of 1.7. Utilizing the measure, I verify whether the transport cost and remoteness effects vary depending on the products' scope for quality differentiation.

The other proxy for the scope for quality differentiation is Mandel's (2010) quality industry indicator at HS 6-digit code product categories.[27] By measuring the skewness

[25]According to the U.S. import data, the "calculated duty" represents the estimated import duties collected. Estimated duties are calculated based on the applicable rates of duty as shown in the Harmonized Tariff Schedule of the United States Annotated for Statistical Reporting.

[26]Refer to Model Appendix A.4 for more detail for these measures.

[27]Mandel uses transaction-level U.S. import and export price data collected by the International

of import price distribution for HS 10-digit products within the transaction-level U.S. import price data, Mandel identifies whether or not a firm's capability is linked to the quality of their product. If a high capability firm exhibits a high product price, then the industry is defined as a quality industry with an indicator value of 1, but if a high capability firm exhibits a low product price, then the industry is defined as a cost industry with an indicator value of 0. In this way, his measure distinguishes between cost industries with a low scope for quality differentiation and quality industries with a high scope for quality differentiation. Contrary to the Khandelwal's quality ladder length which is a continuous measure for scope for quality differentiation, the Mandel's indicator only classifies whether or not an industry exhibits quality differentiation.

5 Empirical Investigation

Based on the discussion in the theoretical model, this section investigates product-level U.S. import data looking for empirical evidence of the effects of exporting countries' market access on its export prices. In the first sub-section, distance between the U.S. and exporting countries is employed as a measure of bilateral market access. Even though distant is a widely-used proxy for transport costs and bilateral market access, it only varies across countries whereas in the real world, bilateral market access varies depending on the type of product as well.

Thus, in the second sub-section, product-country specific transport costs are used as a measure of bilateral market access. The variation of transport costs across countries and products provide more useful information than distance, but the main problem of using this measure is endogeneity between transport costs and export prices that may cause biased estimation of the effects of bilateral market access on

Price Program (IPP) of the Bureau of Labor Statistics (BLS).

export prices. To address this issue, distance and total quantity of exports are used as instrumental variables for transport costs. Each sub-section is organized with empirical specifications and interpretation results, and the results are presented in the tables in the appendix.

5.1 Regressions with Distance Data

5.1.1 Empirical Specification

In this section, I build empirical specifications to test how distance and remoteness determine export prices, controlling for country characteristics, and then examine how these effects vary across industries depending on the industry-specific degree of quality heterogeneity. The following baseline empirical specification examines remoteness and distance effects on f.o.b. unit values of exports:

$$log(U_{pc}) = \alpha_p + \beta_1 log(Remoteness_c) + \beta_2 log(Distance_c) + other\, controls + \epsilon_{pc} \tag{24}$$

The dependent variable is the f.o.b. unit value of a HS 10-digit code product p shipped from country c (U_{pc}). The main explanatory variables include the remoteness of exporting countries, constructed as the GDP-weighted average distance of a country to all other countries ($Remoteness_c$) and the distance between the exporting country c and the importing country, the U.S. ($Distance_c$). α_p is a product fixed effect to control for level differences in unit values and unit differences across products. Robust standard errors are estimated by clustering exporting countries.

Other characteristics of exporting countries that affect export unit values need to be controlled for also. For example, the Log GDP per capita of exporting countries is used to control for the income level of exporting countries, because high income countries tend to produce expensive goods. The Log GDP of exporting countries is used to control for the market size of the exporting country. I used an indicator coded as 1 if the country shares its border with the U.S. and an indicator of 1 if the country has no port to control for the proximity and physical accessibility of the exporters that affect fixed cost of exporting. In addition, I used an indicator coded as 1 if the official language of the exporting country is English. Additionally, I include tariff rates as another control variable to address the potential issue of omitted variables that might affect fixed costs of entering the U.S. market. The linear demand system assumed by the theory has the property of incomplete pass-through of trade costs. The ad valorem tariff rate is constructed by using the calculated duties per value in the U.S. import dataset.

The second part of the empirical investigation focuses on the effects of cross-industry variation of the distance and remoteness on unit values. The model predicts that the magnitude of the effects of distance and remoteness varies depending on the industry-specific scope for quality differentiation. To capture this cross-industry variation of the effects, I examine the baseline regression with different sub-samples of industries – industries with more heterogeneous product quality and industries with more homogenous product quality. The quality industry indicator by Mandel (2010) serves as an indicator to distinguish between heterogeneous and homogenous quality industries.

Another empirical strategy for identifying this cross-industry variation is to use interaction terms for distance and remoteness with a proxy for industry-specific scope for quality differentiation. $QualityDiff_i$ term in (16) represents a proxy for scope for quality differentiation at an industry level i. The coefficient, δ_1, of the interaction term between $QualityDiff_i$ and $log(Remoteness_c)$ is expected to capture the extent to which the remoteness effect changes depending on the scope for quality differentiation and predicted to be negative in the model. The coefficient, δ_2, of the interaction term between $QualityDiff_i$ and $log(Distance_c)$ is expected to capture the extent to which the distance effect changes depending on the scope for quality differentiation and predicted to be positive in the model.

$$\begin{gathered} log(U_{pc}) = \alpha_p + \beta_1 log(Remoteness_c) + \beta_2 log(Distance_c) + Z\gamma \\ +\delta_1 \left[QualityDiff_i \times log(Remoteness_c)\right] + \delta_2 \left[QualityDiff_i \times log(Distance_c)\right] + \epsilon_{pc} \end{gathered} \tag{25}$$

For the proxy for scope for quality differentiation, $QualityDiff_i$, I make use of the quality ladder length by Khandelwal (2010). This continuous measurement is estimated at a HS 10-digit product level using U.S. import data; the longer the length, the greater the scope for quality differentiation.

5.1.2 Results

Table A4 reports the estimation result of equation (15). As shown in column (1), when all products are included in the sample, the coefficient for remoteness is significantly negative while the coefficient for distance is negative but statistically insignificant. This result is not consistent with either quality-sorting or efficiency-sorting case because a negative remoteness effect is predicted in a quality-sorting industry but a negative distance effect is predicted in an efficiency-sorting industry. This result may be attributed to a composition of various product categories in the highly-aggregated level of industry such that some product categories exhibit the characteristics of quality-sorting industry while some others exhibit the characteristics of efficiency-sorting industry.

To investigate more disaggregated industries, I selected manufacturing industries where quality differentiation is more relevant and divide them into 4 sub-categories according to the 1-digit Standard International Trade Classification (SITC1) code. Then, it is found that each of remoteness and distance effects differs in its magnitude and sign across industries. In column (2), the Chemicals (SITC1$=5$) industry significantly exhibits a negative remoteness effect and a positive distance effect, as predicted for a quality-sorting industry; a one standard deviation increase in remoteness is associated with a 0.17% decrease in unit values of exports on average, while a one standard deviation increase in distance is associated with a 0.2% increase in unit values of exports on average.

In column (4), the Machinery (SITC1$=7$) industry exhibits an insignificant remoteness effect and a significantly negative distance effect, as predicted for an efficiency-sorting industry; a one standard deviation increase in remoteness is associated with a 0.02% decrease in unit values of exports on average, but it is not statistically significant, while a one standard deviation increase in distance is associated with a 0.38% decrease in unit values of exports on average.

These two different cases in column (2) and (4) show that quality-sorting and efficiency-sorting models are applicable to more disaggregated product level markets than highly aggregated industry or sector level markets. In column (3) and (5), the results of the Manufactured Material (SITC1$=6$) and Miscellaneous Manufacturing (SITC1$=8$) industries are not consistent with the predictions of the model. Again, these results may be attributed to a composition between efficiency-sorting and quality-sorting industries within those SITC 1-digit industries.

However, the variation of the remoteness and distance effects across SITC 1-digit industry does not provide insight into what the source of variation is. To explore whether this variation is related to industry-specific degree of quality differentiation, I divided the sample into quality industries and cost industries according to classification by Mandel (2010). Mandel's indicator distinguishes quality industry, where quality differentiation is relatively more important and more closely associated with price dispersion, from cost industry, where products are relatively more homogenous in their quality. Using this indicator, I select two groups of industries and run the baseline regression (1) for each group and report the result in Table A5.

Column (1) in Table A5 reports the baseline regression result of the cost industries. The coefficient on remoteness is -.28 and significant at the 10% significance level, while the coefficient on distance is -.13 but statistically insignificant. Column (2) reports the corresponding regression results on the quality industries. The coefficient on remoteness is -.41 and significant at the 10% significance level, and the coefficient on distance is -.29 and also statistically significant. The fact that the remoteness effect turned out significantly negative for quality industries and its magnitude was greater than in cost industry supports the quality-sorting model.

Yet, the result that the remoteness effect is also negative in the cost industries and the distance effects are negative in both industries shows that the data are not fully consistent with the model's prediction. This lack of consistency with the model's prediction can be attributed to two aspects. One is that since the Mandel's indicator only specifies either cost industry or quality industry regardless of the degree of heterogeneity or homogeneity of product quality, it is hard to distinguish industries with large scope for quality differentiation using the indicator. Another possible reason for the indefinite result can be the distance variable. Even though the distance is an exogenous measurement to represent bilateral market access, it may not fully represent the degree of bilateral market access. To address this issue, transport cost data varying across countries and products will be exploited in the next section.

As another method for investigating the cross-industry variation of the effects of remoteness and distance on the export unit values, I employed Khandelwal's quality ladder length to form interaction terms with remoteness and distance. Table A6 reports the estimation result of equation (16). As shown in column (1), the remoteness effect is estimated as -.55, indicating that a one standard deviation of the remoteness (.25) induces on average a .14% decrease in the unit value of exports. However, opposite to the model's prediction, the coefficient on the interaction term of the scope for quality differentiation and the remoteness is positive, indicating that the negative remoteness effect decreases as the industry-specific scope for quality differentiation increases. The distance effect as well as its interaction with scope for quality differentiation is negative but not significant, while the model predicted that both would be positive.

In summary, this section investigates the effects of market access on the unit values of exports using distance as a measure of bilateral market access, and the effects varies significantly in its magnitude and signs as model's prediction. However, while the variation of remoteness effects is relatively consistent with the model's prediction, the variation of distance effect is somewhat discrepant with model's prediction. In the next section, I further investigate the effect of market access using transport costs as a measure of bilateral market access, addressing the outstanding issues in the current section.

5.2 Regressions with Transport Cost Data

5.2.1 Empirical Specification

The baseline empirical specification is as follows:

$$log(U_{pc}) = \alpha_p + \beta_1 log(Remoteness_c) + \beta_2 log(Transport\,cost_{pc}) + other\,controls + \epsilon_{pc} \quad (26)$$

The dependent variable is the unit value of HS10 digit product p shipped from country c. The explanatory variables of interest are the remoteness of the exporting country and the transport cost of each product and exporting country. Product fixed effects are included to control for unit difference across products and level difference in unit values. Robust standard errors are estimated by clustering products.

To control for other factors that affect export unit values, the same set of variables are included as in the previous section. These control variables include the log GDP per capita of exporting countries, the log GDP of exporting countries, an indicator coded as 1 if the country shares its border with the U.S., an indicator of 1 if the country is landlocked, an indicator coded as one if the official language of the exporting country is English, and ad valorem tariff calculated as duties per value from the U.S. import dataset.

However, there is a potential endogeneity issue with this specification due to the reverse causation from unit value to transport costs. The freight charge may increase with unit values because more expensive products pay higher insurance fees and require more handling or shipping, as Hummels and Skiba (2004) point out. Also, according to Harrigan (2010), higher value-per-weight goods are more likely to be shipped by air, which implies higher transport charges.

For these reasons, a high unit value may drive transport costs higher, resulting in biased estimates for transport costs effects on unit values. To address this issue, the transport charge is instrumented by two exogenous variables, namely, the distance between the exporting country and the destination market that is, the U.S., and the quantity of total exports of each product shipped from exporting countries, following Hummels and Skiba (2004).

These two variables are qualified as valid instruments for transport costs. The distance between two trading countries is one of the most critical exogenous determinants for transport costs, with the transport cost increasing with distance. The quantity of exports also affects transport costs due to product-specific shipping requirements or scale effects. According to Hummels and Skiba (2004), there are three possible examples of costs varying with shipment quantities: when shipments of certain products require a specific shipping technology such as refrigerated cargos; when larger shipments require less packaging and handling per unit; and when the shipping industry is not competitive due to a monopolized shipping industry that is engaged in a non-linear pricing scheme.

These two instrumental variables are strongly and directly correlated with transport costs and affect export prices only indirectly through the transport costs. Thus, these two instruments are excluded from the main specification, but only included in the first stage regression. Therefore, the first stage regression for transport costs can be written as a function of the distance between exporting and importing countries and the shipment quantities as in equation (18).

$$log(Transport\,cost_{pc}) = \alpha_p + \alpha_1 log(Quantity_{pc}) + \beta_2 log(Transport\,cost_{pc}) + other\,controls + \epsilon_{pc} \tag{27}$$

The error term represents measurement error and unobserved cost shift factors, including regulatory or technological factors specific to the product-country pair. To show the relevance and validity of the instrumental variables, I report results of identification and under-identification tests in the result section. Because I have two instrumental variables for one endogenous variable, an over-identification test result will also be reported.

The second part of the empirical investigation focuses on the cross-industry variation of the effects of transport cost and remoteness on unit values. The model predicts that the magnitude of the effects of transport costs and remoteness varies depending on the industry-specific scope for quality differentiation. To capture this cross-industry difference in remoteness and transport costs effects, I examine the baseline regression with instruments after dividing the industries into two – industries with more heterogeneous product quality and industries with more homogenous product quality – using the quality industry indicator by Mandel (2010).

Another empirical strategy to identify this cross-industry variation is to use interaction terms for transport costs and remoteness with an industry-specific scope for quality differentiation. The $QualityDiff_i$ term in (19) represents a proxy for scope for quality differentiation at an industry level i. The coefficient, δ_1, of the interaction term between $QualityDiff_i$ and $log(Remoteness_c)$ is expected to capture the extent to which the remoteness effect changes depending on the scope for quality differentiation and predicted to be negative in the model. The coefficient, δ_2, of the interaction term between $QualityDiff_i$ and $log(Transport\,costs_{pc})$ is expected to capture the extent to which the transport costs effect changes depending on the scope for quality differentiation and predicted to be positive in the model.

$$\begin{gathered} log(U_{pc}) = \alpha_p + \beta_1 log(Remoteness_c) + \beta_2 log(Transport\,cost_{pc}) + other\,controls \\ +\delta_1 \left[QualityDiff_i \times log(Remoteness_c)\right] + \delta_2 \left[QualityDiff_i \times log(Transport\,cost_{pc})\right] + \epsilon_{pc} \end{gathered} \tag{28}$$

In this estimation, transport costs are instrumented using distance and export quantity. The proxy for scope for quality differentiation used in this case is a continuous measure, the quality ladder length by Khandelwal (2010)

5.2.2 Results

The estimation result of equation (17) without using instrumental variables is reported in Table A7. Column (1) shows the OLS estimation result when all products are included in the sample. The remoteness effect is significantly negative and the transport costs effect is significantly positive, which is consistent with the prediction of the quality-sorting based model. The magnitude of remoteness effects is estimated to be approximately -.34 on average, suggesting that a one standard deviation increase in remoteness (.25) is associated with a .09% decrease in unit value of exports. The magnitude of transport cost effects is estimated to be approximately .55 on average, suggesting that a one standard deviation increase in transport costs (1.51) is associated with a .83% increase in unit value of exports.

This pattern is also confirmed in the more disaggregated level of the manufacturing industries, where quality differentiation is more relevant. When the sample is divided into SITC 1 digit levels from SITC 5 (Chemicals) to SITC 8 (Miscellaneous Manufactured goods), the coefficient for remoteness is significantly negative and that of transport costs is significantly positive, as shown in columns (2) to (5), even though their magnitude varies across industries. This cross-industry variation in magnitude is relatively stable compared to the large variation of those effects in the previous section with distance data. The positive coefficients for transport costs in the OLS model are supportive evidence for the quality-sorting mechanism. In contrast, the OLS model using distance data as a measure of bilateral market access in the previous section shows inconclusive evidence, with both positive and negative coefficients for distance across industries. These different results suggest that we can find more robust evidence of quality-sorting model by using transport cost data that varies in two dimensions - products and countries.

As a next step to address the potential endogeneity problem between transport costs and unit value of exports, I run IV regressions using total quantity of exports and distance as instrumental variables for transport costs. The result is reported in the Table A8. As shown in column (1), when all products are included in the sample, the magnitudes of the effects of transport costs in the OLS and IV estimation results are very different, implying that the OLS estimate may be biased due to the endogeneity between unit value and transport costs.

The IV estimation result suggests that the effect of transport cost on unit value was underestimated in OLS estimation due to the positive effect of unit value on transport costs. The coefficient for transport costs implies that a 10% increase in transport costs induces a 9% increase in unit value of exports. However, the OLS method estimated the correlation between transport costs and unit value of export as approximately .55, understating the causal effect of transport costs on unit value of exports.

More specifically, the OLS estimation result shows that a 10% increase in transport costs is correlated with a 5.5% increase in unit value of exports on average. However, approximately 4% of the increase in transport costs is reversely caused by the higher unit value of exports. Hence, only approximately 6% increase in transport costs induces the 5.5% increase in unit value of exports, so that the transport costs effect on the unit value is approximately 9%.

The transport cost effect turns out to be approximately .91, suggesting that a one standard deviation increase in transport costs (1.51) is associated with a 1.37% increase in unit value of exports on average. Also, the remoteness effect is estimated to be approximately -.23, suggesting that a one standard deviation increase in remoteness (.25) is associated with a .06% decrease in unit value of exports on average. Compared to the OLS estimation, the magnitude of the remoteness effect is lower in the IV estimation.

These patterns are also confirmed in the disaggregated groups of manufacturing industry at the SITC 1-digit level. As shown in columns (2) to (5), in each manufacturing industry the coefficient on remoteness is significantly negative and the coefficient on transport costs is significantly positive, even though their magnitudes vary across industries. This tendency of positive transport cost effects and negative remoteness effects across manufacturing industries are consistent with the prediction from the quality-sorting model.

Table A8 also provides evidence that the instrument variables are relevant and valid. The under-identification test statistics and p-values reject the null hypothesis that the equation is under-identified. This test indicates that the excluded instrumental variables – distance and export quantity – are relevant and correlated with the endogenous regressor, transport costs. Also, the weak identification test rejects the claim that excluded instruments are only weakly correlated with the endogenous regressor. These two tests verify the relevance of distance and export quantity as instruments for transport costs. The over-identification test result is also reported. For the major manufacturing sectors, Chemical, Manufacturing Materials, and Machinery industries, the test results show that the instruments are valid and uncorrelated with the error term, implying that these instruments are strongly valid for manufacturing industries.

Next, I further examine how the effects of transport costs and remoteness on the export price differ across industries depending on the industry-specific degree of quality differentiation. To keep the validity of instruments more strictly based on the over-identification test result, I limit the sample to the major manufacturing sectors; Chemical, Manufacturing Materials, and Machinery industries.

As proxies for industry level scope for quality differentiation, I make use of the following two measures: the indicator of quality industry and cost industry created by Mandel (2010) at a HS 6-digit code product level and the quality ladder length created by Khandelwal (2010) at a HS 10-digit code product level. Mandel's indicator distinguishes quality industry, where quality differentiation is relatively more important and more closely associated with price dispersion, from cost industry, where products are relatively more homogenous in quality. Using this property of the indicator, I run the baseline regression (1) for each group of these industries.

Table A9 reports the result of OLS and IV estimation for cost industries and quality industries classified by Mandel (2010). In the OLS estimation, as shown in columns (1) and (2), I find that the magnitudes of the effects of remoteness and transport cost are greater for quality industries than for cost industries, which is consistent with the model's prediction. However, the significantly negative remoteness effect and the significantly positive transport cost effects for cost industry seem to be not well explained by the quality-sorting model.

On the other hand, when the possible endogeneity issue of transport cost is taken into account using IV estimation, as shown in column (3) and (4), the remoteness effect for cost industries turned out to be insignificant, while for quality industries it is still significantly negative as the model predicts. This supports more strongly the model's prediction that the remoteness effect is negligible in an industry with homogenous product quality while the effect is significantly negative in an industry with heterogeneous product quality. The changes in the magnitude of the effects of transport costs from .66 and .73 in the OLS results to .94 and .97, respectively, in the IV results suggest that these effects were under-estimated by OLS estimation. In the IV estimation result, transport costs in quality industries is still larger than in cost industries in terms of magnitude showing supportive evidence for the model's prediction that transport cost effects increase with scope for quality differentiation.

However, the positive effects of transport costs in cost industries show the limited supportive evidence for the model because the transport costs effect is expected to be negative for industries with homogenous product quality.

Finally, I used the quality ladder length of Khandelwal (2010) at a HS 10-digit product level as a proxy for scope for quality differentiation and its result is reported in Table A10. The quality ladder length is a continuous measurement varies from zero to its maximum 5.8, with a mean of 1.7. As in equation (19), I form interaction terms of this product-specific measure with each of transport costs and remoteness. The coefficient of the interaction term with remoteness is expected to be negative, indicating that the negative remoteness effect is magnified as the scope for quality differentiation increases. The coefficient of the interaction term with transport costs is expected to be positive, indicating that the positive effect of transport costs is magnified as the scope for quality differentiation increases.

The result of OLS estimation reported in column (1) in Table A10 shows that the remoteness effect is significantly negative and the transport costs effect is significantly positive, which is consistent with the predictions of the quality-sorting model. A one standard deviation increase in remoteness (.25) is associated with a .07% decrease in unit value of exports on average, and a one standard deviation increase in transport costs (1.51) is associated with a 1% increase in unit value of exports on average.

The interaction of these effects with scope for quality differentiation shows quite limited results in terms of its magnitude and significance, even though the signs of both interaction effects turn out to be consistent with the quality sorting model's prediction. In IV estimation, the directions of the interaction effects are still consistent with the model's prediction, with a negative sign in the interaction term for remoteness and quality ladder length and a positive sign in the interaction term for transport costs and quality ladder length. As expected from the use of IV, the transport cost effect is estimated to be greater than in OLS estimation. A one standard deviation increase in transport costs (1.51) induces a 1.44% increase in unit value of exports on average. Also, the magnitudes of interaction effects are greater than for OLS estimation as expected even though their statistical significance is still weak.

The model with interaction terms using Khandelwal's measure does not result in clear and convincing values for interaction effects, in contrast to the previous estimation with the Mandel's industry dummy. This can be attributed to possible noise of the interaction terms of the continuous measure at very narrowly disaggregated product levels and transport costs at the product and country level. Also, the use of instrument variables for interaction terms may cause more complexity in estimation compared to the use of a dummy variable which essentially fits a separate regression for each subgroup. Further empirical investigation to identify the cross-industry variation associated with scope for quality differentiation will be a future work, and may lead to more robust results.

6 Concluding Remarks

This study explores how both the bilateral and multilateral market access of exporting countries influences their export prices. The effects of both types of market access on export prices is explored theoretically using the QHFT model with a four-country open economy and a selection mechanism through which high capability firms that produce high quality products at high prices are selected to enter foreign markets. The model shows that firms in countries with poor bilateral market access have greater difficulty exporting their products—due to high transport costs—and have higher average export prices than firms in countries with better bilateral market access. In contrast, firms in countries with poor multilateral market access find it easier to export to a specific destination market—since the labor costs in remote countries are lower—and their average export prices are lower than in countries with better multilateral market access. The model further predicts that the effects of market access on export prices vary depending on industry-specific scopes for quality differentiation.

Empirical investigation using product-level U.S. import data, with remoteness and transport costs employed as proxies for multilateral and bilateral market access, shows negative remoteness and positive transport cost effects on export unit values, which supports the QHFT model's prediction. Further investigation suggests that industry-specific scopes for quality differentiation are an important source of cross-industry variations in the magnitude of the effects of market access on export prices.

These findings support the predictions of the QHFT model that quality heterogeneity significantly influences the price of export products. The ability of the QHFT model to explain real-world empirical findings shows the great impact that quality differentiation has on the pricing of many export products. Findings of this study also broaden our understanding of how a country's market access, which is determined by its geographical location and efficiency of logistics, significantly affects its trading activities and thus is a critical determinant of its export performance in international trade.

Though these findings are important, this study has a few limitations for future studies to address. First, the empirical findings do not conclusively show a significant relationship between cross-industry variations in the effects of market access on export unit values and the scope for quality differentiation. One of the potential causes of this limitation may be attributed to the exceptional cases that were not perfectly excluded from the sample. As shown in the theoretical model, there can be some exceptional cases where the magnitude of the market access effects do not necessarily increase with the quality elasticity. Identifying these cases more thoroughly using relative size of wages and transport costs should improve this result. On the other hand, incoherence between the results produced using the two different proxies for the scope for quality differentiation, the quality ladder length by Khandelwal (2010) and the quality industry indicator by Mandel (2010), requires more rigorous analysis. Future efforts to address these limitations should include the use of other proxies for the scope for quality differentiation, such as industry-specific R&D intensity, and stricter treatment of data noise and proxy variables.

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Model Appendix

A.1 Efficiency-sorting Industry with Heterogeneous Quality

An industry with quality heterogeneity across firms and with its quality elasticity between 0 and 1 (or equivalently, $-1 < \theta < 0$) is called an efficiency-sorting industry with heterogeneous quality. In this type of industry, those firms that produce low product quality with high efficiency make greater profits and are more capable ones. Compared to the efficiency-sorting industries with homogeneous product quality, this industry is different from them since this industry does exhibits quality differentiation, even though they share the similarity in that high capability firms are those that produce at higher efficiency. Compared to the quality-sorting industries with heterogeneous product quality, this industry differs from them since firms producing lower quality is more capable ones while firms producing higher quality is more capable ones in the quality-sorting industries. Literature on HFT and QHFT models consider the other two cases above more relevant to the real world examples based on the recent empirical findings. However, since this case with $-1 < \theta < 0$ is also worth to consider, I add this case in the appendix.

A.1.1 Closed Economy

When $-1 < \theta < 0$, each firm produces its product quality represented by $z_i = c_i^{1+\theta}$, and the product quality does not elastically respond to an increase in unit labor requirement c_i. Unlike the second case with $\theta > 0$, the effective cost producing one unit of quality, $wc_i^{-\theta}$ increases with c_i. For a given θ, those firms with a smaller c_i, producing lower product quality with higher efficiency, are more capable. In this type of industry, firms' capability is sorted by efficiency, thus, this industry is called 'efficiency-sorting industry' with heterogeneous product quality.

In this case, $z_i = c_i^{1+\theta}$, quality increases inelastically with respect to an increase in unit labor requirement. Firms' profit maximization problem and the performance functions including optimal quantity, price, revenue, and profit functions are the same as in the cases where $\theta > 0$, but the survival condition will be the opposite, $c_i \leq c_D$.

$$q(c_i) = \frac{wL}{2\gamma c_i^{1+\theta}} \left[c_D^{-\theta} - c_i^{-\theta}\right], \, c_i \leq c_D, \, -1 < \theta < 0 \tag{29}$$

$$p(c_i) = \frac{wc_i^{1+\theta}}{2} \left[c_D^{-\theta} + c_i^{-\theta}\right], \, c_i \leq c_D, \, -1 < \theta < 0 \tag{30}$$

$$r(c_i) = \frac{w^2 L}{4\gamma} \left[c_D^{-2\theta} - c_i^{-2\theta}\right], \, c_i \leq c_D, \, -1 < \theta < 0 \tag{31}$$

$$\pi(c_i) = \frac{w^2 L}{4\gamma} \left[c_D^{-\theta} - c_i^{-\theta}\right]^2, \, c_i \leq c_D, \, -1 < \theta < 0 \tag{32}$$

In this case, the optimal quality-adjusted price, $\frac{p_i}{z_i} \equiv \frac{p_i}{c_i^{1+\theta}}$, increases with c_i, and firms' revenue and profit decrease with c_i as shown in $\frac{\partial r(c_i)}{\partial c_i} < 0$ and $\frac{\partial \pi(c_i)}{\partial c_i} < 0$. Thus, high capability firms producing higher product quality gain lower operating revenue and profit. Thus, the case where $-1 < \theta < 0$ yields different properties than the case where $\theta > 0$ even though both cases exhibit quality heterogeneity across firms.

When a firm enters the industry, it randomly draws its c_i from a distribution function $G(c_i)$ on the support of $[0, c_M]$. Since firms are sorted by their efficiency such that firms with lower c_i earns higher profits, the distribution is reasonably assumed to be the same as in the efficiency-sorting industry with homogeneous product quality: $G(c_i) = \left(\frac{c_i}{c_M}\right)^\alpha$. When $\alpha = 1$, the distribution of c_i is uniform, but as α increases, the the distribution of c_i is more concentrated at higher levels of c_i. To learn their own unit labor requirement, firms must pay a fixed sunk entry cost, f_e. Thus, only those firms satisfying the survival condition, $c_i \leq c_D$, can profitably operate, and all other firms exit immediately. In the industry equilibrium, the free entry condition becomes as follows:

$$E(\pi) = \int_0^{c_D} \pi(c_i) dG(c_i) = \frac{w^2 L}{4\gamma} \int_0^{c_D} \left[c_D^{-\theta} - c_i^{-\theta}\right]^2 dG(c_i) = f_e \tag{33}$$

The free entry condition and the survival condition pin down the cut-off level of the c_D.[28]

The output-weighted average price is as follows:

$$\bar{P} = \int_0^{c_D} \omega_i p_i dG(c_i) = \frac{\int r_i dG(c_i)}{\int q_i dG(c_i)} \equiv \frac{R}{Q} \tag{34}$$

where R and Q are the industry total revenue and quantity respectively and ω_i denotes the share of quantity of products.

A.1.2 Open Economy

In a efficiency-sorting industry with $-1 < \theta < 0$, product quality is heterogeneous across firms with $z_i = c_i^{1+\theta}$. In this type of industry, as in the quality-sorting industry with $\theta > 0$, the demand for a firm i's exports will be $q_X^{od} = \frac{L}{z\gamma}\left[\hat{P}^d - \frac{p_X^{od}}{z}\right]$ where $\hat{P}^d$ is the quality-adjusted choke price in the destination market d and its exporting profit becomes $\pi_X^{od} = \left[p_X^{od} - w^o \tau^{od} c_i\right] q_X^{od}$. From the zero profit conditions, the choke price of the destination country relates the origin country's exporting cut-off and the destination country's domestic cut-off as follows: $\hat{P}^d = w^d \frac{c_D^d}{z_D} = w^o \tau^{od} \frac{c_X^{od}}{z_X}$, which becomes $\hat{P}^d = w^d \left(c_D^d\right)^{-\theta} = w^o \tau^{od} \left(c_X^{od}\right)^{-\theta}$. Then, c_X^{od}, the cut-off above which firms in country o cannot profitably export to country d, can be expressed in terms of c_D^d, the cut-off above which domestic firms in country d cannot profitably operate in their

[28] Refer to Model Appendix A.2.3 for solutions.

domestic market d as follows: $c_X^{od} = \left[\frac{w^o\tau^{od}}{w^d}\right]^{1/\theta} c_D^d$.

Performance functions of a firm of a country o in an export market d are also the same as the quality-sorting industry with $\theta > 0$, however, the difference is that exporting cut-off condition is $c_i \leq c_X$, where firms that can profitably export are those with their c_i lower than a certain cut-off c_X and producing lower quality with higher efficiency. The profit maximizing export output, c.i.f. pricing rule, f.o.b pricing rule, exporting revenue, revenue based on the f.o.b price, and profit functions are as follows:

$$p_X^{od} = \frac{1}{2}w^o\tau^{od}c^{1+\theta}\left[\left(c_X^{od}\right)^{-\theta} + c_i^{-\theta}\right];\ p_{Xfob}^{od} = \frac{1}{2}w^o c^{1+\theta}\left[\left(c_X^{od}\right)^{-\theta} + c_i^{-\theta}\right]$$

$$q_X^{od} = \frac{L}{2\gamma c_i^{1+\theta}}w^o\tau^{od}\left[\left(c_X^{od}\right)^{-\theta} - c_i^{-\theta}\right];\ r_X^{od} = \frac{L}{4\gamma}\left(w^o\tau^{od}\right)^2\left[\left(c_X^{od}\right)^{-2\theta} - c_i^{-2\theta}\right]$$

$$r_{Xfob}^{od} = \frac{L}{4\gamma}(w^o)^2\tau^{od}\left[\left(c_X^{od}\right)^{-2\theta} - c_i^{-2\theta}\right];\ \pi_X^{od} = \frac{L}{4\gamma}\left(w^o\tau^{od}\right)^2\left[\left(c_X^{od}\right)^{-\theta} - c_i^{-\theta}\right]^2$$

For a firm in each country, its domestic profit is $\pi_D^o(k) = \frac{(w^o)^2 L}{4\gamma}\left[\left(c_D^o\right)^{-\theta} - c_i^{-\theta}\right]^2$ and its exporting profit is $\pi_X^{od}(k) = \frac{L}{4\gamma}\left(w^o\tau^{od}\right)^2\left[\left(c_X^{od}\right)^{-\theta} - c_i^{-\theta}\right]^2$. Each country has its own free entry condition in a form of $\int_0^{c_D^o}\pi_D^o(c_i)dG(c_i) + \sum_{d\neq o}\int_0^{c_X^{od}}\pi_X^{od}(c_i)dG(c_i) = f_e$ where $o = A, B, C, D$ and $d \neq o$. Solving these four free entry conditions using the cut-off conditions yields the domestic cut-offs of the four countries, c_D^A, c_D^B, c_D^C, and c_D^D, below which firms cannot operate profitably in each country.[29]

Due to the symmetry, domestic cut-offs in the central countries are identical ,$c_D^{central} \equiv c_D^B = c_D^C$, and those in the remote countries are identical, $c_D^{remote} \equiv c_D^A = c_D^D$.[30]

[29] When a firm enters the industry, it randomly draws its c_i from a distribution function $G(c_i)$ on the support of $[0, c_M]$. Since firms are sorted by their efficiency such that firms with lower c_i earns higher profits, the distribution is reasonably assumed to be the same as in the efficiency-sorting industry with homogeneous product quality: $G(c_i) = \left(\frac{c_i}{c_M}\right)^{\alpha}$.

[30] Refer to Model Appendix A.2.3 for solutions.

Consider one case where the central country B imports from the other three exporting countries, A, C, and D. For a given domestic threshold c_D^B in B, the exporting countries face different exporting cut-offs as follows:

The exporting cut-off of remote country A to B:	$c_X^{AB} = \left(\frac{\tau_1}{w}\right)^{1/\theta} c_D^B$
The exporting cut-off of central country C to B:	$c_X^{CB} = (\tau_1)^{1/\theta} c_D^B$
The exporting cut-off of remote country D to B:	$c_X^{DB} = \left(\frac{\tau_3}{w}\right)^{1/\theta} c_D^B$

When comparing country A and C, the remote county A has an advantage of lower wage relative to its competing central country C in the same market B. Noting that $-1 < \theta < 0$, therefore, for the same central destination market, firms in the remote country A face a relatively higher cut-off level of unit labor requirement c_i (less competition to export) than firms in the central country, $c_X^{AB} > c_X^{CB}$. On the other hand, when comparing A and D, the county A has an advantage of lower transport costs relative to its competing country D in the same market B. Therefore, for the same central destination market, firms in the proximate country A face a relatively higher cut-off level of unit labor requirement c_i (less competition to export) than firms in the distant country, $c_X^{AB} > c_X^{DB}$.

Output-Weighted Average F.O.B. Export Prices

The output-weighted average f.o.b. exports price can be calculated as the industry's total exporting revenue, calculated with f.o.b. export prices, divided by the industry's total exports as follows:

$$\bar{P}_{Xfob}^{od} = \int_0^{c_X^{od}} \omega_X^{od} p_{Xfob}^{od} dG(k_i) = \frac{\int r_{Xfob}^{od} dG(k_i)}{\int q_X^{od} dG(k_i)} \equiv \frac{R_X^{od}}{Q_X^{od}} \tag{35}$$

where R_X^{od} and Q_X^{od} are the total exporting revenue and quantity from an origin country o ($o = A, C, D$) to the destination d ($d = B$), respectively, and $\omega_X^{od} \equiv \frac{q_X^{od}}{\int q_X^{od} g(k_i) dk_i} \equiv \frac{q_X^{od}}{Q_X^{od}}$ is the share of quantity of exports of an exporting firm relative to the total exports of the industry. In the efficiency-sorting industry with heterogeneous product quality, as in the quality-sorting industry with heterogeneous product quality, the output-weighted average f.o.b. export price depends on the quality elasticity (θ) as well as the exporting cut-off (c_X^{od}), the wage level (w^o) of the exporting county, and the shape parameter of the Pareto distribution (α) as follows.

$$\bar{P}_{Xfob}^{od} = \frac{R_X^{od}}{Q_X^{od}} = \xi_2(\alpha, \theta) w^o c_X^{od} \tag{36}$$

where $\xi_2(\alpha, \theta) \equiv \frac{(\alpha-\theta-1)(\alpha-2\theta-1)}{\alpha(\alpha-2\theta)}$. Using the export cut-off in each country, c_X^{AB}, c_X^{CB}, and c_X^{DB}, the output-weighted average f.o.b. export prices of country A, C and D to the central destination market B are expressed as follows:

$$\bar{P}_{Xfob}^{AB} = \xi_2(\alpha, \theta) c_X^{AB} = \xi_2(\alpha, \theta) \left(\frac{\tau_1}{w}\right)^{1/\theta} c_D^B$$

$$\bar{P}_{Xfob}^{CB} = \xi_2(\alpha, \theta) w c_X^{CB} = \xi_2(\alpha, \theta) w \left(\tau_1\right)^{1/\theta} c_D^B$$

$$\bar{P}_{Xfob}^{DB} = \xi_2(\alpha, \theta) c_X^{DB} = \xi_2(\alpha, \theta) \left(\frac{\tau_3}{w}\right)^{1/\theta} c_D^B$$

By comparing $\bar{P}_{Xfob}^{AB}$ and $\bar{P}_{Xfob}^{CB}$, we can find that average f.o.b. export price of the remote country A, $\bar{P}_{Xfob}^{AB}$, is higher than that of the central country C, $\bar{P}_{Xfob}^{CB}$:[31]

$$\bar{P}_{Xfob}^{AB} > \bar{P}_{Xfob}^{CB}$$

[31] Refer to Model Appendix A.2.3 for details.

Since the exporting cut-off of country A, c_X^{AB}, is higher than in central country C due to lower relative wage in the remote country A, export participation is less selective in country A. This selection leads more inefficient firms, with higher $c_i$with higher price to export from A to B, resulting in the export price of remote country, $\bar{P}_{Xfob}^{AB}$ to be higher than that of central country in the same market B, $\bar{P}_{Xfob}^{CB}$. This result tells us that the output-weighted average f.o.b. export price from a remote country is observed to be higher than that of a central country when the industry is engaged in quality differentiation but more capable firms are those that produce lower product quality at a lower marginal cost and charge lower prices.

On the other hand, a distance effect on the average export prices can be found from a comparison between $\bar{P}_{Xfob}^{AB}$ and $\bar{P}_{Xfob}^{DB}$. The higher transport costs for country D ($\tau_3 > \tau_1$) causes the export threshold to be lower in country D than in A ($c_X^{AB} > c_X^{DB}$). Therefore,

$$\bar{P}_{Xfob}^{AB} > \bar{P}_{Xfob}^{DB}$$

This result is caused by the selection channel because a higher transport cost for the distant country D lowers the exporting threshold. Thus, only high capability firms that produce low product quality at a lower marginal costs with charging low prices are able to export for the same destination country, resulting in the lower average price of exports from the more distant country D.

A.2 Solutions of Cut-offs

A.2.1 Efficiency-sorting Industry with Homogenous Product Quality

When $\theta = -1$;

- **Closed Economy:**

By solving the free entry condition, $E(\pi) = \int_0^{c_D} \pi(c_i) dG(c_i) = \frac{w^2 L}{4\gamma} \int_0^{c_D} \left[c_D - c_i\right]^2 dG(c_i) = f_e$ where $G(c_i) = \left(\frac{c_i}{c_M}\right)^{\alpha}$, $c_i \in [0, c_M]$, for c_D, the cut-off value is given as follows: $c_D = \left[\frac{2\gamma(\alpha+1)(\alpha+2)c_M^{\alpha} f_e}{w^2 L}\right]^{1/(\alpha+2)}$ for $\theta = -1$

- **Open Economy:**

By solving four free entry conditions, $\int_0^{c_D^o} \pi_D^o(c_i) dG(c_i) + \sum_{d \neq o} \int_0^{c_X^{od}} \pi_X^{od}(c_i) dG(c_i) = f_e$, where $o = A, B, C, D$ and $d \neq o$ with Pareto distribution, $G(c_i) = \left(\frac{c_i}{c_M}\right)^{\alpha}$, $c_i \in [0, c_M]$, for c_D^o, the domestic cut-offs for four countries are given as follows:

$$c_D^A = c_D^D = c_D^{remote} = \left[\frac{\tau_1^{\alpha}\tau_2^{\alpha}\tau_3^{\alpha}\left(\tau_2^{\alpha}(1+\tau_1^{\alpha}) - w^{\alpha}(\tau_2^{\alpha}+\tau_1^{\alpha})\right)}{\tau_1^{\alpha}\tau_2^{2\alpha}\left(1+\tau_1^{\alpha}\right)+\left(-\tau_1^{2\alpha}+\left(\tau_1^{2\alpha}+\tau_1^{\alpha}-1\right)\tau_2^{2\alpha}\right)\tau_3^{\alpha}-2(\tau_1\tau_2\tau_3)^{\alpha}}\frac{\gamma}{L}\phi\right]^{1/(\alpha+2)}$$

$$c_D^B = c_D^C = c_D^{central} = \frac{1}{w}\left[\frac{\tau_1^{\alpha}\tau_2^{\alpha}\left(w^{\alpha}(\tau_1^{\alpha}\tau_2^{\alpha})(1+\tau_3^{\alpha}) - \tau_3^{\alpha}(\tau_1^{\alpha}+\tau_2^{\alpha})\right)}{\tau_1^{\alpha}\tau_2^{2\alpha}\left(1+\tau_1^{\alpha}\right)+\left(-\tau_1^{2\alpha}+\left(\tau_1^{2\alpha}+\tau_1^{\alpha}-1\right)\tau_2^{2\alpha}\right)\tau_3^{\alpha}-2(\tau_1\tau_2\tau_3)^{\alpha}}\frac{\gamma}{L}\phi\right]^{1/(\alpha+2)}$$

where $\phi = (\alpha+1)(\alpha+2)c_M^{\alpha} f_e$ for $\theta = -1$.

A.2.2 Quality-sorting Industry with Heterogeneous Product Quality

When $\theta > 0$;

- **Closed Economy:**

To solve the following free entry condition simply,

$E(\pi) = \int_{c_D}^{\infty} \pi(c_i) dG(c_i) = \frac{w^2 L}{4\gamma} \int_{c_D}^{\infty} \left[c_D^{-\theta} - c_i^{-\theta}\right]^2 dG(c_i) = f_e$ where $G(c_i) = 1 - \left(\frac{c_L}{c_i}\right)^{\alpha}$, $c_i \in [c_L, \infty)$, c_i^{-1} is replaced with k_i. Then the equation and the distribution function are inversed as follows: $E(\pi) = \int_0^{k_D} \pi(k_i) dG(k_i) = \frac{w^2 L}{4\gamma} \int_0^{k_D} \left[k_D^{\theta} - k_i^{\theta}\right]^2 dG(k_i) = f_e$ where $G(k_i) = \left(\frac{k_i}{k_M}\right)^{\alpha}$, $k_i \in [0, .k_M]$ and $k_M = 1/c_L$. The solution of the free entry condition is given as

$k_D = \left[\frac{2\gamma(a+2\theta)(a+\theta)}{\theta^2 w^2 L} k_M^{\alpha} f_e\right]^{1/(\alpha+2\theta)}$ for $\theta > 0$; therefore, $c_D = \left[\frac{2\gamma(a+2\theta)(a+\theta)}{\theta^2 w^2 L} c_L^{-\alpha} f_e\right]^{-1/(\alpha+2\theta)}$ for $\theta > 0$.

- **Open Economy:**

To solve the following free entry condition simply, $\int_{c_D^o}^{\infty} \pi_D^o(c_i)dG(c_i)+\sum_{d\neq o}\int_{c_X^{od}}^{\infty} \pi_X^{od}(c_i)dG(c_i) = f_e$ where $o = A, B, C, D$ and $d \neq o$ with $G(c_i) = 1-\left(\frac{c_L}{c_i}\right)^{\alpha}$, $c_i \in [c_L, \infty)$, c_i^{-1} is replaced with k_i. Then the equations and the distribution function are transformed as follows: $E(\pi) = \int_0^{k_D^o} \pi_D^o(k_i)dG(k_i) + \int_0^{k_X^{od}} \pi_X^{od}(k_i)dG(k_i) = \frac{w^2 L}{4\gamma}\int_0^{k_D^o}\left[k_D^{\theta} - k_i^{\theta}\right]^2 dG(k_i) + \frac{L}{4\gamma}\left(w^o\tau^{od}\right)^2\int_0^{k_X^{od}}\left[\left(k_X^{od}\right)^{\theta} - k_i^{\theta}\right]^2 dG(k_i) = f_e$ where $G(k_i) = \left(\frac{k_i}{k_M}\right)^{\alpha}$, $k_i \in [0, .k_M]$ and $k_M = 1/c_L$. Solving these four free entry conditions using the cut-off conditions yields the domestic cut-offs of the four countries, c_D^A, c_D^B, c_D^C, and c_D^D, for $\theta > 0$.

$$c_D^A = c_D^D = c_D^{remote}$$
$$= \left[\frac{(\tau_1^n+\tau_2^n)\tau_3^n((1/(\tau_1 w))^n+(1/(\tau_2 w))^n)w^n-(1+\tau_1^n)\tau_2^n(1+\tau_3^n)}{\tau_3^n((\tau_1^n+\tau_2^n)w^n-(1+\tau_1^n)\tau_2^n)}\frac{\theta^2 L c_M^{\alpha} f_e}{2\gamma(\alpha+\theta)(\alpha+2\theta)}\right]^{\frac{1}{\alpha+2\theta}}$$
$$c_D^B = c_D^C = c_D^{central}$$
$$= \left[\frac{w^2((\tau_1^n+\tau_2^n)\tau_3^n((1/(\tau_1 w))^n-(1+\tau_1^n)\tau_2^n(1+\tau_3^n)-(1/(\tau_2 w))^n)w^n))}{\tau_1^n\tau_2^n(-1+\tau_3^n(-1+(1/(\tau_1 w))^n+(1/(\tau_2 w))^n)}\frac{\theta^2 L c_M^{\alpha} f_e}{2\gamma(\alpha+\theta)(\alpha+2\theta)}\right]^{\frac{1}{\alpha+2\theta}}$$

where $n \equiv \frac{\alpha}{\theta}$

A.2.3 Efficiency-sorting Industry with Heterogeneous Product Quality When $-1 < \theta < 0$;

- **Closed Economy:**

To solve the following free entry condition simply, $-\theta$ is replaced with ς. Then, $E(\pi) = \int_0^{c_D} \pi(c_i)dG(c_i) = \frac{w^2 L}{4\gamma}\int_0^{c_D}\left[c_D^{\varsigma} - c_i^{\varsigma}\right]^2 dG(c_i) = f_e$ where $G(c_i) = \left(\frac{c_i}{c_M}\right)^{\alpha}$, $c_i \in [0, c_M]$. By solving the free entry condition, $c_D = \left[\frac{2\gamma(a+2\varsigma)(a+\varsigma)}{\varsigma^2 w^2 L} c_M^{\alpha} f_e\right]^{1/(\alpha+2\varsigma)} = \left[\frac{2\gamma(a-2\theta)(a-\theta)}{\theta^2 w^2 L} c_M^{\alpha} f_e\right]^{1/(\alpha-2\theta)}$ for $-1 < \theta < 0$.

- **Open Economy:**

To solve the following free entry condition simply, $\int_0^{c_D^o} \pi_D^o(c_i)dG(c_i)+\sum_{d\neq o}\int_0^{c_X^{od}} \pi_X^{od}(c_i)dG(c_i) = f_e$ where $o = A, B, C, D$ and $d \neq o$ with $G(c_i) = \left(\frac{c_i}{c_M}\right)^\alpha$, $c_i \in [0, c_M]$, $-\theta$ is replaced with ς. Then, the equations and the distribution function are Using the conditions that limit the potential value of these parameters, there can be six different cases that can be considered.transformed as follows: $E(\pi) = \int_0^{c_D^o} \pi_D^o(c_i)dG(c_i) + \sum_{d\neq o}\int_0^{c_X^{od}} \pi_X^{od}(c_i)dG(c_i) = \frac{w^2L}{4\gamma}\int_0^{c_D}\left[c_D^\varsigma - c_i^\varsigma\right]^2 dG(c_i) + \frac{L}{4\gamma}\left(w^o\tau^{od}\right)^2\int_0^{c_X^{od}}\left[(c_X^{od})^\varsigma - c_i^\varsigma\right]^2 dG(c_i) = f_e$. Solving these four free entry conditions using the cut-off conditions yields the domestic cut-offs of the four countries, c_D^A, c_D^B, c_D^C, and c_D^D, for $-1 < \theta < 0$.

$$\begin{aligned} c_D^A = c_D^D &= c_D^{remote} \\ &= \left[\frac{(\tau_1^n+\tau_2^n)\tau_3^n((1/(\tau_1 w))^n+(1/(\tau_2 w))^n)w^n-(1+\tau_1^n)\tau_2^n(1+\tau_3^n)}{\tau_3^n((\tau_1^n+\tau_2^n)w^n-(1+\tau_1^n)\tau_2^n)}\frac{\theta^2 Lc_M^\alpha f_e}{2\gamma(\alpha-\theta)(\alpha-2\theta)}\right]^{\frac{1}{\alpha-2\theta}} \\ c_D^B = c_D^C &= c_D^{central} \\ &= \left[\frac{w^2((\tau_1^n+\tau_2^n)\tau_3^n((1/(\tau_1 w))^n-(1+\tau_1^n)\tau_2^n(1+\tau_3^n)-(1/(\tau_2 w))^n)w^n))}{\tau_1^n\tau_2^n(-1+\tau_3^n(-1+(1/(\tau_1 w))^n+(1/(\tau_2 w))^n)}\frac{\theta^2 Lc_M^\alpha f_e}{2\gamma(\alpha-\theta)(\alpha-2\theta)}\right]^{\frac{1}{\alpha-2\theta}} \end{aligned}$$

where $n \equiv -\frac{\alpha}{\theta}$

- **Comparison between $\bar{P}_{Xfob}^{AB}$ and $\bar{P}_{Xfob}^{CB}$**

To compare $\bar{P}_{Xfob}^{AB}$ and $\bar{P}_{Xfob}^{CB}$, $\frac{\bar{P}_{Xfob}^{AB}}{\bar{P}_{Xfob}^{CB}} = \frac{\xi_2(\alpha,\theta)\left(\frac{\tau_1}{w}\right)^{1/\theta}c_D^B}{\xi_2(\alpha,\theta)w(\tau_1)^{1/\theta}c_D^B} = w^{-(1+\frac{1}{\theta})}$. Since $-1 < \theta < 0$ and $w > 1$, $\frac{\bar{P}_{Xfob}^{AB}}{\bar{P}_{Xfob}^{CB}} = w^{-(1+\frac{1}{\theta})} > 1$. Therefore, $\bar{P}_{Xfob}^{AB} > \bar{P}_{Xfob}^{CB}$.

- **Comparison between $\bar{P}_{Xfob}^{AB}$ and $\bar{P}_{Xfob}^{DB}$**

To compare $\bar{P}_{Xfob}^{AB}$ and $\bar{P}_{Xfob}^{DB}$, $\frac{\bar{P}_{Xfob}^{AB}}{\bar{P}_{Xfob}^{DB}} = \frac{\xi_2(\alpha,\theta)\left(\frac{\tau_1}{w}\right)^{1/\theta}c_D^B}{\xi_2(\alpha,\theta)\left(\frac{\tau_3}{w}\right)^{1/\theta}c_D^B} = \left(\frac{\tau_1}{\tau_3}\right)^{1/\theta} > 1$ since $-1 < \theta < 0$ and $\frac{\tau_1}{\tau_3} < 1$. Therefore, $\bar{P}_{Xfob}^{AB} > \bar{P}_{Xfob}^{DB}$.

A.3 Effects of Market Access on Export Prices and θ

First, the comparative statics of the export prices with respect to wage and θ is given as follows;

$$\frac{\partial \bar{P}^{od}_{Xfob}}{\partial w \partial \theta} = \xi_\theta(\alpha, \theta)\frac{\partial c^{od}_X}{\partial w} + \xi(\alpha, \theta)\frac{\partial c^{od}_X}{\partial w \partial \theta} \tag{37}$$

Based on this comparative statics, the export prices from the remote exporting country A yields the following result;

$$\frac{\partial \bar{P}^{AB}_{Xfob}}{\partial w \partial \theta} = \frac{1}{\alpha}\left(\frac{\tau_1}{w^{1+\theta}}\right)^{1/\theta}\left[\frac{(1+\alpha+\theta)(1+\alpha+2\theta)ln(\frac{\tau_1}{w})}{\theta^2(\alpha+\theta)} + \frac{2+\alpha}{(\alpha+2\theta)^2} - 1\right] c^B_D \tag{38}$$

Second, the comparative statics of the export prices with respect to transport costs and θ is given as follows;

$$\frac{\partial \bar{P}^{od}_{Xfob}}{\partial \tau \partial \theta} = \xi_\theta(\alpha, \theta)\frac{\partial c^{od}_X}{\partial \tau} + \xi(\alpha, \theta)\frac{\partial c^{od}_X}{\partial \tau \partial \theta} \tag{39}$$

Based on this comparative statics, the export prices from the remote exporting country A yields the following result;

$$\frac{\partial \bar{P}^{DB}_{Xfob}}{\partial \tau \partial \theta} = \frac{1}{\alpha\theta^2}\left(\frac{\tau_3^{\theta-1}}{w}\right)^{1/\theta}\left[\frac{(1+\alpha+\theta)(1+\alpha+2\theta)(\theta+ln(\frac{\tau_3}{w}))}{\alpha+2\theta} - \theta^2\left(1-\frac{2+\alpha}{(\alpha+2\theta)^2}\right)\right] c^B_D \tag{40}$$

Each of these two expressions may have either negative or positive values depending on the value of θ, α, and τ/w.

$$\frac{\partial \bar{P}^{AB}_{Xfob}}{\partial w \partial \theta}\begin{cases} > 0 \; if \quad ln(\frac{\tau_1}{w}) > \Theta \\ < 0 \; if \quad ln(\frac{\tau_1}{w}) < \Theta \end{cases}$$

$where\,\Theta \equiv \frac{\theta^2(4\theta^2+4\alpha\theta+\alpha(\alpha-1)-2)}{(1+\alpha+\theta)(\alpha+2\theta)(1+\alpha+2\theta)}$

$$\frac{\partial \bar{P}^{DB}_{Xfob}}{\partial\tau\partial\theta}\begin{cases} >0\ if \quad ln(\frac{\tau_3}{w}) > \Lambda \\ \\ <0\ if \quad ln(\frac{\tau_3}{w}) < \Lambda \end{cases}$$

$where\,\Lambda \equiv \frac{\theta(-4\theta(\alpha+1)^2-2\theta^2(2\alpha+3)-\alpha(\alpha+1)^2)}{(1+\alpha+\theta)(\alpha+2\theta)(1+\alpha+2\theta)}$

Since $ln(\frac{\tau_3}{w}) > ln(\frac{\tau_1}{w})$ ($\because \tau_3 > \tau_1$) and $\Theta > \Lambda$ ($\because \Theta - \Lambda = \theta > 0$), the conditions above can be specified in the following six cases.

		$\frac{\partial \bar{P}^{AB}_{Xfob}}{\partial w\partial\theta}$	$\frac{\partial \bar{P}^{DB}_{Xfob}}{\partial\tau\partial\theta}$
1	$ln(\frac{\tau_3}{w}) > ln(\frac{\tau_1}{w}) > \Theta > \Lambda$	+	+
2	$ln(\frac{\tau_3}{w}) > \Theta > ln(\frac{\tau_1}{w}) > \Lambda$	-	+
3	$\Theta > ln(\frac{\tau_3}{w}) > ln(\frac{\tau_1}{w}) > \Lambda$	-	+
4	$ln(\frac{\tau_3}{w}) > \Theta > \Lambda > ln(\frac{\tau_1}{w})$	-	+
5	$\Theta > ln(\frac{\tau_3}{w}) > \Lambda > ln(\frac{\tau_1}{w})$	-	+
6	$\Theta > \Lambda > ln(\frac{\tau_3}{w}) > ln(\frac{\tau_1}{w})$	-	-

Additionally, it is evident that $\Theta > 0$ and $\Lambda < 0$ since $\alpha \geq 1$ and $\theta > 0$. Case 1 represents a case where the lowest transport costs are even larger than the relative wage, and case 6 represents a case where the relative wage is even larger than the highest transports costs. These two cases can be considered as extreme cases. Thus, except for these two cases, in most cases, the comparative statics show that the negative remoteness effects increase with θ, and the positive transport cost effects increase with θ. As a result, the magnitude of remoteness effects and transport cost effects are expected to increase with the degree of quality differentiation, θ.

A.4 Proxies for the Scope for Quality Differentiation

A.4.1 The Quality Ladder Length

The quality ladder length by Khandelwal (2010) measures the scope of quality differentiation for different product categories based on the methodology of a nested logit demand system by Berry (1994); $ln(s_{cht})\text{-}ln(s_{0t}) = \lambda_{ch} + \lambda_{2t} + \alpha p_{cht} + ln(ns_{cht}) + lnpop_{ct} + \lambda_{3,cht}$ where s_{cht} is variety ch's overall market share and ns_{cht} is its market share within product category h, which is considered as a nest. Product quality is defined with three components: $\lambda = \lambda_{ch} + \lambda_{2t} + \lambda_{3,cht}$, a time-invariant component (λ_{ch}), a common quality component (λ_{2t}), and an unobserved component ($\lambda_{3,cht}$). He estimates the product quality λ by using U.S. import data that provides information on price and market share of imports at a very narrowly-defined product level, HS 10-digit product codes, based on the identification methodology by Berry, Levinsohn, and Pakes (1995). The difference between maximum and minimum of quality within each product category, $\lambda_{max} - \lambda_{min}$, is defined as the quality ladder length. The estimates range from 0 to 5.8. Some examples of HS 10-digit product categories with their quality ladder length estimates are presented in Table A..4.1.

A.4.2 The Quality Industry Indicator

Mandel (2010) estimates the scope of quality differentiation measures by using price distribution within HS 6-digit code product categories with transaction-level U.S. import data from International Price Program. Controlling for other factors affecting the price distribution within product categories, he utilizes skewness of price distribution to identify whether an industry's scope for quality differentiation is low or high. Based on the idea that, within a given industry, more productive exporting

Table A.4.1. Examples of Products with their Quality Ladder Length

HS 10 code	The Quality Ladder Length	Product Description
7211292090	.572	Flat-rolled products of iron or nonalloy steel, width of less than 300 mm, not clad, plated or coated, thickness exceeding 0.25 mm
5208592025	2.313	Woven fabrics of cotton, containing 85 % or more by weight of cotton, weighing not more than 200 g/m2: Satin weave or twill weave, other than 3-thread or 4-thread twill or cross twill
6302313020	3.038	Bed linen, table linen, toilet linen and kitchen linen: Of cotton: Containing any embroidery, lace, braid, edging, trimming, piping or applique work: Sheets
9104002510	4.292	Instrument panel clocks and clocks of a similar type for vehicles, aircraft, spacecraft or vessels: With clockmovements measuring over 50 mm in width or diameter : Valued over $10 each: With opto-electronic display only
8406811020	5.706	Steam turbines and other vapor turbines, and parts thereof: Other turbines: Of an output exceeding 40 MW: Steam turbines Stationary steam turbines, condensing type

countries sell quality products at higher prices and cost products at lower price in export market, the skewness of price distribution provides the key information to distinguish quality industries from cost industries. Examples of quality industries and cost industries classified by his indicator are presented in Table A.4.2.1 and Table A.4.2.2.

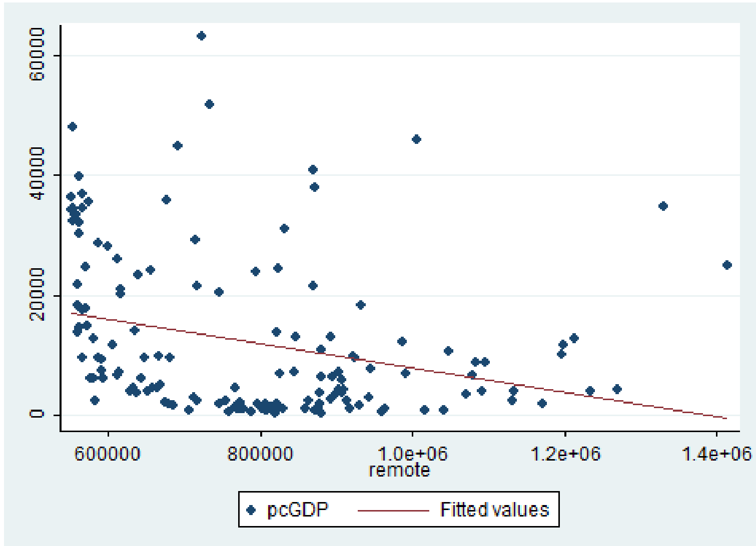
Table A.4.2.1 Quality Industry with high scope of quality differentiation

HS 6 code	Product Description
370231	photo film no sprocket holes, not over 105mm
620311	men's or boys' suits of wool, not knit
841990	parts for machinery plant or lab equipment etc
850910	vacuum cleaners, electromechanical domestic
900130	contact lenses
950662	inflatable balls

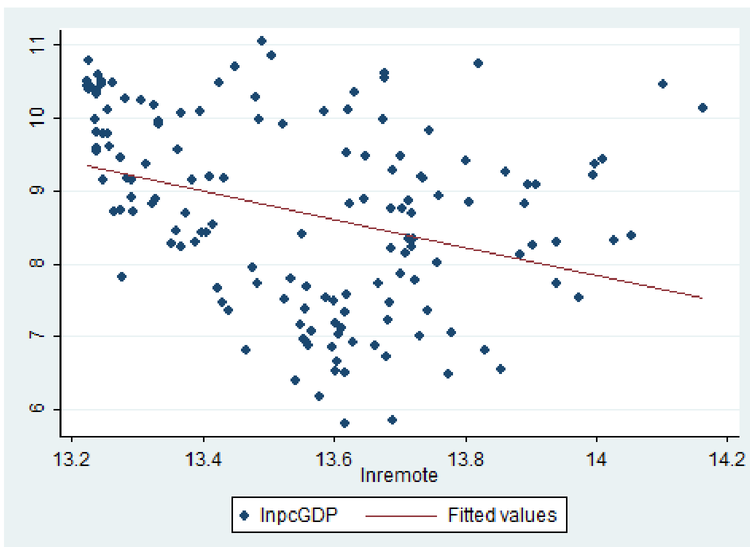
Table A.4.2.2 Cost Industry with low scope of quality differentiation

HS 6 code	Product Description
441820	doors, frames and thresholds, of wood
490199	printed books, brochures, etc., nesoi
620520	mens, boys shirts, of cotton, not knit
760711	aluminum foil, nov .2mm th, no back, rolled only
853620	auto circuit breakers voltage not exceeding 1000 v
950350	toy musical instruments, apparatus, parts & accessories

Figure 2: The inverse relationship between GDP per capita and Remoteness



X axis: Remoteness measure, Y axis: GDP per capita



X axis: ln(Remoteness), Y axis: ln(GDP per capita)

Correlation coefficient (X,Y) = -0.2972

Table A1. Summary Statistics

	Mean	Std. Dev.	Min	Max
(ln) Unit Value	3.246	2.685	-10.393	17.773
demeaned (ln) Unit Value	0	1.332	-9.552	12.749
(ln) Remoteness	13.49	.251	13.222	14.162
(ln) Distance	8.814	.708	6.306	9.691
(ln) Transport costs	.137	2.707	-15.434	12.868
demeaned (ln) Transport costs	0	1.59	-12.719	12.147
(ln) GDP per capita	9.018	1.344	4.691	10.611
(ln) GDP	27.052	1.469	19.188	29.310
Tariff	.041	.169	0	67.225
Border	.084	.278	0	1
Landlocked	.061	.241	0	1
English	.226	.418	0	1
Number of Countries	143	Number of Obs		204610
Quality Ladder Length at HS10 by Khandelwal (2010)	1.716	1.067	0	5.802
	Num. of Quality industry		Num. of Cost industry	
Quality industry Indicator at HS6 by Mandel (2010)	499		599	

Table A2. The Number of Product Categories

This table reports the number HS6 and HS10 products within the entire manufacturing sectors.

Industry	# HS 6 products	# HS 10 products
Manufacturing Sector	3,751	12,140
SITC5	832	2,071
SITC6	1,469	4,474
SITC7	786	2,496
SITC8	664	3,099
Non-Manufacturing Sector	1,012	3,113

Table A3. Countries Classified by Remoteness

This table shows countries in the sample in order of their remoteness. The remoteness measure is constructed as a GDP-weighted average distance, following Wei (1996).

Remoteness	Countries
500K-600K	The Netherlands, Denmark, Germany, Norway, Belgium-Luxembourg, Sweden, UK, Czech Rep., Latvia, Estonia, France, Finland, Poland, Ireland, Switzerland, Austria, Slovakia, Belarus, Hungary, Slovenia, Croatia, Iceland, Ukraine, Russia, Bosnia-Herzegovina, Moldova, Italy, Romania, Bulgaria, Macedonia, Albania
600K-700K	Spain, Turkey, Tunisia, Greece, Algeria, Portugal, Malta, Armenia, Libya, Morocco, Cyprus, Azerbaijan, Lebanon, Syria, Israel, Jordan, Egypt, Iran, Turkmenistan, Uzbekistan, Canada, Kyrgyzstan, Kazakhstan, Tajikistan, Kuwait
700K-800K	Mongolia, Bahrain, Pakistan, Saudi Arabia, Qatar, Arab Emirate, Oman, Mauritania, India, Niger, Chad, China, Burkina Faso, Senegal, Yemen, Mali, Nepal, Gambia, Guinea Bissau, South Korea, Djibouti
800K-900K	Guinea, Nigeria, Ethiopia, Sierra Lion, Togo, Bangladesh, Ghana, Liberia, Ivy Cost, Central Africa, St. Kitts and Nevis, Cameroon, Dominica Rep., Haiti, Japan, Jamaica, Gabon, Uganda, Trinidad, Macao, Hong Kong, Rwanda, Kenya, Lao, Congo, Belize, Venezuela, Burundi, Mexico, Guyana, Suriname, Honduras
900K-1000K	Thailand, Guatemala, Sri Lanka, El Salvador, Angola, Nicaragua, Tanzania, Panama, Costa Rica, Cambodia, Seychelles, Philippines, Colombia, Malawi, Zambia, Malaysia, Ecuador
1000K-1100K	Singapore, Madagascar, Mozambique, Mauritius, Indonesia, Peru, South Africa, Bolivia, Brazil
1100K-1200K	Kiribati, Paraguay, New Guinea, Uruguay, Argentina
1200K-	Chile, Samoa, Fiji, Australia, New Zealand

Table A4. OLS Estimation Results with Distance

This table examines the effects of country specific remoteness and distance on export unit values, controlling for country characteristics and tariff rates. Column (1) presents the results of OLS estimation for the full sample, and columns (2)-(5) present the results for each of SITC-1 digit industries. All regressions include product fixed effects, and the robust standard errors are estimated by clustering countries. Robust standard errors are reported below the coefficient estimates. ***, **, and * indicate significance at the 1%, 5%, and 10% level.

Dependent variable: (ln) average f.o.b unit value, by HS-10 product and country					
		Manufacturing Sectors			
	All products	SITC 5	SITC 6	SITC 7	SITC 8
		Chemicals	Manuf. Materials	Machinery	Misc. Manuf.
	(1)	(2)	(3)	(4)	(5)
(ln) **Remoteness**	**-.447*** **	**-.679*** **	**-.374*** **	**-.084**	**-.638*** **
	.158	.202	.127	.313	.226
(ln) **Distance**	**-.102**	**.275*** **	**-.015**	**-.532*** **	**-.207* **
	.103	.081	.119	.175	.119
(ln) GDP per capita	.244***	.181***	.250***	.270***	.266***
	.049	.049	.043	.084	. .058
(ln) GDP	-.065*	-.100**	-.070**	-.174***	-.042
	.036	.043	.036	.057	.044
Border	-.507***	-.040	-.459*	-1.03***	-.509***
	.179	.131	.252	.312	.181
Landlocked	.266***	.580***	.305***	.031	.255***
	.057	.118	.077	.132	.088
English	.081	.270***	.162	-.098	.061
	.130	.092	.122	.211	.156
Tariff	-.019	-.013	.082	-.353	.393
	.016	.190	.168	.435	.327
Product FE	Y	Y	Y	Y	Y
R-squared	0.78	0.61	0.67	0.75	0.69
# observations	204,610	21,575	58,795	40,226	56,526
# products	15,253	2,071	4,474	2,496	3,127

Table A5. Regressions with Scope for Quality Differentiation Measures: Mandel's Quality Industry Indicator

This table reports the estimation results of the interaction effects of industry-specific scope for quality differentiation with distance and remoteness on export unit values. I use the quality industry indicator from Mandel (2010) as a proxy for scope for quality differentiation at a HS6 product level. The column (1) shows the regression result for cost industries and the column (2) reports the regression result for quality industries. All regressions include product fixed effects, and cluster errors by country. Robust standard errors are reported below the coefficient estimates. ***, **, and * indicate significance at the 1%, 5%, and 10% level.

Dependent variable: (ln) average f.o.b unit value, by HS-10 product and country

	Efficiency-sorting model's prediction	Quality-sorting model's prediction	Cost Industry	Quality Industry
			(1)	(2)
(ln) Remoteness	**0**	**-**	**-.279***	**-.407***
			.164	.225
(ln) Distance	**-**	+	**-.125**	**-.292****
			.095	.127
(ln) GDP per capita			.236***	.207***
			.048	.065
(ln) GDP			-.071**	-.107**
			.036	.049
Border			-.413	-.665***
			.074	.229
Landlocked			.104***	.085
			.061	.096
English			.042	.071
			.126	.163
Tariff			.845**	.554
			.385	.349
Product FE			Y	Y
R-squared			0.81	0.81
# observations			23,395	29,494
# products			1,379	1,726

Table A6. Regressions with Scope for Quality Differentiation Measures: Khandelwal's Quality Ladder Length

This table reports the regression results of the interaction effects of industry specific scope for quality differentiation with distance and remoteness on export unit values. I use Quality Ladder length from Khandelwal (2010) as a proxy for scope for quality differentiation at HS10 product level. Column (1) reports the result with all product categories in the sample, and column (2) reports the result with product categories with quality ladder length greater than 1. All regressions include product fixed effects, and cluster errors by countries. Robust standard errors are reported below the coefficient estimates. ***, **, and * indicate significance at the 1%, 5%, and 10% level.

Dependent variable: (ln) average f.o.b unit value, by HS-10 product and country

	Quality-sorting model's prediction	All Products with Quality ladder length	Products with Quality ladder length > 1
		(1)	(2)
(ln) Remoteness	**-**	**-.547*** **	**-.433*** **
		.188	.209
(ln) Remoteness x QulaityDiff	**-**	**.064***	**.019**
		.037	.035
(ln) Distance	**+**	**-.135**	**-.149**
		.104	.110
(ln) Distance x QulaityDiff	**+**	**-.015**	**-.008**
		.019	.010
(ln) GDP per capita		.232***	.232***
		.053	.054
(ln) GDP		-.055	-.058
		.042	.043
Border		-.516***	-.520***
		.186	.193
Landlocked		.217***	.217***
		.061	.062
English		.071	.074
		.139	.142
Tariff		.217	.190
		.219	.218
Product FE		Y	Y
R-squared		0.81	0.81
# observations		143,444	116,599
# products		9,719	7,353

Table A7. OLS Estimation Results with Transport Costs

This table reports the estimation results for the effects of country-product specific transport costs and country specific remoteness on export unit values. Column (1) presents the result of OLS estimation for the full sample, and columns (2)-(5) report the corresponding results for each of SITC-1 digit industries. All regressions include product fixed effects, and the robust standard errors are estimated by clustering products at HS 10-digit codes. Robust standard errors are reported below the coefficient estimates. ***, **, and * indicate significance at the 1%, 5%, and 10% level.

Dependent variable: (ln) average f.o.b unit value, by HS-10 product and country					
	OLS Estimation				
		Manufacturing			
	All products	SITC 5 Chemicals	SITC 6 Manuf. Materials	SITC 7 Machinery	SITC 8 Misc. Manuf.
	(1)	(2)	(3)	(4)	(5)
(ln) **Remoteness**	**-.335***** .010	**-.279***** .039	**-.286***** .018	**-.293***** .023	**-.445***** .018
(ln) **Transport costs**	**.550***** .004	**.624***** .012	**.475***** .007	**.689***** .006	**.506***** .007
(ln) GDP per capita	.146*** .002	.109*** .007	.155*** .003	.141*** .005	.170*** .003
(ln) GDP	-.048*** .002	-.043*** .007	-.044*** .003	-.081*** .005	-.047*** .003
Border	.594*** .012	.560*** .033	.395*** .018	.947*** .021	.514*** .020
Landlocked	.140*** .010	.298*** .034	.167*** .016	.039* .021	.151** .017
English	.015*** .005	.142*** .018	.076*** .009	-.057*** .012	-.044*** .009
Tariff	-.298** .124	-.159 .153	-.133 .172	-.228 .293	-.932*** .108
Product FE	Y	Y	Y	Y	Y
R-squared	0.53	0.52	0.50	0.67	0.52
# observations	191,854	20,707	55,560	37,535	51,405
# products	14,223	1,958	4,291	2,415	2,908

Table A8. IV Estimation Results for Equation (1)

This table reports the IV estimation results for the effects of country-product specific transport costs and country specific remoteness on export unit values. Column (1) presents the result of IV estimation for the full sample, and columns (2)-(5) present the corresponding result for each of SITC-1 digit industries. All regressions include product fixed effects, and the robust standard errors are estimated by clustering products at HS 10-digit codes. Robust standard errors are reported below the coefficient estimates. ***, **, and * indicate significance at the 1%, 5%, and 10% level.

Dependent variable: (ln) average f.o.b unit value, by HS-10 product and country					
	IV Estimation				
		Manufacturing			
	All products	SITC 5 Chemicals	SITC 6 Manuf. Materials	SITC 7 Machinery	SITC 8 Misc. Manuf.
	(1)	(2)	(3)	(4)	(5)
(ln) **Remoteness**	**-.227***** .012	**-.259***** .047	**-.211***** .023	**-.181***** .025	**-.271***** .020
(ln) **Transport costs**	**.912***** .004	**1.006***** .047	**.895***** .008	**.914***** .006	**.823***** .007
(ln) GDP per capita	.096*** .002	.073*** .008	.087*** .004	.102*** .005	.125*** .004
(ln) GDP	-.039*** .002	-.034*** .008	-.038*** .004	-.053*** .005	-.043*** .003
Border	1.160*** .014	1.237 *** .042	1.081*** .025	1.25*** .024	.893*** .025
Landlocked	.091*** .011	.114*** .037	.069*** .021	.061*** .023	.142*** .021
English	-.027*** .006	.088*** .021	.017 .015	-.081*** .013	-.097*** .010
Tariff	-.434** .176	-.266*** .245	-.287 .278	-.192 .312	-1.430*** .146
Product FE	Y	Y	Y	Y	Y
R-squared	0.34	0.35	0.20	0.60	0.37
# observations	191,854	20,707	55,560	37,535	51,405
# products	14,223	1,958	4,291	2,415	2,908
Under-identification test (Kleibergen-Paap rk Wald F statistic)	4719.476	784.973	1545.659	977.617	1241.751
Chi-sq P value	0.000	0.000	0.000	0.000	0.000
Weak identification test (Kleibergen Paap rk Wald F statistic)	8808.594	1716.951	2796.421	2975.432	2464.753
Over-identification test of all instruments (Hansen J statistic)	35.648	1.641	2.376	0.060	55.010
Chi-sq P value	0.000	0.200	0.123	0.807	0.000

Note: For the weak identification test, Stock-Yogo weak ID test critical values are given as 19.93 at 10% maximal IV size, 11.59 at 15% maximal IV size, 8.75 at 20% maximal IV size. At any critical values, the test results reject the null hypothesis that instruments are weakly correlated with the endogenous variable.

Table A9. OLS and IV Estimation with Scope for Quality Differentiation Measures: Mandel's Quality Industry Indicator

This table reports he effects of transport costs and remoteness on export unit values for separate sub-samples with different industry-specific scopes for quality differentiation. As an indicator for industry level degree of quality differentiation, I use Mandel's industry indicator that differentiates cost industry from quality industry. Column (1) and (2) reports OLS estimation results, and (3) and (4) present IV estimation results. All regressions include product fixed effects, and cluster errors by product. Robust standard errors are reported below the coefficient estimates. ***, **, and * indicate significance at the 1%, 5%, and 10% level. The sample is limited to manufacturing industries covering SITC 1-digit code 5, 6, and 7.

Dependent variable: (ln) average f.o.b unit value, by HS-10 product and country				
	OLS		IV	
	Cost Industry	Quality Industry	Cost Industry	Quality Industry
	(1)	(2)	(3)	(4)
(ln) Remoteness	**-.145***** . 043	**-.341***** .030	**-.031** .048	**-.182***** .034
[95% CI]	[-.229, -.062]	[-.401, -.282]	[-.126, .063]	[-.249, -.115]
(ln) Transport Cost	**.662***** .012	**.728***** .008	**.936***** .011	**.974***** .007
[95% CI]	[.639, .685]	[.712, .743]	[.914, .958]	[.959, .989]
(ln) GDP per capita	.159*** .008	.120*** .006	.102*** .008	.080*** .007
(ln) GDP	-.081*** .007	-.075** .006	-.062*** .008	-.039*** .006
Border	.746*** .037	.962*** .028	1.131*** .043	1.331*** .031
Landlocked	.073** .036	.071*** .026	.068*** .039	.085*** .028
English	-.005 .019	-.018 .015	-.034 .022	-.060*** .017
Tariff	-2.056*** .534	-.057 .271	-2.920*** .687	-.216 .403
Product FE	Y	Y	Y	Y
R-squared	0.64	0.68	0.55	0.61
# observations	14978	24631	14,978	24,631
# products	937	1389	937	1,389
Under-identification test (Kleibergen-Paap rk Wald F statistic)			313.372	562.296
Chi-sq P value			0.000	0.000
Weak identification test (Kleibergen Paap rk Wald F statistic)			956.236	2062.001
Over-identification test of all instruments (Hansen J statistic)			2.391	2.464
Chi-sq P value			0.122	0.117

Table A10. OLS and IV Estimation with Scope for Quality Differentiation Measures: Khandelwal's Quality Ladder Length

This table reports the estimation results for the interaction effects of industry specific scope for quality differentiation with transport costs and remoteness on export unit values. I use Quality Ladder length from Khandelwal (2010) as a proxy for scope for quality differentiation at a HS10 product level. Column (1) reports OLS estimation results, and (2) presents IV estimation results. All regressions include product fixed effects, and cluster errors by HS10 products. Robust standard errors are reported below the coefficient estimates. ***, **, and * indicate significance at the 1%, 5%, and 10% level. The sample is limited to manufacturing industries covering SITC 1-digit code 5,6, and 7

Dependent variable: (ln) average f.o.b unit value, by HS-10 product and country

	Quality-sorting model's prediction	OLS	IV
		(1)	(2)
(ln) Remoteness	**-**	**-.273*** **	**-.152*** **
		.035	.046
(ln) Remoteness x QulaityDiff	**-**	**-0.014**	**-0.028**
		0.016	0.019
(ln) Transport Cost	+	**.657*** **	**.951*** **
		0.005	0.009
(ln) Transport Cost x QulaityDiff	+	**1.64e-06**	**.000067**
		1.52e-06	.000093
(ln) GDP per capita		.136***	.082***
		.003	.003
(ln) GDP		-.067***	-.048***
		.003	.004
Border		.737***	1.231***
		.015	.024
Landlocked		.121***	.070***
		.014	.016
English		.041***	.041***
		.008	.008
Tariff		-.196	.005
		.139	.013
Product FE		Y	Y
R-squared		0.62	0.48
# observations		96,217	96,217
# products		6,949	6,949
Under-identification test (Kleibergen-Paap rk Wald F statistic)			57.994
Chi-sq P value			0.000
Weak identification test (Kleibergen Paap rk Wald F statistic)			14.472
Over-identification test of all instruments (Hansen J statistic)			3.513
Chi-sq P value			0.173