Heterogeneous Firms in Trade: Quality Matters *

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Abstract

In this paper, I study to what extent countries differ in their preferences for quality and their technologies for improving quality. The paper also quantifies the contribution of those differences to the differences in gains from trade across countries. I adopt Antoniades (2015), which allows endogenous quality choice of firms. This paper extends that framework into multi-country and multi-sector setting. The new feature is that bilateral trade liberalization yields spillover effects on the competitiveness of another country. This paper structurally estimates the model under multi-country and multi-sector framework. It is found that richer countries generally have stronger valuation for quality. The quantification demonstrates that variations in the strength of quality preferences and in the technology of improving quality across countries add to their heterogeneities in market competitiveness. Subsequently, I simulate a 5% increase in the trade barriers. If the quality channel is shut down, countries with stronger preferences for quality have larger degrees of underestimations in their losses from the trade barrier. Finally, gains from a universal rise in quality preference are unequal among countries, with larger economies generally gaining more than smaller economies.

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1. Introduction

Trade economists have paid particular attention to the role played by product quality in international trade. Under quality sorting, more efficient firms produce higher-quality goods, enter more competitive markets and charge higher prices,[1] which enriches conventional efficiency-based trade theories.[2] Additionally, quality differentiations across firms and markets can explain price variations in exports and imports.[3] Finally, the product quality is related to welfare gains from trade.[4]

This paper analyzes differences in quality preferences and technologies among countries and investigates the impact of these differences on gains from trade. Despite the growing literature linking quality, price and welfare, little has considered the contribution of quality either to cross-country differences in market competitiveness or to unequal gains from trade. In addition, this paper is the first to quantify the countries' heterogeneities in quality preferences and costs from both demand and supply sides. In this paper, I investigate this problem using a combination of empirical, theoretical and structural analyses. Two findings emerge from this analysis: first, differences in quality preferences among countries enlarge the inequality in gains from trade; second, a universal rise in quality preferences brings higher gains to larger economies.

To provide micro-foundations, I use a recent Chinese firm-level export transaction dataset to explore firm-level evidence. Evidence from this dataset shows that firms charging higher prices sell to larger countries, earn higher revenues and enter more markets. The positive relationship between price, revenue, and market entry is strengthened in sectors of high research and development (R&D) intensity. Typically, R&D intensity can be viewed as a proxy for scope of quality differentiation in Manova and Zhang (2012). Additionally, I choose two sectors with different levels of R&D intensity - tobacco (R&D intensity approximately zero) and pharmaceutical (R&D intensity approximately 50%). In the pharmaceutical sector, the positive relationship between price, revenue and market entry still holds. However, in tobacco sector, price is negatively correlated to revenue and the destination market size. The evidence reveals that the price is positively correlated destination market size, firm revenues and market entry in a subset of sectors only. This implies that price reveals quality only in

[1] See, for example, Baldwin and Harrigan (2011), Baller (2015), Crozet, Head, and Mayer (2012), Demir (2011) and Eckel et al. (2015).

[2] Conventional heterogeneous firm trade theories include Melitz (2003) and Melitz and Ottaviano (2008).

[3] See, for example, Mandel (2010).

[4] See, for example, Fan et al. (2018)

selected industries and that some sectors are homogeneous with limited quality differentiation space.

Motivated by these stylized facts, I extend the framework of Antoniades (2015) into the multi-country and multi-sector setting. The framework introduces quality differentiation into Melitz and Ottaviano (2008) (MO, thereafter). According to Antoniades (2015), firms compete along the quality dimension as well as cost dimension so that more productive firms charge higher prices because they can produce higher-quality products. I also extend Antoniades (2015) so that a firm can produce multiple products. The extension suggests that more productive firms produce more products with higher average qualities. On the demand side, quality preferences are homogeneous within a country and sector. On the supply side, the cost of improving quality is embedded in both variable and sunk costs that firms have to pay.

In the multi-country setting in this paper, it is possible to assess spillover effects of the bilateral trade liberalization and the preference shock. The spillover effect is unique to this multi-country model. A bilateral trade liberalization between two countries can generate negative effect on competitiveness of other countries. The effect on the third country is higher, the larger the trade-liberalizing economies. Apart from that, a positive preference shock on one country could have positive effect on competitiveness of other countries. This occurs since quality differentiation scope in selling to that market are widened following positive preference shock. Firms in all countries respond by rising quality of goods sold to that market. The responses are higher for more productive firms. Therefore, the productivity threshold of entering the market with preference shock rises. As for other countries without shocks, the least productive firms cannot profitably export to the market with the positive preference shock. This makes this group of firms unable to cover the sunk cost of entry. Thus, the least productive firms are driven out of the market, in all countries. The productivity thresholds of other countries without preference shock could also rise. The larger the country with preference shock, the higher the effects on productivity of other countries. Finally, if the trade liberalization negatively affect competitiveness of a third country, higher quality preference alleviate the negative effect. If the trade liberalization positively affect competitiveness of a third country, higher quality preference strengthen the positive effect. This occurs since higher quality preference have positive selection effect.

The multi-country setting of this paper enables computation of equilibrium. I bring the model to data to estimate the relevant parameters of quality in the model. An extended gravity model can be derived from the above theoretical framework. In addition to the bilateral trade costs and the importer/exporter fixed effects typically included in a gravity model estimation,[5] I include (a non-linear function of) quality preferences and costs into the the gravity equation. According to this gravity model, bilateral trade flow is positively affected by the destination country's quality preferences and negatively affected by the origin country's costs of improving quality.[6] I parameterize that gravity equation to estimate quality preferences/costs parameters as well as trade costs. After the estimation, I recover two measures of the degree of competition for each country-sector pair. The first measure is endogenous competitiveness. This is the productivity threshold above which firms can make non-negative profits. Thus, before a firm makes a random draw of productivity, a firm will be, ex ante, less likely to enter a market where the cutoff productivity is high and competition is fierce. The second is the exogenous measure of competitiveness. This is the fundamental productivity level in a market. Firms are more likely to draw a high productivity if the level of fundamental productivity is higher. I follow Corcos et al. (2011) and estimate the endogenous competitiveness first and back out the exogenous competitiveness using free-entry conditions.[7]

The structural analysis suggests that quality preferences are related to income and that considering quality enlarges differences in competitiveness across countries. First, the preference for quality is positively correlated with GDP per capita in more than half of the sectors studied.[8] This indicates that for these industries, the preferences for quality are on average stronger in richer countries. Second, the distribution of preferences for quality vary across sectors. The variance of the estimates across countries is particularly large for certain sectors such as HS 85 (Electrical machinery and equipment), which is 56.19, and small for certain sectors such as HS 37 (Photographic or cinematographic goods), which is approximately 9.94.[9] These findings are, to some extent, consistent with empirical evidence on the correlation between price and market size.[10] For example, Khandelwal (2010) and Kneller and Yu (2016) finds that prices are a good proxy for quality in some industries but not in

[5]The original gravity model starts from Tinbergen (1962) and is augmented by Anderson and Wincoop (2003).

[6]The details of this are discussed in the Section 3 and Section 4.

[7]This is discussed in detail in Section 4.

[8]For the rest of sectors, GDP per capita has insignificant effect on quality preferences.

[9]As for the cost of quality, it is found that the mean is smaller than the preference parameters within the same sector and the variance are also smaller.

[10]Syverson (2007) among other, reports a negative correlation between market size and output price, while Verhoogen (2008) and Hallak and Sivadasan (2009) report positive correlations.

others. I compare the endogenous competitiveness estimated from this model with that estimated from the MO canonical model. Comparing across countries by sector, it is noticeable that endogenous competitiveness is more dispersed under this model. This more dispersed distribution can be explained by the additional heterogeneity introduced by differentials in both quality preferences and costs of improving quality among countries.

A counterfactual exercise is performed to examine the competitiveness-enhancing effect of quality. Exogenous competitiveness and quality parameters are kept constant. I experiment with a 5% universal increase in international trade costs. This exercise is implemented under both this model and the MO model. In general, the productivity cutoffs, which measure the endogenous competitiveness, decrease in both models. This implies that the average productivity is lower and the economy becomes less competitive. Quantitatively, the decline of the productivity cutoff is 25% to 300% larger in this model with quality than that it is in the MO setup (depending on the sector). Furthermore, the differences between this model and the MO model in degrees of the declines of productivity cutoffs rise in the magnitude of preferences for quality, in most sectors. If consumers value quality more in some countries, the difference between the rise of productivity cutoffs in this model and in the MO model will be larger in these countries than the difference in other countries where quality is not valued. This suggests that gains from trade across countries are more heterogeneous than in a canonical model, in which quality is considered.

For the second counterfactual exercise, I simulate a universal positive shock in preference for quality. Although quality preferences are exogenous to this model, they can change over time by promoting consumers' awareness of product quality. Most countries experience gains in productivity of less than 141.2%. Approximately 25 countries experience a loss in productivity. The total gains in productivity is nearly 5 times the total losses in productivity, from the global scale. It is noticeable that large economies generally gain more than small economies. On average, 1% rise in population size leads to 7.876% more gains in productivity. This finding is consistent with the model implication that larger economies have wider scope for quality differentiation.

Quality in international trade has been intensively studied, but existing work pays limited attention to sources of quality variation from both the demand and the supply side and does not link them to heterogeneity among countries. Hallak (2006) estimates the demand for quality across countries on the demand side. Other studies focus more on firms' behavior in quality improvement (Bas and Strauss-Kahn (2015), among others). Nevertheless, Antoniades (2015) reconciles both the demand and the supply sides into a single theoretical framework. This paper uses a more general framework and compares predictive differences between that quality-extended model and the MO model.

The analysis of this paper provides new insight into the sources of unequal gains from trade from a quality perspective. That countries do not gain equally has been well documented. Gains from trade can be divergent among countries of different sizes (Markusen (1981), among others) or incomes (Trela and Whalley (1990), among others). A recent study by Anderson and Yotov (2016) suggests that free trade agreement (FTA) can bring -0.3% to 5% gains to different countries. However, little literature provides explanations for the unequal gains across countries. The paper points out and quantifies the strengthening effect on competition brought by higher quality preferences and quantifies it.

The paper relates to three strands of literature: heterogeneous firms' quality choices, pricing-to-market and non-homothetic preferences. Trade liberalization induces firms' quality-upgrading behavior (Fan, Li, and Yeaple (2015), among others). Larger plants have higher output prices and use more expensive materials (Kugler and Verhoogen 2012).[11] This paper embraces the above findings by allowing quality choices to be endogenous to firms such that prices and markups vary with plant size and productivity. The model also includes findings by Feenstra and Romalis (2014) that export unit values vary to a larger extent than quality-adjusted prices.[12] Finally, the study, by estimating quality preferences and relating to the country-level income, incorporates non-homothetic preferences proposed by Fajgelbaum, Grossman, and Helpman (2011).[13]

The remainder of the paper is organized as follows. Section 2 uses firm-product level trade statistics to explore the relationship between price, market features and firm exporting performances. I use these statistics to show the micro foundations of the model. Section 3 lays out the theoretical framework under a multi-country and multi-product setting. Section 4 discusses the data and how relevant parameters are estimated. Section 5 implements the counterfactual analysis. Finally, Section 6 concludes.

[11] Other studies include Manova and Zhang (2012).

[12] Atkeson and Burstein (2008) finds that price deviate from purchasing power parity.

[13] Similarly, Fieler (2011) proposes that richer households consume higher-elasticity goods more thus leading to more trade flows between high income countries than between low-income ones.

2. Stylized Facts

2.1. Data

In order to document stylized facts regarding *f.o.b.* export prices across destinations and across firms within the same destination, I use a unique micro-level data and two sets of macro-level data. The specific micro dataset used here is the China Customs Trade Statistics (CCTS) issued in 2013 by The General Administration of Customs. The advantage of this dataset is that it is highly disaggregated in recording the import/exports of Chinese firms. Additionally, it records the prices of exports/imports, origins/destinations of imports/exports, the product (HS8) of the transaction, and the mode (ordinary or processing) of international trade. I use the CEPII-Dist dataset to obtain bilateral characteristics of destination countries and China. The Penn World Table dataset is used to obtain population of destination countries.

2.2. Empirical Findings

In this subsection, I report three stylized facts concerning export prices across destinations and across firms within destinations. Although the existing literature such as Manova and Zhang (2012) has documented these findings, it is important to show that they hold in the more recent years. Moreover, these are the facts to be embraced in the model and that lay the micro foundation in the model setup.

On export prices across destinations — Based on the entire customs export data in 2013, Table 1 reports the regression results using (log) export prices as the dependent variable and destination country's population as the main explanatory variable, controlling for destination's GDP per capita and distance to China. Columns 1-2 use the prices at the firm-HS8-country level and Columns 3-4 use HS8-country level. The coefficients on (log) population in all specifications are significantly positive, suggesting that export prices increase with the destination's market size, consistent with Manova and Zhang (2012). Thus, it is summarized as the following fact:

Stylized Fact 1: *On average, firms set higher export prices for the same product in larger markets.*

On export prices and revenues - Table 2 presents robust evidence that firms charging higher export prices earn greater revenues even within very narrowly defined destination-product markets. In Columns 1-2, I use prices at the firm-HS8-country level and Columns

3-4 I use prices at firm-product level. This relationship is highly statistically significant. Importantly, it is also markedly stronger for goods with greater scope for quality upgrading, as proxied by sectors' R&D intensity compiled by Kroszner, Laeven, and Klingebiel (2007). The magnitudes and signs of estimated coefficients are relatively robust to different specifications and different level of aggregations. The elasticity of export prices with respect to revenues is 0.15. A doubling in firm sales in a given market is thus associated with 20% higher bilateral unit prices for the average product. That number is bigger for sectors with higher R&D intensity. This yields the following fact:

Stylized Fact 2: *On average, firms charge higher prices simultaneously earn greater revenues in each destination. The correlation between price and revenue is higher in R&D intensive sectors.*

On prices and market entry -As reported in Table 3, exporters that supply more countries systematically charge higher average prices (Columns 1-2). Firms selling to more destinations also exhibit greater price dispersion across importers (Columns 3-4). In this table, I use prices (or price dispersions) at firm-HS8 product level. These results are both largely enhanced by products with substantial potential for quality differentiation. As columns (2) and (4) show, the patterns are stronger for sectors with larger scope for quality differentiation, which is proxied by sectoral R&D intensity, defined as before. The finding is consistent with Manova and Yu (2017) and Manova and Zhang (2012) which use earlier versions of CCTS. This finding suggests the following fact:

Stylized Fact 3: *On average, exporters entering more destinations and offering a wider range of export prices charge higher prices. The correlation between price and market entry is higher in R&D intensive sectors.*

One caveat is that the above relationships can be sector-dependent. The above relationship exist only in a subset of sectors. In Figure 1 and 2, I plot the above 3 stylized facts for sector HS 24 (Tobacco) and HS 6, respectively. The findings of the three stylized facts continue to hold in the sub-sample of HS 6, while they are reversed in HS 24. From Figure (1a), the average price decreases with destination market size. Firms charging higher prices earn lower revenues, as in Figure (1b). The relationship between the firm's price charged and the number of market it entered (Figure (1c)) is not as significant as in sector HS 6 (2c). The comparison suggests that competition improves quality in only a subset of sectors. This is also consistent with the Table (2) -(3) where the relationship between price, revenue and market entry are "more positive" in R&D intensive sectors. In sector 30 (Pharmaceuticals), the average R&D intensity is approximately 58% while that ratio of sector 24 is 0.

3. Theory

I lay out theoretical frameworks that incorporate endogenous quality choices in the linear demand system. The demand side features heterogeneous quality preferences among different countries; In addition, quality upgrading requires additional variable and fixed costs such that producers endogenously choose the level of quality in their products. The model is built on a multi-country basis for the convenience of quantification in subsequent empirical studies. For simplicity, sector notations are dropped as there are no interactions between them.

3.1. Setup

I follow the framework of Antoniades (2015) and Foster, Haltiwanger, and Syverson (2008), the preference of a consumer in country j is represented as (1). This utility function has the advantage that the price/quantity are linear in quality preference

$$\begin{aligned} U_j = \quad q_0^c \quad &+ \sum_s \left[\alpha_s \int_{\omega \in \Omega_s} q_s(\omega)^c d\omega + \kappa_{js} \int_{\omega \in \Omega_s} z_s(\omega) q_s(\omega)^c d\omega \right] \\ &- \sum_s \left[\frac{1}{2} \gamma_s \int_{\omega \in \Omega_s} (q_s(\omega)^c)^2 d\omega + \frac{1}{2} \eta_s \left(\int_{\omega \in \Omega_s} q_s(\omega)^c \right)^2 \right] \end{aligned} \tag{1}$$

where q_0^c and $q_s(\omega)$ are individual c's consumption in numeraire and differentiated goods (in sector s) respectively. The quality of each variety ω is given by $z_s(\omega)$ and the taste for quality by consumers in country j in sector s is κ_{js}. In the above utility function, $\kappa_{js} z_s(\omega)$ is equivalent to the variety-specific taste shifter in Foster, Haltiwanger, and Syverson (2008).[14] If qualities of all varieties are zero or if the taste parameters are zero, the model becomes traditional Melitz and Ottaviano (2008) model. Finally, α_s and η_s capture the degree of substitution between each variety and the numeraire. The parameter γ measures the degree of differentiation between varieties. κ_{js} picks up the degree of preference for variety. Specifically, κ_{js} are assumed to be positive and differ across countries and sectors.

This generates a linear inverse demand function that depends on both quantity and quality:

$$p_j(\omega) = \alpha - \gamma q(\omega)^c + \kappa_j z(\omega) - \eta Q^c \tag{2}$$

[14] The difference between this paper and Foster, Haltiwanger, and Syverson (2008) is that the latter regard the shifter as the idiosyncratic term.

where $Q^c = \int_{\omega \in \Omega} q(\omega)^c d\omega$. By re-arranging (2) one can obtain the total demand in country j of each variety:

$$q_j(\omega) = L_j q(\omega)^c = \frac{\alpha L_j}{\eta N_j + \gamma} - \frac{L_j}{\gamma} p_j(\omega) + \frac{L_j \kappa_j}{\gamma} z(\omega) + \frac{\eta N_j L_j}{\gamma\,(\eta N_j + \gamma)} \bar{p}_j - \frac{\eta N_j L_j \kappa_j}{\gamma\,(\eta N_j + \gamma)} \bar{z}_j \quad (3)$$

where $\bar{p}_j = \frac{1}{N_j} \int_{\omega \in \Omega} p_j(\omega) d\omega$ is the mean price over all varieties in country j, $\bar{z}_j = \frac{1}{N_j} \int_{\omega \in \Omega} z_j(\omega) d\omega$ is the mean quality over all varieties in j. This form of preference over quantity and quality ensures that demand function is linear in price and quality.

On the supply side, firms have to incur costs in both production and quality improvements. For simplicity, labor is assumed to be the only factor of production. As with most heterogeneous firm trade models, firms have to pay a sunk cost f_e before they draw the productivity c (marginal cost of production). If a firm in country i produce and sell to country j, it should choose both the quantity and the quality of its product, given the total cost function:

$$TC_{ij}(\omega) = q_{ij}(\omega)(\tau_{ij} c + \mu_i z_{ij}(\omega)) + \delta z_{ij}(\omega)^2 \quad (4)$$

where τ_{ij} is the ice-berg trade cost from country i to j and z_{ij} is the quality level of goods sold from i to j. The first term implies that firms have to incur additional marginal cost of quality upgrading,which depends on both quality level z_{ij} and quality improving technology at origin country μ_i, when producing in country i; the second term picks up the fixed cost of improving quality. To generate closed form solutions, I assume that the fixed cost is a quadratic function of quality level. A more generalized function form in the fixed cost can be found in Fan, Li, and Yeaple (2015) in which CES preference is assumed. In the cost function (4), the marginal cost of upgrading quality differs across countries/sectors, since labor productivity are heterogeneous across countries. The multiplier in the fixed cost δ is assumed to be identical across countries, since the fixed costs of innovation across countries, which include high-skilled workers, tend to be homogeneous across countries.[15]

3.2. Firms' Problem

For a firm (of marginal cost c) from country i selling to each (potential) market $j \in J$, it chooses quantity and quality to maximize profit:

$$\pi_{ij}(c) = \max_{q_j(\omega), z_j(\omega)} p_{ij}(\omega) q_{ij}(\omega) - TC_{ij}(\omega) \quad (5)$$

[15] This assumption is made since the highly skilled labor migrate to regions where wages are high, according to Parikh and Leuvensteijn (2003). Therefore the wage for high skilled workers tend to converge over time.

Given the demand structure, the quantity of goods sold from country i to country j satisfies a linear function with respect to price p_{ij}:

$$q_{ij}(c,z) = \frac{Lj}{\gamma}\left[c_D^j - p_{ij}(c,z) + \kappa_j z_{ij}\right] \tag{6}$$

where c_D^j is the cost threshold so that firms with marginal cost of production $c \leq c_D^j/\tau_{ij}$ can sell to market j and make non-negative profits. Equation (6) shows that demand is linear to both price and quality. This makes it convenient for later analysis in optimal pricing.

Given the demand function and the firms' problem, the optimal price and quantity as a function of quality z is linear in marginal cost[16]:

$$p_{ij}(c,z) = \frac{1}{2}(c_D^j + \tau_{ij}c) + \frac{1}{2}(\kappa_j + \mu_i)z_{ij} \tag{7a}$$

$$q_{ij}(c,z) = \frac{L_j}{2\gamma}(c_D^j - \tau_{ij}c) + \frac{L_j}{2\gamma}(\kappa_j - \mu_i)z_{ij} \tag{7b}$$

where c_D^j is the cost-cutoff in country j, above which firms cannot profitably sell in market j. This is also the endogenous competitiveness of country j (lower cutoff, more endogenous competition), which changes with factors such as ice-berg trade costs, quality parameters and market size. Thus, that the profit of selling to market j can be re-written as

$$\pi_{ij}(c,z) = \frac{L_j}{4\gamma}\left[(c_D^j - \tau_{ij}c) + (\kappa_j - \mu_i)z_{ij}\right]^2 - \delta z_{ij}^2 \tag{8}$$

Solving for the first-order conditions for profit, the optimal quality choice to sell from i to j of firm c is written as a decreasing function of marginal cost so that more productive firms offer higher quality within a market

$$z_{ij}(c) = \rho_{ij}(c_D^j - \tau_{ij}c) \tag{9}$$

where $\rho_{ij} = L^j(\kappa_j - \mu_i)/\left(4\delta\gamma - L^j(\kappa_j - \mu_i)^2\right)$. As Equation (9) shows, the quality is linearly related to marginal cost c. Consistent with other international trade in quality literature,[17] for the same firm c from country i, it is expected to offer higher quality goods to larger markets and countries with higher taste for quality. Higher quality is also expected from countries with higher labor productivity in quality improvement (i.e., lower μ_i). It is noticeable that at the first glance, a lower cutoff resulting from trade liberalization seems to

[16] Per unit trade cost $(\tau_{ij} - 1)\,c$ does not depend on quality

[17] For example, see Fan et al. (2018) in which more productive firms offer higher quality products with lower quality-adjusted costs.

have negative impact on quality updates. However, a lower cutoff indicates that the average marginal cost is also lower, since firms with marginal cost above the new cutoff exit the market. Since firm-level quality $z(c)$ decreases with c, the average quality of products sold in the economy rises. That effect is higher the larger quality differentiation scope ρ_{ij}.

Given optimal quality function in (9) and price/quantity functions, it is evident that price and quantity can be further expressed as

$$p_{ij}(c,z) = \frac{1}{2}(c_D^j + \tau_{ij}c) + \frac{1}{2}(\kappa_j + \mu_i)\rho_{ij}(c_D^j - \tau_{ij}c) \tag{10a}$$

$$q_{ij}(c,z) = \frac{L_j}{2\gamma}(c_D^j - \tau_{ij}c) + \frac{L_j}{2\gamma}(\kappa_j - \mu_i)\rho_{ij}(c_D^j - \tau_{ij}c) \tag{10b}$$

So the for each firm with marginal cost of production c, the operating revenue of exporting from country i to j is:

$$r_{ij}(c) = \frac{\rho_{ij}\left((c_D^j)^2 - (\tau_{ij}c)^2\right) + \delta\rho_{ij}^2(\kappa_j + \mu_i)(c_D^j - \tau_{ij}c)^2}{\kappa_j - \mu_i} \tag{11}$$

Equation (10) and (11) implies that other things equal, more productive firms charge higher prices and earn greater revenues from each destination, if $(\kappa_j + \mu_i)\rho_{ij} > 1$. This is consistent with Stylized 2 in the prior section.

The operating profit can be expressed as[18]:

$$\pi_{ij} = \frac{L^j}{4\gamma}\left[1 + (\kappa_j - \mu_i)\rho_{ij}\right](c_D^j - \tau_{ij}c)^2 \tag{12}$$

Profit function in (12) implies that countries of higher quality preferences offer higher profits, all else being equal. This is related to the third stylized facts. From (12), more productive firms earn higher profits and earn non-zero profits in a larger set of markets.

This profit function is a quality-adjusted form of Melitz and Ottaviano (2008), in which profits are magnified by a term larger than one. This quality-adjusted term is key to the later empirical analysis.

3.3. Equilibrium

In equilibrium, the free entry condition of each country implies that the expected profit (earned from selling to each market) of a firm is zero. Such that that

$$\sum_{j\in J}\int_0^{c_D^{J(c)}/\tau_{ij}} \pi_{ij}(c)dG_i(c) = f_E^i \tag{13}$$

[18]Following Antoniades (2015), the fixed cost of upgrading quality is also regarded as sunk since this model is not dynamic.

where f_E is the sunk cost a firm have to pay prior to entry. It is assumed to be positive and can vary across countries and sectors. Equation (13) implies that operating profit from all markets are expected to merely compensate for the sunk cost.

Following prior literature, it is assumed here that marginal cost draws follow Pareto distribution: $G_i(c) = \left(\frac{c}{c_M^i}\right)^k$ so that firms draw the marginal cost c from the range $[0, c_M^i]$. The term c_M^i is the exogenous competitiveness in market i. Lower values indicates that a firm in country i is more likely to draw a lower cost. The power k governs the Pareto distribution dispersion: higher k implies that the distribution of c is more concentrated.

Given profit as in (12), one can re-write the equilibrium condition in (13) for country i so that the summation of expected profit from each market equals the sunk cost paid.

$$\sum_{j \in J} \frac{L^j}{4\gamma} \left[1 + (\kappa_j - \mu_i)\, \rho_{ij}\right] \tau_{ij}^{-k} (c_D^j)^{k+2} = \frac{(k+1)(k+2)\gamma f_e}{2} \left(c_M^i\right)^k \tag{14}$$

The same equilibrium condition can be written for each country h, in the matrix form. In the multi-country case, the vector of cost threshold c_D for each country j satisfies:

$$\mathbf{B} * \mathbf{L} * \mathbf{c_D}^{k+2} = 2\gamma\,(k+1)\,(k+2)\,\mathbf{f_e c_M}^k \tag{15}$$

where matrix B is the the "quality adjusted" matrix of trade freeness. If there are a total of J countries, the dimension is $J \times J$. This matrix is represented as the following form:

$$\mathbf{B} = \begin{bmatrix} [1 + (\kappa_1 - \mu_1)\, \rho_{11}]\, \tau_{11}^{-k} & [1 + (\kappa_2 - \mu_1)\, \rho_{12}]\, \tau_{12}^{-k} & \dots & [1 + (\kappa_J - \mu_1)\, \rho_{1J}]\, \tau_{1J}^{-k} \\ [1 + (\kappa_1 - \mu_2)\, \rho_{21}]\, \tau_{21}^{-k} & [1 + (\kappa_2 - \mu_2)\, \rho_{22}]\, \tau_{22}^{-k} & \dots & [1 + (\kappa_J - \mu_2)\, \rho_{2J}]\, \tau_{2J}^{-k} \\ \dots & & & \\ [1 + (\kappa_1 - \mu_J)\, \rho_{J1}]\, \tau_{J1}^{-k} & [1 + (\kappa_2 - \mu_J)\, \rho_{J2}]\, \tau_{J2}^{-k} & \dots & [1 + (\kappa_J - \mu_J)\, \rho_{JJ}]\, \tau_{JJ}^{-k} \end{bmatrix}$$

It is noticeable that whether elements in B are larger or smaller than one depends on the trade freeness, κ's and μ's. If trade cost is small (i.e., τ_{ij}^{-k} is larger) and κ_j is large, i, jth element can exceed one.

The matrix L is of dimension $J \times J$ and is the diagonal matrix of market size L_i for each country i:

$$\mathbf{L} = \begin{bmatrix} L_1 & 0 & \dots & 0 \\ 0 & L_2 & \dots & 0 \\ \dots & & & \\ 0 & 0 & \dots & L_J \end{bmatrix}$$

The last term on the right-hand-side of (15) $\mathbf{c_D}^{k+2}$ is the vector of cutoffs (to the power of $k+2$), with the *ith* element being $(c_D^i)^{k+2}$. On the right hand side of Equation (15), c_M^k is the vector of exogenous competitiveness (to the power k), with *ith* element being $c_M^{i,k}$. Both c_D^k and c_M^k are of dimension $J \times 1$.

By inverting matrix B, cost threshold c_D^j for each country j can be computed as follows:

$$\left(c_D^j\right)^{k+2} = \frac{2\gamma(k+1)(k+2)f_e}{\mid B \mid} \frac{\sum_i \mid C_{ij} \mid \left(c_M^i\right)^k}{L_j} \tag{16}$$

where $\mid B \mid$ is the determinant of matrix B and C_{ij} is the cofactor of B_{ij}. A closer examination of the matrices and Equation (16) implies that higher market size L_j leads to a lower calculated cutoff, all else being equal.[19] If ice-berg trade cost is symmetric, i.e. $\tau_{ij} = \tau_{ji}$, bilateral trade liberalization can have heterogeneous effects on cost cutoffs of different countries. Following this argument, bilateral trade liberalization can have negative externalities on countries without trade liberalization.

Proposition 1. *If ice-berg trade cost is symmetric, i.e. $\tau_{ij} = \tau_{ji}$, the effect of a bilateral trade liberalization between i and j on cutoffs is not universal i.e. $\exists\ k,\ k' \in \{1, ..., J\}$ such that $\frac{\partial c_D^k}{\partial \tau_{ij}} > 0$ and $\frac{\partial c_D^{k'}}{\partial \tau_{ij}} < 0$. Additionally, $\exists\ \boldsymbol{B}$ such that $\frac{\partial c_D^i}{\partial \tau_{ij}}$, $\frac{\partial c_D^j}{\partial \tau_{ij}} > 0$ and $\frac{\partial c_D^k}{\partial \tau_{ij}} < 0$, $\forall k \neq i, j$. The larger the trade liberalizing economies, the higher the effects on the cutoff of country $k \in \{1, ..., J\}$.*

Proof. See Appendix B QED

The intuition for the negative externalities is comparable to the special case of two-country world. It is driven by the long-term entry.In the long run, the market entries in trade-liberalizing economies rise. This drives up the competitiveness, i.e. the cost cutoff decrease as a result. For other countries without trade liberalization, the profit from selling to these markets are higher, relative to countries with trade liberalization. This results in decreased entries and higher cost threshold.

Another implication from (16) is on the effect of a preference shock, i.e. a change in κ_j, on cutoffs of countries.

Proposition 2. *The effects of a shock in preference for quality κ_j of any country j on cutoffs are universal, i.e. $\exists\ \boldsymbol{B}$ such that $\frac{\partial c_D^k}{\partial \kappa_k} < 0$, $\forall\ k$. The larger the country with preference shock, the higher the effects on the cutoff of country $k \in \{1, ..., J\}$*

[19] This also holds under multi-product setting in Appendix A.

Proof. See Appendix B QED

The intuition for this lies in the selection effect. Quality differentiation scope in selling to that market are widened following positive preference shock. Firms in all countries respond by rising quality of goods sold to that market. The responses are higher for more productive firms. Therefore, the productivity threshold of entering the market with preference shock rises. As for other countries without shocks, the least productive firms cannot profitably export to the market with the positive preference shock. This makes this group of firms unable to cover the sunk cost of entry. Thus, the least productive firms are driven out of the market, in all countries. The productivity thresholds of other countries without any preference shock also rise.

Additionally, the average bilateral *f.o.b* price $\bar{p}_{ij}$ and trade value r_{ij} can be computed by aggregating over $c \in [0, c_D^i]$[20]

$$\bar{p}_{ij} = \frac{1}{2}\left[\frac{2k+1}{k+1} + \frac{1}{k+1}\left(\kappa_j + \mu_i\right)\rho_{ij}\right]\frac{c_D^j}{\tau_{ij}} \tag{17}$$

This is related to the first stylized fact, which links price with market size. From (17), one can observe that market size affect price both by decreasing the cost cutoff c_D^j and by increasing the scope for quality differentiation. If the latter dominates, the relationship between price and market size is similar to Figure (2a), otherwise, it is closer to (1a).

The total trade value from i to j

$$r_{ij} = \frac{kN_i^E (c_m^i)^{-k}}{2\gamma} L^j (\tau_{ij})^{-(k+1)} \left(c_D^j\right)^{k+2} \left[1 + (\kappa_j - \mu_i)\rho_{ij}\right] \left(\frac{1}{k(k+2)} + \frac{(\kappa_j + \mu_i)\rho_{ij}}{k(k+1)(k+2)}\right) \tag{18}$$

where N_i^E denotes the expected number of entrants in country i. From Equation (17) and (18), the quality components have two effects: higher μ_i raises prices and reduces the trade values because of the additional (variable) costs incurred in manufacturing higher-quality goods in the origin country. Higher quality preferences in the destination country raise the willingness to pay and thus average price and trade value rise. Another countervailing effect is that, higher quality preferences drive down the cost cutoffs in the importing country thus to some extent lowering prices and values.

Finally, one can compute other aggregate variables, which are the number of varieties, entries, price indexes and welfare. The expected number of varieties in a country j (i.e., the number of producers from domestic and abroad servicing market j) is similar to the M.O

[20] Trade value is computed based on *f.o.b* price.

model multiplied by a quality-adjustment term that is negatively related to κ (of the market j) and positively affected by μ (of each sourcing country). That can be characterized as:

$$N_j = \frac{2(k+1)\gamma}{\eta} \frac{\alpha - c_D^j}{c_D^j} \frac{1}{\overline{1 + (\kappa_j - \mu)\rho}} \tag{19}$$

where $\overline{[1 + (\kappa_j - \mu)\rho]} = \{[1 + (\kappa_j - \mu_1)\rho_{1j}]\, N_{1j} + [1 + (\kappa_j - \mu_2)\rho_{2j}]\, N_{2j} + ...\}/N_j$. N_{kj} denotes the number of varieties sold from country k to country j. Equation (19) indicates that a higher preference for quality can be countervailing: κ can directly lower the number of varieties because it imposes higher requirements for the quality firms offer to market j such that fewer firms can meet the high-quality requirement. On the other hand, higher quality preferences lower the cutoffs as is previously argued, which then encourages entry by raising average profits.

One can solve for the number of entrants by noting that the number of producers from origin to destinations depends on the exogenous competitiveness of the origin country and the cutoff in the destination country. Equation (19) can be used to solve for the number of entrants in each country. Notice that the number of bilateral varieties N_{ij} satisfies the following condition

$$N_{ij} = N_i^E * G(c_D^{ij}) = N_i^E \tau_{ij}^{-k} c_j^k (c_M^i)^{-k}$$

For each country j, the total number of varieties from each sourcing country should equal Equation (19), which can be represented in the following condition

$$\sum_{i \in J} N_i^E \left[1 + (\kappa_j - \mu_i)\rho_{ij}\right] (\tau_{ij} c_M^i)^{-k} = \frac{2(k+1)\gamma}{\eta} \frac{\alpha - c_D^j}{c_D^{j,k+1}} \tag{20}$$

Under the multi-country set-up, refer to M.O model, re-arranging (19) leads to the following condition:

$$D * c_M^k * N^E = F \tag{21}$$

If there are J countries, D has the dimension of $J \times J$ and is the transpose of matrix B:

$$D = \begin{bmatrix} [1 + (\kappa_1 - \mu_1)\,\rho_{11}]\,\tau_{11}^{-k} & [1 + (\kappa_1 - \mu_2)\,\rho_{21}]\,\tau_{21}^{-k} & \dots & [1 + (\kappa_1 - \mu_J)\,\rho_{J1}]\,\tau_{J1}^{-k} \\ [1 + (\kappa_2 - \mu_1)\,\rho_{12}]\,\tau_{12}^{-k} & [1 + (\kappa_2 - \mu_2)\,\rho_{22}]\,\tau_{22}^{-k} & \dots & [1 + (\kappa_2 - \mu_J)\,\rho_{J2}]\,\tau_{J2}^{-k} \\ \dots & & & \\ [1 + (\kappa_J - \mu_1)\,\rho_{1J}]\,\tau_{J1}^{-k} & [1 + (\kappa_J - \mu_2)\,\rho_{2J}]\,\tau_{2J}^{-k} & \dots & [1 + (\kappa_J - \mu_J)\,\rho_{JJ}]\,\tau_{JJ}^{-k} \end{bmatrix}$$

The second term on the left hand side c_M^{-k} is the diagonal matrix of $c_M^{i,-k}$ and is also dimension of $J \times J$ written as

$$c_M^k = \begin{bmatrix} c_M^{1,-k} & 0 & \dots & 0 \\ 0 & c_M^{2,-k} & \dots & 0 \\ \dots & & & \\ 0 & 0 & \dots & c_M^{J,-k} \end{bmatrix}$$

and the third term N^E denotes the vector of entrants with dimension $J * 1$. The $i-th$ element is N_i^E.

On the right-hand-side, matrix F is of dimension $J * 1$ and the $i-th$ element is

$$\frac{2\gamma(k+1)(\alpha - c_D^i)}{\eta c_D^{i,k+1}}$$

The average price in a market is obtained by aggregating over the average delivered price over destinations. Using the bilateral price in (17), it is implied that the (weighted) expected price levels in country i are as follows:

$$p_i = \frac{2k+1+\overline{(\kappa_i+\mu)\rho}}{2(k+1)} c_D^i \tag{22}$$

where $\overline{(\kappa_i+\mu)\rho} = \left[(\kappa_i+\mu_1)\rho_{1i}N_{1i} + (\kappa_i+\mu_2)\rho_{2i}N_{2i} + ...\right]/N_i$. From (22), similar argument can be applied: higher κ can lower the cutoff thus lowering the price index. However, this raises prices, since the consumers could have a higher willingness to pay for high quality.

Finally, the welfare in country i is as follows:

$$\begin{aligned} U_i &= 1 + \sum_s \left[\frac{1}{2}\frac{N_i(\alpha_s - \bar{p}_i + \beta\bar{z}_i)^2}{\gamma_s + \eta_s N} + \frac{N_i}{\gamma_s}\left(\frac{1}{2}\sigma_p^2 + \frac{1}{2}\beta^2\sigma_z^2 - \beta Cov(p,z)\right)\right] \\ &= 1 + \sum_s \frac{1}{2\eta_s}(\alpha_s - c_D^i)\left[\alpha_s - \frac{k+1}{k+2}c_D^i + \frac{\overline{(\kappa_{is}-\mu_s)\rho_{jis}}}{k+2}c_D^i\right] \end{aligned} \tag{23}$$

where the quality component $\frac{\overline{(\kappa_{is}-\mu)\rho_{jis}}}{k+2}$ is defined in the similar manner as previous. Other things equal, higher valuation on quality always raises welfare: it directly raises welfare by raising the utility obtained from consuming higher quality goods; it indirectly increases welfare by reducing the cost cutoff so that more productive firms enters and provide higher quality goods.[21]

[21] The third term in the square bracket has the opposite effect compared with the first two terms. I attempted to compute the last term (multiplied by $\frac{1}{2\eta}(\alpha - c_D^i)$) and found that its proportion to the total welfare is less than 5%.

The above derivations indicate that the existence of quality can be double-sides. The subsequent proposition argues that if the quality scope is high, the quality preference amplifies the effect of the trade cost change.

Proposition 3. *The larger the scope for quality differentiation* $1 + (\kappa_j - \mu_i)\rho_{ij}$ $(i, j \in \{1, ..., J\})$*, the more likely the selection effect of quality preference* κ_j*, i.e.* $\frac{\partial^2 (c_D^h)^{k+2}}{\partial \kappa_j \partial \tau_{ij}^{-k}}$ *smaller.*

Proof. See Appendix B. QED

3.4. Discussion

The theory sketched above is based on linear demand, and it addresses the point of pricing-to-market. Specifically, it relates market toughness to the behavior of firms, and consequently, to the economic aggregates such as price index and welfare. In such a setting, market toughness operates through two channels: an increase in competition and an increase in the scope for quality differentiation. The theory identifies the second channel through which market toughness affects firms' outcomes. An increase in market toughness (e.g., an increase in market size or a decrease in trade costs) raises the scope of quality differentiation because it makes it easier for firms to recover the fixed cost of innovation. Under such circumstances, each firm responds by raising quality, mark-ups, and prices. The (endogenous) relation between the scope of quality differentiation and market toughness is a key element of the model and constitutes an important deviation from past work.[22] For the most productive firms, quality, prices and profit rise as the innovation effect dominates the competition. These firms can earn positive profit from exporting to more competitive market. This features the advantages of exporters. The theory provides clarity on the relation between prices, productivity, market shares, and quality. In heterogeneous firms' trade models, if no quality is present, these models predict a negative correlation between prices and productivity. However, if quality is present, and if higher quality indicates higher prices, then the correlation between prices and productivity, and (possibly) between prices and firm size becomes positive. Furthermore, since these models produce a quality sorting along the productivity axis, then the correlation between prices and quality is also positive.

The model is also connected to prior theoretical frameworks. For example, Fan et al. (2018) modified CES utility by allowing positive baseline utility. The derived price is then

[22] These include works using CES framework, for example Gervais (2016), Mandel (2010) and Fan, Li, and Yeaple (2015), etc.

positively related to the destination market's income. Variable markup is implied by this modification. The slight difference from this model is that quality does not depend on market size. The implications of the model are also consistent with other forms of extensions of Melitz-Ottaviano under quality framework. For example, using slightly different extensions of the MO framework with quality, Bellone et al. (2016) confirms the dominance of the quality-enhancing effect of competition using French firm-level data.

Furthermore, the setting can be extended to multi-product case. For instance, Eckel et al. (2015) discovers that core products have lower costs so that firms have more incentives to invest in upgrading quality in these groups of products. I follow Mayer, Melitz, and Ottaviano (2014) and extend the current framework by allowing firms to sell more than one product to a market.[23] The implications are isomorphic to this extension. Under this setup, it is concluded that higher product customization costs lead to a more competitive market. For individual firms, rising market competitiveness exerts a larger effect on quality improvements of products closer to the core.

4. Quantification

This section discusses the dataset used in the study and the methodologies to compute relevant parameters. I focus on sectors that are for final consumption, since producers and consumers can have different attitudes towards quality.[24] As there is no sectoral interaction here, I carry out estimations sector by sector. According to the theoretical model, the parameters to be estimated are as follows: 1) preference $\kappa_{i,s}$ and cost $\mu_{i,s}$ for each country i and sector s; 2) cutoffs (endogenous competitiveness) $c_D^{i,s}$ for each country/sector; and 3) cost upper-bound (exogenous competitiveness) $c_M^{i,s}$. Finally, sector s refers to HS 2 product level. As one step in the counterfactual analysis, I perform the quantification under quality model and M.O model.

These are the steps to estimate the model:

Step 1. Given the bilateral trade flow in the data, the bilateral trade cost τ_{ij} can be estimated using aggregate bilateral trade flow in (18).

Step 2. Obtain the residuals from the first step estimation and compute preference for quality κ_i and cost of improving quality μ_i for each country i, using Generalized Method of

[23]Details of setup and derivations are in Appendix A.

[24]Sectors for intermediate use, capital investment and final consumption are recognized by Broad Economic Classification (BEC) conversion.

Moments.

Step 3. With the above set of parameters, the cost cutoff (endogenous competitiveness, c_D^i) of each country is projected using bilateral price in (17).

Step 4. With parameters from the above three steps,the exogenous competitiveness (multiplied by fixed cost f_e) $c_M^i f_e$ can be computed from free entry condition in (15).

4.1. Data

The main dataset used here is the BACI world trade database provided by CEPII. The origin of the dataset is COMTRADE of the United Nations Statistical Division. The advantage of BACI data is that it reconciles records of both exporter and importer when there are inconsistencies in the transaction records from both sides (Gaulier and Zignago 2010). Thus, the dataset is more accurate since the reliability of the reported data of both exporter and importer are evaluated and cross-proofed. Another advantage is that the dataset is highly disaggregated: it reports the bilateral trade value and quantity at the HS6 level for more than 5,000 HS6 sectors.

To complement the dataset, I collect bilateral remoteness data to proxy for ice-berg trade cost. The major statistics is from GeoDist data compiled by CEPII. This dataset records bilateral information on distance, and other variables used in gravity equations to identify particular links between two countries. These variables include colonial relation, common languages, the contiguity (Mayer and Zignago 2011). Further, data on bilateral regional trade agreement and bilateral common currency relations are collected from de Sousa. These variables are used to proxy bilateral ice-berg trade cost. Finally, I proxy market size by population and this dataset is from Penn World Table.

I obtain Pareto distribution parameter from a global firm-level database. Here I use Orbis dataset for this purpose. The ORBIS database (compiled by the Bureau van Dijk Electronic Publishing, BvD) is a commercial dataset, which contains administrative data on 130 million firms worldwide. ORBIS is an umbrella product that provides firm-level data covering approximately 100+ countries, both developed and emerging, since 2008. This dataset covers both public and private firms. I access the financial module to obtain firm-level variables. Following Kalemli-Ozcan et al. (2015), I use total asset, employment and material cost (either recorded in the original dataset or imputed by subtracting the total cost of employees from the cost of goods sold) to estimate total factor productivity (TFP) at the firm level. To get k, I regress firm ranking (in TFP) on (computed) firm productivity.[25] This gives $k = 3.38$.

Prior to the empirical studies, some summary statistics for the feature of the data are displayed first. Table 4 reports the number of observations for each HS 2 sector. A small number of observations in one sector indicates that zero trade occur very frequently. It is implied that sectors are heterogeneous in international trade transactions: HS 61 and HS 62 (clothing) has the most observations, followed by HS 85 (machinery/equipment). Table 5 and Table 6 report the number of HS 6 products a country imports (Table 5) or exports (Table 6). From Table 5, the USA imports the highest number of products, followed by Italy, Netherlands and United Kingdom. From Table 6, China and the USA export the highest number of products, followed by Netherlands and Italy and United Kingdom. To some extent, a large exporter can also be a large importer. Finally, it is evident in Table 5 and Table 6 that the distribution of the number of HS 6 products exported/imported is uneven across countries. Some countries import/export fewer than 100 products.

Another stylized fact lies in the *f.o.b* price. Figure (3a) displays the relation between (log of average) *f.o.b* price and (log of) GDP per capita in the destination country for the sector of 020422 (meat sheep or goats; fresh, chilled or frozen). The price to a destination market is the average *f.o.b* price across all source countries exporting to that destination. Figure (3b) presents for the sector of 940169 (Seats). These two sectors are chosen since they have many importing countries. From the graph, it is implied that sectors can be heterogeneous in relation between price and destination market income. Therefore, the 'quality sorting' channel can exist only in a subset of sectors. The finding is to some extent consistent with Manova and Zhang (2012), which reveals that firms charge higher prices in richer destinations within a firm-product category, using Chinese Customs Trade Statistics. It is also consistent with with Kneller and Yu (2016), which uses the same dataset as Manova and Zhang (2012) and finds that quality sorting (competition raise quality and price) exists in a subset of HS 2 industries while some other industries have efficiency sorting (competition lowers price).

4.2. Quality Preference and Cost Parameters

I recover quality preference and cost parameters based on the estimation of the gravity equation. According to (18), the bilateral trade flow can be decomposed into origin fixed

[25] I use Levinsohn and Petrin (2003) to compute TFP. In the sample of firms, the majority consists of manufacturing.

effects, destination fixed effects, bilateral trade costs and a non-linear function of κ_j and μ_i. Specifically, I estimate the following gravity equation for each HS2 sector s (I suppress sector notation here):

$$\ln r_{ij} = \delta_i + \delta_j - (k+1)\ln \tau_{ij} + \ln\left[1 + (\kappa_j - \mu_i)\rho_{ij}\right] + \ln\left(\frac{1}{k(k+2)} + \frac{(\kappa_j + \mu_i)\rho_{ij}}{k(k+1)(k+2)}\right) \quad (24)$$

where origin fixed effects $\delta_i = \ln(N_i^E \left(c_M^i\right)^{-k})$ and destination fixed effects $\delta_j = \ln\left(L^j \left(c_D^j\right)^{k+2}\right)$. This form is the original Melitz and Ottaviano (2008) gravity equation with additional quality terms. Equation (24) has the advantage of explaining residuals in the original MO model. The ice-berg trade cost is proxied by several bilateral variables, so that the specification of 24 can be re-written as

$$\ln r_{ij} = \delta_i + \delta_j + \beta_1 Contig + \beta_2 Comlang + \beta_3 Colony + \beta_4 Comcol + \beta_5 Curcol + \beta_6 Smctry + \beta_7 LnDist + \beta_8 RTA + \beta_9 Comcur + \epsilon_{ij}$$

In the above specification, $Contig = 1$ if the exporter (i) and the importer (j) are contiguous, and $Contig = 0$ otherwise. $Comlang = 1$ if i and j share common official language, $Colony = 1$ if i and j have ever in colonial relationship, $Comcol = 1$ if i and j have a common colonizer after 1945, $Curcol = 1$ if i and j are currently in colonial relation, $Smctry = 1$ if i and j were the same country. $LnDist$ is the (log) distance between i and j. [26] The data of those variables are from CEPII GeoDist. Additionally, $RTA = 1$ if i and j have reached any trade agreements and $Comcur = 1$ if i and j are in the same currency union. This is from Sousa (2012).

An issue with the ordinary least squares (OLS) is the presence of zero trade as is discussed before. The above gravity equation can be subject to bias due to the existence of zero bilateral trade, which to some extent suggested by Table 4. As is argued by Helpman, Melitz, and Rubinstein (2008), disregarding country pairs that do not trade with each other can cause biased estimates on the data. Additionally, it is documented in their empirical study that half of countries do not trade with each other. To address such issue, I use Poisson Pseudo Maximum Likelihood (PPML) proposed by Silva and Tenreyro (2006) by including zero trade flows. The same estimation strategy is also used in Corcos et al. (2011).

Table 7 reports results from PPML estimates for selected sectors. At the first glance, the coefficients are within expectations. Specifically, distance has negative effects on trade flows. Regional trade agreements, common language and colonial relations can have positive

[26] This is the simple distance, which is the distance between the most populated cities of the two countries.

effects on bilateral trade. Common currency can have both positive and negative effects. It is noticeable that most other sectors not reported here have similar patterns in terms of trade cost proxies.

Given the estimated equation, I am able to back parameters of quality preferences and costs from the residuals. These parameters are recovered using residuals in specification (24). Although BACI covers more than 200 countries, only 168 of them have data on population in the Penn World Table. Thus, for each HS2 sector, I have at most 336 parameters to recover. There are much more residuals than parameters. Therefore, the system is over-identified and hence I employed a least square procedure to hunt for the optimal solution. [27]

I estimate those parameters for each sector and discovered stylized patterns from them. Table 8 reports the summary statistics of estimates of κ's for each sector; Table 9 reports the summary statistics of μ's. First, a comparison of Table 8 and Table 9 indicates that κ is on average larger than μ and tends to be more dispersed than μ. This to some extent implies that (dis) tastes for quality are more heterogeneous among countries than the technology of quality-improving. Second, a closer examination of Table 8 indicates that sectors differ in the dispersion of κ's across countries. For instance, HS 50 (textiles) has relatively small dispersion in κ, while HS 85 (electric motors and generators) has a very high dispersion. Thus, in some sectors countries tend to be homogeneous in preferences, while in other sectors countries can be divergent.

Table 10 attempts to explore the relation between the parameters and GDP per capita. Illustrations of the positive relation for 40 sectors are in the two panels of Figure 4. [28]. Table 10 presents coefficients in regressing estimated κ on GDP per capita for 63 HS 2 sectors. It is evident that the positive correlation between κ and GDP per capita exists in a subset of industries, while in other sectors insignificant effects exist. Comparing with Table 8, it is implied that sectors with medium level of dispersion tend to have κ correlated with GDP per capita. One caveat is that the formation of quality preferences κ is exogenous to the model. This differentiate with Feenstra and Romalis (2014) where quality preferences are modeled as endogenous to income. According non-homothetic preferences setup in Fajgelbaum and Khandelwal (2016), quality preference of a country can also depend on income inequality inside the country. In sum, consumer preferences result from multiple socio-economic con-

[27] Specifically, the optimal κ and μ satisfy: $[\kappa, \mu] = \frac{1}{N} argmin \sum_{ij} \left[\ln\left[1 + (\kappa_j - \mu_i)\rho_{ij}\right] + \ln\left(\frac{1}{k(k+2)} + \frac{(\kappa_j + \mu_i)\rho_{ij}}{k(k+1)(k+2)}\right) - \epsilon_{ij}\right]^2$, where N is the number of observations of trade flows in each sector.

[28] Consistent with Table 10, I illustrate those sectors where GDP per capita has positive and significant effect on κ

ditions and it is out of the scope of the this paper.

In addition, I also examine the correlation between cost of quality and country income. Table 11 reports coefficients on GDP per capita in regressing μ on GDP per capita. Compared with Table 10, significant effects appear in fewer sectors. In addition, 3 of these sectors exhibit negative and significant results. The correlation between the marginal cost and income is less explicit compared with preferences. The explanation for this has two sides: the positive association can be accommodated by the fact that richer countries have higher labor cost while the negative association can be explained by that richer countries have a comparative advantage in producing higher quality goods since the demand for higher-quality is larger.

4.3. Endogenous and Exogenous Competitiveness

After parameters of preferences and cost of quality are estimated in the last subsection, the cost cutoff for each country is computed using the parameters estimated in the last step. Specifically, I use average bilateral $f.o.b$ price in (17), the calculated trade cost and κ_j (and μ_i) to back out the cost threshold for each country. However, it is worth noting that price calculated using value divided by quantity is noisy even though units are converted to tons. This potentially results in multiple cost cutoffs for one country in one sector. Thus, I modify (17) by allowing noisy terms. To account for this, I regress price on trade costs, nonlinear terms of κ /μ and destination country fixed effects, as in the following specification:

$$\ln p_{ij} = cons + \ln\left[\frac{2k+1}{k+1} + \frac{1}{k+1}\left(\kappa_j + \mu_i\right)\rho_{ij}\right] - \beta_1 \ln \tau_{ij} + \psi_j + \epsilon_{ij} \tag{25}$$

In (25), the exponential of the coefficients on each of the destination fixed effects are the cost cutoffs. [29] This corresponds to the endogenous competitiveness in Corcos et al. (2011).[30]

With the cutoffs obtained from the empirical implementations, I back out cost upper bounds (exogenous competitiveness) c^i_M (multiplied by f_e) for each country i in each sector s. For this set of parameters, I use Equation (16) to back out exogenous competitiveness for each country/sector ($(c^i_M)^k f_e$) by the following relation:

$$f_e * c^k_M = \frac{B*L*c_D^{k+2}}{2\gamma(k+1)(k+2)}$$

[29]This follows from Allen and Atkin (2016), where preference parameters in that paper is recovered from good-level fixed effects.

[30]In Corcos et al. (2011), the cost cutoffs are computed using price index of countries in each sector. The practice is infeasible here due to data coverage issues.

where c_M^k is the vector of $(c_M^i)^k$ and c_D^{k+2} is the vector of $(c_D^i)^{k+2}$, which is estimated as in Equation (25). Matrix B is defined in the prior subsection. I also implement above two steps under M.O by eliminating all quality components in the relevant equations. Table 12a and Table 12b report results as summaries in estimations of exogenous competitiveness across sectors.

Exogenous competitiveness displays several characteristics. First, the levels of these statistics vary to a large extent across sectors. For example, for HS 50, the figures are in 10^{12}, while in other sectors the mean is below one. The cause in the large variation across sectors can be attributed to the different degrees of variations in the multiplication $[1 + (\kappa_j - \mu_i)\rho_{ij}]$ for different sectors.[31] The different degrees of variation results from the dispersion differences in κ and μ across sectors, which are analyzed in the prior subsection. Comparing with preference for quality, sectors having a large variation in κ can also have large variations in c_M^k. Another explanation could be that the sunk cost f_e vary across industries.

The similar estimation strategy is also implemented without quality considerations. This follows from multi-country Melitz and Ottaviano (2008) and Corcos et al. (2011). Subsequently, I compute c_D^{k+2} implied by the two models. The purpose of this practice is to compare the predicted endogenous competitiveness of the two models. Table 13 and Table 14 summarize cutoffs computed from the two different models across sectors. Illustrations of the distribution of cutoffs implied by both models for all sectors are displayed in the two panels of Figure 5. In comparison with the two models, several implications arise. Firstly, for most sectors, the levels of cutoffs are on the same scale: the means in cutoffs do not significant differ from each other. Second, for most sectors, the distribution of cutoffs are more dispersed under quality model than under the MO model: the variances in Table 13 is larger and for most sectors, cutoffs under quality sorting have higher maximum values and smaller minimum values. Those comparisons suggest that adding quality sorting enlarges the inequality among countries in competitiveness.

To further compare the two models, I summarize the differences in the predictions in cutoffs across countries for each sector. Figure 6 displays the kernel density of prediction differences across countries of various sectors. For most industries, the majority of differences lie around zero. The distribution in differences vary across sectors, which is observed from the skewness. For sectors such as HS 2 and HS 3, the difference distributions are nearly

[31] I perform the similar estimation of c_M^k following multi-country version of Melitz and Ottaviano (2008), typically, the means and standard deviations are smaller for almost all sectors.

normal so the probability of overestimation and underestimation are nearly equal. Right skewness occurs in sectors such as HS 74 and HS 82, indicating that quality model over-predicts more than it under-predicts. Left skewness happens in sectors such as HS 4 and HS 10 so that more under-estimates of quality model exist in these sectors. In general, within most sectors, predictive differences between the two models do not deviate to a large extent from zero.

5. Counterfactual Scenario

Having estimated the model, one can use it to simulate the effects of trade frictions/liberalizations. This is achieved by recomputing for each sector the (quality-adjusted) trade freeness matrix B while keeping the exogenous competitiveness, shape parameters and preference/costs for quality parameters constant. The resulting matrix is then used to compute new endogenous competitiveness. Specifically, the following statistic is to be computed:

$$\hat{c}_D^j = \frac{c_D^{'j}}{c_D^j} - 1$$

where $c_D^{'j}$ is the cutoff after trade liberalization. I estimated the above statistics under both this model and the M.O model and compare the differences between the two models to discover the underlying regularities leading to the differences.

Furthermore, I also experiment with preference and technological shocks. The purpose of the counterfactual is to explore the effect of preferences or technological progress (in improving quality) on endogenous competitiveness across countries and sectors. This practice is infeasible under the framework of Melitz and Ottaviano (2008) or other efficiency-based settings to the best of my knowledge. Thus, it is a significant contribution of this model.

5.1. International Trade Costs

The first exercise is to examine the effect of bilateral trade cost changes. I would like to examine the change in cutoffs across countries and sectors. I simulate a 5% increase in international trade cost while keeping intra-national trade costs constant. This counterfactual analysis is to examine the effect of protectionism on the endogenous competitiveness. This counterfactual analysis is relevant since the temptation of protectionism in the past decade has been large and increasing for a large number of policy makers. Thus there is possibility of introducing new external tariffs or other types of trade barriers.

As is noted above, I focus on two aspects: the changes in cutoffs and the differences in predictions implied by the two models. Table 15 summarizes the mean, standard deviation, minimum and maximum in the changes of cutoffs. Table 16 reports those statistics implied by Melitz and Ottaviano (2008). It is worth noting that in almost all sectors here, an increase in international trade cost (while keeping intra-national trade cost constant) can lead to a decrease in cost cutoff for some countries, regardless of the models. This decline in cutoff (or rise in the endogenous competitiveness) is justified by the rising entry of local producers since the relative cost of intra-national trade is cheaper than international costs. In the two-country case, consider that in MO with two countries, the cutoff is computed as

$$c_D^{i,k+2} = \frac{\gamma\phi}{L^i}\frac{1-\omega^j}{1-\omega^i\omega^j}$$

where $\omega_i = \tau_{ji}^{-k}$ and indicates the freeness of trade. If the both ω^j and ω^i increase, the change in cutoff is then

$$\Delta c_D^{i,k+2} = \frac{\gamma\phi}{L^i}\left(1-\omega^i\omega^j\right)^{-2}\left[(1-\omega^j)\omega^j\Delta\omega^i - (1-\omega^i)\Delta\omega^j\right]] \tag{26}$$

so that the direction of change in cutoff depends on the magnitudes of ω^i, ω^j and the degrees in the changes of both. Under the current model, ω^i and ω^j can be higher than 1, since in this model it is replaced with $\left[1+(\kappa_j-\mu_i)\,\rho_{ij}\right]\tau_{ij}^{-k}$ and thus the sign of Δc_D^{k+2} can be negative when $\Delta\omega^j$ and $\Delta\omega^i$ are negative.

Nonetheless, the aggregate cutoffs increase, for both models. A closer examination of the two sets of results implies the following regularities. First, the mean changes are all positive for both models, with the changes implied by the quality models higher than the MO model for most sectors. This difference can be partially driven by the higher maximum value in Table 15 (for most sectors). Second, and related to the prior section, the variance of changes is larger under this model. This is connected with the prior section in that variance under this model is higher than under Melitz and Ottaviano (2008) with additional quality components. Finally, under both models, the maximum of the change is larger than 1 for all sectors. Thus, the magnitude of effect on endogenous competitiveness is larger than the degree of trade cost rise.

Finally, it is worth exploring the underlying forces driving these changes. The focal points lie in whether such difference is systematic across countries in some (or all) sectors. If such regularities exist, then one can argue that these changes are not randomly driven.

For all sectors, I attempt to correlate with quality preference of each country.[32] In the two panels of Figure 7, I tried to plot the (log) quality preferences with the prediction differences (changes predicted by this model minus changes predicted by MO).[33] All else being equal, the higher the quality preference of the country, the larger the predicted difference between the current model and MO model. This result indicates that in models with quality preference differentials across countries, the disparity in terms of loss from higher trade barriers is larger than in models without quality considerations. This implication is to some extent consistent with simulations on the market size by Antoniades (2015), in which it is shown that larger market size results in larger cutoff decrease in countries with higher quality preferences.

5.2. Preference/Cost Changes

The second counterfactual exercise is to examine the effect of a universal preference or technology shocks on endogenous competitiveness. This analysis is infeasible under models of MO or other models based on the efficiency sorting of heterogeneous firms in international trade. It is perceived to be relevant since consumers' preferences are changing over time. Although quality preferences are exogenous to this model, they can be altered in several ways. An increase in quality preference can result from higher expectations of consumers for the products they purchase. For instance, in food industry, food safety issues motivate more consumers to pursue organic food, which is perceived to be high-quality, thus raising the willingness-to-pay (Grunert 2005). The pervasiveness of advertisements and other multi-media can also shape consumers' preference for high quality products. Apart from that technology progress drives down the cost of quality updates.

Essentially, the two changes are consistent. As is shown in the model, higher preference and lower marginal cost in quality raise the scope for quality differentiation. Therefore, I combine the two exercises by adding/ subtracting 0.1 units in either κ_j/ μ_i in computing ρ_{ij}. All else being equal, individual producers entering each market raise product quality and charge higher prices. If other conditions remain unchanged, resulting cost cutoffs are lowered. In the long run, a trade diversion effect can occur in that a subset of countries can experience a rise in their cost cutoffs. This arises since the cutoff of each country depends on

[32] I also attempt to link them with cost of quality of each country. However, no systematic regularities are found.

[33] I find similar patterns in the following sectors: HS2, HS4, HS7, HS8, HS9, HS11, HS15, HS16, HS17, HS18, HS19, HS35, HS36, HS38, HS39, HS52, HS58, HS63, HS64, HS65, HS69, HS73, HS76, HS81, HS86, HS95 and HS96.

both its own κ (and μ) and others' κ (μ). This can be explained in detail in Equation (26) if one replaces ω_i with $\left[1 + (\kappa_i - \mu_j)\,\rho_{ji}\right]\tau_{ji}^{-k}$. Therefore, the direction of change in cutoffs depends on the magnitudes of κ and μ across countries.

As is expected, trade diversion occurs in a few countries. Table 17a and 17b summarize the percentage changes in cost cutoffs across countries. Figure 8 visualizes the changes using the world map. I compute the weighted cutoff changes for each country. The weight is calculated as an industry's share of total value of imports of a country. Although the majority experience rising market competitiveness revealed in declining cost cutoffs, 25 of them have the opposite change. Overall, the magnitude of increase in cost cutoffs is lower than decrease: the decrease in cost cutoffs ranges from around 500% to around 0.6%. Thus positive preference or technology shocks brings more positive effects on productivity improving globally. A further plot in Figure 8 reveals that the more than half of the countries have their declines in cutoffs falling less than 141.2%. The change in endogenous competitiveness falling in the range of $[-141.2, 0.58]$ occupies the most area.

Large countries generally gain more than small economies. This can be supported from the optimal quality choice in (9). Loss in utility which is revealed from rise in cost cutoff occur mostly in small economies. The justification of this observation can be that small economies have smaller scopes for quality differentiation, thus firms have less incentive to sell high-quality goods. Faced with the same degree of preference rise, firms are diverted to sell higher-quality goods to larger markets. I prove that by regressing gains from trade on their (log) population and other country level controls in Table (18). They reveal negative relationship between the change in cost cutoffs and population size. This exercise implies that market size is negative associated with changes in cost cutoff, i.e., positively related to changes in productivity and welfare gains. On average, 1% rise in population size leads to 7.876% more gains in productivity. However, one caveat is that the aggregate gain in productivity is affected by other factors such as compositions of imports of a country.

6. Conclusion

This paper extends a theory on quality with endogenous markups. Theoretical framework is of multi-country type, which is a generalization of two-country model commonly used in Melitz and Ottaviano framework. Different from competition on cost, the theory identifies that in some sectors and countries, firms can also compete on quality. Tough competition featured by larger market, lower trade cost and higher preference for quality are more likely to induce firms to improve quality. The selection effect is larger when quality differentiation scope is wide.

Empirical study is undertaken to compare this theory with efficiency framework. Structural estimation is used to identify relevant parameters. These parameters are later used to compute cutoffs and average prices under quality competition. The same steps are used to compute counterparts under efficiency competition. The structural estimation implies that considering quality differentials among countries enlarges heterogeneities in competitiveness. The counterfactual study points out that in most sectors, the higher the quality preference of a country, the larger the loss from rising trade barrier, compared with Melitz and Ottaviano. Finally, positive universal preference shocks generally bring more gains to larger countries.

Though the paper addresses the importance of considering quality preference differentials across countries, it still has insufficiencies in investigating this issue. This study can be extended to examine the spatial distribution in quality preferences and technologies, using more disaggregated data, such as China Customs Trade Statistics and China Inter-Provincial Input-Output Statistics. Furthermore, one can compare the impacts of international and intra-national trade costs on competitiveness of different regions in China, under both the current model and Melitz-Ottaviano model.

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Appendix

A. Multi-Product Extension

A.1. Setup

The theoretical model is based on single product. The setup in the model assumes that each firm produces one product only. However, it can be generalized to assume that each firm produces multiple products and sells to multiple countries. The utility function in (1) and the production cost in (4) remain unchanged. I follow Mayer, Melitz, and Ottaviano (2014) by assuming that there exist "product ladder" with increasing customization cost for products further from the core product. Specifically, I assume that each product m produced by a firm with core marginal cost c incurs the marginal cost of

$$v(m,c) = \lambda^{-m}c \tag{A.1}$$

with $\lambda \in (0,1)$.

In the above setup, more peripheral products require higher customization costs. In (A.1), m is positive and represents the distance from the core product of firm c: $m = 0$ indicates that product m is the core product and higher m implies that product m requires higher adjustment cost. Higher m reflects decreasing product appeal. Thus, if a firm in country i decides to sell product m to country j, its total cost becomes

$$TC_{ij}(c,m) = q(c,m)(c + \mu_j z(c,m)) + \delta z(c,m)^2 \tag{A.2}$$

and its problem becomes:

$$\pi_{ij}(c,m) = \max_{q_j(c,m), z_j(c,m)} p_{ij}(c,m) q_{ij}(c,m) - TC_{ij}(c,m) \tag{A.3}$$

Similar to the case of single-product model, one can derive the optimal quality of product m as

$$z_{ij}(c,m) = \rho_{ij}(c_D^j - \tau_{ij}\lambda^{-m}c) \tag{A.4}$$

where $\rho_{ij} = L^j(\kappa_j - \mu_i)/\left(4\delta\gamma - L^j(\kappa_j - \mu_i)^2\right)$. Therefore, within a firm, more peripheral products are sold with lower quality. More productive firms provide higher-quality core products. Additionally, products are affected differently within a firm. A simple algebra in (A.4) implies that competitiveness of market j (revealed in trade costs and market size) imposes heterogeneous effects on products of different hierarchies. To see this, the first-order derivative of $z_{ij}(c,m)$ with respect to τ_{ij} is

$$\frac{\partial z_{ij}(c,m)}{\partial \tau_{ij}} = \rho_{ij}\left(\frac{\partial c_D^j}{\partial \tau_{ij}} - \lambda^{-m} c\right)$$

That derivative with respect to m is then

$$\frac{\partial^2 z_{ij}(c,m)}{\partial \tau_{ij}\partial m} = \rho_{ij} c \lambda^{-m} \ln \lambda \leq 0 \tag{A.5}$$

since $0 < \lambda < 1$. From (A.5), the second order derivative implies that products closer to the core (lower m) are affected by market competition more significantly.

The number of products a firm can offer to the destination market depends on the firm-level marginal cost c. Firms with lower marginal cost c generally produce more products to a destination market. If the cost cutoff to export from i to j is c_x^{ij}, the number of products the firm $c \leq c_x^{ij}$ offers is

$$M_{ij}(c) = \max\left\{m \mid c \leq c_x^{ij}\lambda^m\right\} + 1$$

the total profit of firm c in exporting to country j is the sum of profits from all products:

$$\Pi_{ij}(c) = \sum_{m=0}^{M_{ij}(c)} \pi_{ij}(c,m) \tag{A.6}$$

A.2. Equilibrium

Similar to single product setting, a firm draws its marginal cost c prior to entry to the market with sunk cost f_e. The expected profit from selling to all markets equal to the sunk cost in equilibrium. The total expected profit can then be decomposed into profits from each product sold to each destination. This can then be expressed as

$$\sum_{j\in J}\int_0^{c_x^{ij}} \Pi_{ij}(c) dG(c) = \sum_{j\in J}\sum_{m=0}^{\infty}\left[\int_0^{\lambda^m c_x^{ij}} \pi_{ij}(c,m) dG(c)\right] = f_e \tag{A.7}$$

Again, I assume Pareto distribution of c. Thus the expected profit of a firm in country i can be expressed as

$$\frac{2c_M^{-k}}{(k+1)(k+2)}\left(1-\lambda^k\right)^{-1}\sum_{j\in J}\frac{L_j}{4\gamma}\left[1+\left(\kappa_j-\mu_i\right)\rho_{ij}\right]\tau_{ij}^{-k}\left(c_D^j\right)^{k+2} = f_e \tag{A.8}$$

The above form can be re-written for J countries. Thus, one can write the condition (A.8) in the matrix form in a similar manner as in single product setting. The cutoff c_D^j satisfies the following:

$$\left(c_D^j\right)^{k+2} = \frac{2\gamma(k+1)(k+2)(1-\lambda^k)f_e}{\mid B \mid}\frac{\sum_i C_{ij}\left(c_M^i\right)^k}{L_j} \tag{A.9}$$

where $\mid B \mid$ is the determinant of matrix B and C_{ij} is the cofactor of B_{ij}. Other parameters in (A.9) are defined in the similar manner as in single product setting. It is implied from the above condition that endogenous competitiveness can also depend on product flexibility λ: if $(1-\lambda^k)^{-1}$ is large, the cutoff is small and the market is more competitive.

Other aggregate variables are derived in the similar approach as in single product setup. It is important to notice that the product flexibility can vary across countries and sectors. The aggregate bilateral trade value from i to j also depends on the product flexibility and larger flexibility implies higher bilateral trade value. The expected number of entrants are also determined by the product flexibility.

$$r_{ij} = \frac{kN_i^E(c_m^i)^{-k}}{2(1-\lambda^k)\gamma}L^j(\tau_{ij})^{-(k+1)}\left(c_D^j\right)^{k+2}\left[1+(\kappa_j-\mu_i)\rho_{ij}\right]\left(\frac{1}{k(k+2)}+\frac{(\kappa_j+\mu_i)\rho_{ij}}{k(k+1)(k+2)}\right) \tag{A.10}$$

For computing the number of entrants, the matrix F becomes

$$\frac{2\gamma(k+1)(1-\lambda^k)(\alpha-c_D^i)}{\eta c_D^{i,k+1}}$$

B. Proofs of Propositions

B.1. Proof of Proposition 1

By the free entry condition in 15, we can obtain J conditions in the following form:

$$\left[1+(\kappa_1-\mu_i)\rho_{i1}\right]L_1\tau_{i1}^{-k}(c_D^1)^{k+2}+...+\left[1+(\kappa_J-\mu_i)\rho_{iJ}\right]L_J\tau_{iJ}^{-k}(c_D^J)^{k+2} = 2\gamma(k+1)(k+2)f_e c_M^k \tag{B.1}$$

When $\tau_{ij} = \tau_{ji}$ and when there is a bilateral trade liberalization, the first-order condition with respect to $\tau_{ij}(\tau_{ji})$ implies the following:

$$\sum_{d\in J} B_{dd'}L_{d'}\frac{\partial(c_D^{d'})^{k+2}}{\partial\tau_{ij}^{-k}} = 0 \tag{B.2}$$

if $d \neq i, j$

and

$$\sum_{d' \in J} B_{id'} L_{d'} \frac{\partial (c_D^{d'})^{k+2}}{\partial \tau_{ij}^{-k}} + \frac{B_{ij}}{\tau_{ij}^{-k}} L_j (c_D^j)^{k+2} = 0 \tag{B.3a}$$

$$\sum_{d' \in J} B_{jd'} L_{d'} \frac{\partial (c_D^{d'})^{k+2}}{\partial \tau_{ji}^{-k}} + \frac{B_{ji}}{\tau_{ji}^{-k}} L_i (c_D^i)^{k+2} = 0 \tag{B.3b}$$

for countries i and j respectively.

Since $\frac{B_{ji}}{\tau_{ji}^{-k}} L_i c_D^i > 0$ and $\frac{B_{ij}}{\tau_{ij}^{-k}} L_j c_D^j > 0$, from (B.3), at least one of $\frac{\partial (c_D^{d'})^{k+2}}{\partial \tau_{ji}^{-k}}$ (or $\frac{\partial (c_D^{d'})^{k+2}}{\partial \tau_{ji}^{-k}}$, $d' \in \{1, ..., J\}$) is negative. However, if all of them are negative, the condition in (B.2) cannot be satisfied. The conditions in (B.2) and (B.3) can be written in the matrix form:

$$\mathbf{BLc'} = \mathbf{F} \tag{B.4}$$

where $\mathbf{B}$ and $\mathbf{L}$ is defined the same as in Section 3. $\mathbf{c'}$ is the vector with the d th element being $\partial (c_D^d)^{k+2} / \partial \tau_{ij}^{-k}$. On the right hand side, $\mathbf{F}$ is the vector with ith element being $-\frac{B_{ij}}{\tau_{ij}^{-k}} L_j c_D^j$, j th element being $-\frac{B_{ij}}{\tau_{ij}^{-k}} L_j c_D^j$ and other elements being 0. Thus, the sign of $\partial (c_D^d)^{k+2} / \partial \tau_{ij}^{-k}$ depend on those two non-zero elements, determinant and the cofactors of matrix $\mathbf{B}$:

$$\partial (c_D^d)^{k+2} / \partial \tau_{ij}^{-k} = -\frac{1}{\mid B \mid} \left(C_{di} \frac{B_{ij}}{\tau_{ij}^{-k}} L_j (c_D^j)^{k+2} + C_{dj} \frac{B_{ij}}{\tau_{ij}^{-k}} L_j (c_D^j)^{k+2} \right) \tag{B.5}$$

where C_{di} is the di th element in the cofactor matrix of $\mathbf{B}$.

B.2. Proof of Proposition 2

The proof of Proposition 2 is similar to Proposition 1. Taking the derivative of Equation (B.1) with respect to κ_j, one can obtain J equations in the following form:

$$\sum_{h \in J} B_{ih} L_h \frac{\partial (c_D^h)^{k+2}}{\partial \kappa_j} + \frac{\partial B_{ij}}{\partial \kappa_j} L_j (c_D^j)^{k+2} = 0 \tag{B.6}$$

In the matrix form, (B.6) can be written as

$$\mathbf{BL} \frac{\partial \mathbf{c}_D^{k+2}}{\partial \kappa_j} = \mathbf{G} \tag{B.7}$$

where $\mathbf{G}$ is the vector with with ith element being $\frac{\partial B_{ij}}{\partial \kappa_j} L_j (c_D^j)^{k+2} > 0$.

Thus, the vector of partial derivatives can be computed as:

$$\frac{\partial (c_D^i)^{k+2}}{\partial \kappa_j} = -\frac{L_j (c_D^j)^{k+2}}{L_i \mid B \mid} \sum_{h \in J} \mid C_{ih} \mid \frac{\partial B_{hj}}{\partial \kappa_j} \tag{B.8}$$

The sign of $\frac{\partial (c_D^i)^{k+2}}{\partial \kappa_j}$ depends on the determinant of $\mathbf{B}$ as well as its cofactors. By the definition of $\mathbf{B}$, $\frac{\partial B_{hj}}{\partial \kappa_j} > 0$, $\forall\, h$. Therefore, $\exists\, \mathbf{B}$ such that $\frac{\partial (c_D^i)^{k+2}}{\partial \kappa_j} > 0$, $\forall\, i,\, j$.

B.3. Proof of Proposition 3

Taking the derivative of (B.6) with respect to τ_{ij} (τ_{ji}), one can obtain two sets of equations, if the origin country is i or j, the following holds:

$$\sum_{h \in j} B_{i(j)h} L_h \frac{\partial^2 (c_D^h)^{k+2}}{\partial \kappa_j \partial \tau_{ij}^{-k}} + L_j \frac{\partial B_{i(j)j}}{\partial \tau_{ij}^{-k}} \frac{\partial (c_D^j)^{k+2}}{\partial \kappa_j} + \frac{\partial^2 B_{i(j)j}}{\partial \kappa_j \partial \tau_{ij}^{-k}} L_j (c_D^j)^{k+2} + L_j \frac{\partial B_{i(j)j}}{\partial \kappa_j} \frac{\partial (c_D^j)^{k+2}}{\partial \tau_{ij}^{-k}} = 0 \tag{B.9}$$

where $\frac{\partial B_{ij}}{\partial \tau_{ij}^{-k}} > 0$. If the origin country is not i or j, the following shall hold:

$$\sum_{h \in J} B_{dh} L_h \frac{\partial^2 (c_D^h)^{k+2}}{\partial \kappa_j \partial \tau_{ij}^{-k}} + L_j \frac{\partial B_{dj}}{\partial \kappa_j} \frac{\partial (c_D^j)^{k+2}}{\partial \tau_{ij}^{-k}} = 0 \tag{B.10}$$

If $\frac{\partial (c_D^j)^{k+2}}{\partial \tau_{ij}^{-k}}$, $\frac{\partial (c_D^j)^{k+2}}{\partial \kappa_j} < 0$, $\exists\, \mathbf{B}$ such that $\frac{\partial^2 (c_D^h)^{k+2}}{\partial \kappa_j \partial \tau_{ij}^{-k}} < 0$.

From the above polynomial equations, the higher B_{dh}, the lower $\frac{\partial^2 (c_D^h)^{k+2}}{\partial \kappa_j \partial \tau_{ij}^{-k}}$, i.e. more like that $\frac{\partial^2 (c_D^h)^{k+2}}{\partial \kappa_j \partial \tau_{ij}^{-k}} < 0$.

C. Productivity Estimation

I construct the firm-level measures based on the ORBIS enterprise database of Bureau van Dijk (BvD). This dataset provides comprehensive information on listed and de-listed private companies around the world. I use the financial module of the database. It provides firm-level financial report items including total revenues, employment, total assets, and research and development (R&D) expenses.[34]

I follow long-established methods of estimating firm productivity as a residual of Cobb-Douglas production function. In this regard, both methodologies proposed by Olley and

[34] Data are downloaded in US dollars.

Pakes (1996) (OP) and Levinsohn and Petrin (2003) (LP) are possible candidates given the current dataset. I choose to estimate firm productivity based on LP, because the LP approach relies on intermediate inputs as a proxy rather than on investment, whose level may be non-positive and depends on the assumption of the depreciation rate. On the other hand, it is common that firms record positive use of materials/energy so that I preserve as many observations as possible.[35]

I choose to download recent 10 years of financial data for each firm. The missing values exist. Thus, this is an unbalanced panel. The procedure to estimate productivity is as follow. First, gross output, capital and total inputs are proxied by total revenues, total assets, and Costs of Goods Sold (COGS), respectively. The cost of material/energy (in short, material, henceforth) is calculated by COGS minus total wage payable, by the accounting definition of COGS, if material cost is unavailable. Second, these values are deflated to obtain the quantity counterpart.[36] The number of employees are directly observable from the data. Given the observations on gross output, labor, material, and capital, I estimate the production function based on the Stata program *levpet* using as instruments current capital, lagged material, lagged labor, lagged two year material and lagged capital. Because industries can vary in their production technologies, the estimation is done separately for each 3-digit NAICS sector.

[35] I also use OP as a robustness check and estimated productivities are similar.

[36] The total sales revenues are deflated by Consumer Price Index (CPI), the total assets deflated by the index of fixed asset investment deflator, and the material normalized by Producer Price Index (PPI). Currently, I use the US CPI (Total All Items) and PPI (for All Commodities), and construct the index of fixed asset investment deflator from gross fixed investment flows. They are retrieved from the US Federal Reserve Bank of St. Louis website, https://fred.stlouisfed.org/.

Table 1: Price and Destination Country Population

	Dependent Variable: ln($price$)			
	ln(p_{fhc})		ln(p_{hc})	
	(1)	(2)	(3)	(4)
(log) Population	0.035***	0.051***	0.208***	0.245***
	(0.000)	(0.000)	(0.001)	(0.001)
Country-level Controls	No	Yes	No	Yes
Firm FE	Yes	Yes	No	No
Product FE	Yes	Yes	Yes	Yes
Observations	11,224,467	11,038,879	449,135	440,783
R-Squred	0.697	0.698	0.763	0.780

Notes: *** p < 0.01, ** p < 0.05, * p < 0.1. Robust standard errors are in parentheses. The dependent variable in specifications (1)-(2) is the (log) price at the firm-HS8-country level, and in specifications (3)-(4) is the (log) price at the HS8-country level. Country-level other controls include GDP per capita and distance. All regressions include a constant term.

Table 2: Price and Revenue

	Dependent Variable: ln(*price*)			
	$\ln(p_{fhc})$		$\ln(p_{fh})$	
	(1)	(2)	(3)	(4)
$\ln(Revenue)$	0.154***	0.155***	0.206***	0.210***
	(0.000)	(0.000)	(0.000)	(0.000)
$\ln(Revenue) * RD\_Intensity$		0.048***		0.009
		(0.005)		(0.009)
Firm FE	Yes	Yes	Yes	Yes
Product FE	Yes	Yes	Yes	Yes
Observations	12,476,096	11,070,256	4,146,176	3,660,845
R-Squred	0.696	0.695	0.722	0.725

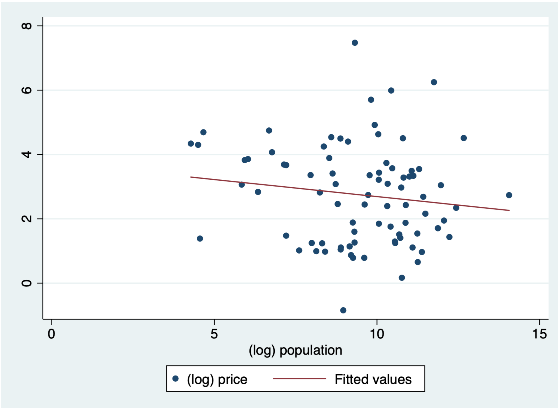
Notes: *** p < 0.01, ** p < 0.05, * p < 0.1. Robust standard errors are in parentheses. The dependent variable in specifications (1)-(2) is the (log) price at the firm-HS8-country level, and in specifications (3)-(4) is the (log) price at the firm-HS8 level. *RD_Intensity* is compiled by Kroszner, Laeven, and Klingebiel (2007) at ISIC level, which can be converted to HS 6 codes. All regressions include a constant term.

Table 3: Price and Entry

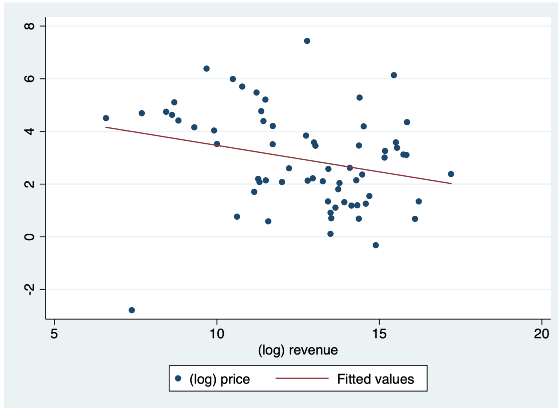
	Dependent Variable: ln(*price*)			
	$\ln(p_{fh})$		$std.(\ln(p_{fh}))$	
	(1)	(2)	(3)	(4)
Num_Destinations	0.007***	0.006***	0.006***	0.005***
	(0.000)	(0.000)	(0.000)	(0.000)
Num _Destinations*RD_Intensity		0.009***		0.015***
		(0.001)		(0.000)
Firm FE	Yes	Yes	Yes	Yes
Product FE	Yes	Yes	Yes	Yes
Observations	11,622,117	10,314,550	9,069,247	8,065,339
R-Squred	0.681	0.680	0.459	0.463

Notes: *** p < 0.01, ** p < 0.05, * p < 0.1. Robust standard errors are in parentheses. The dependent variable in specifications (1)-(2) is the (log) price at the firm-HS8 level, and in specifications (3)-(4) is the standard deviation of (log) prices at the firm-HS8 level. *RD_Intensity* is compiled by Kroszner, Laeven, and Klingebiel (2007) at ISIC level, which can be converted to HS 6 codes. All regressions include a constant term.

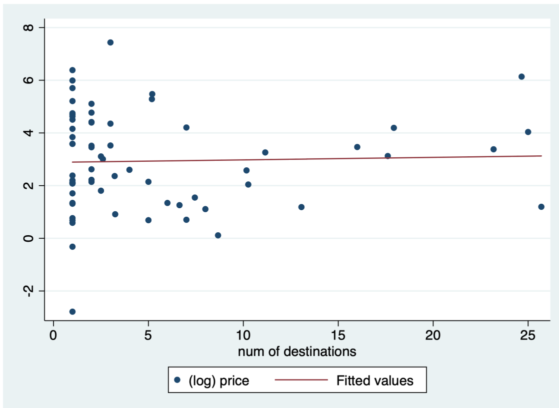
Figure 1: Price, Revenue and Destination Market Characteristics HS 24



(a) Price and Market Size: HS 24



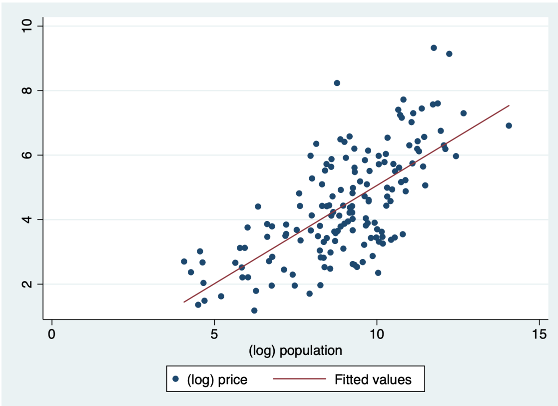
(b) Price and Revenue: HS 24



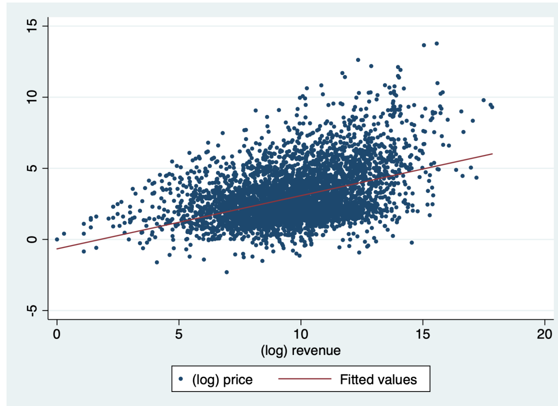
(c) Price and Market Entry: HS 24

Note: The three figures show the correlation between average (log) price across firms exporting to a destination and destination market size (Panel a), average (log) price and average (log) revenue across destinations of each firm (Panel b), and average (log) price of a firm across destinations and average number of markets a firm enters (Panel c), of firms in sector HS 24 (Tobacco). Market size is proxied by population size and the data is from Penn World Table.

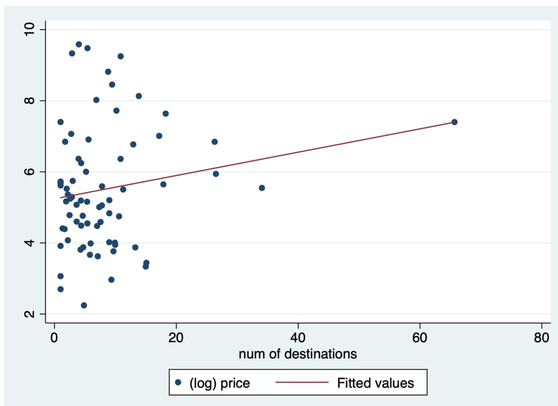
Figure 2: Price and Destination Market Size



(a) Price and Market Size: HS 30



(b) Price and Revenue: HS 30



(c) Price and Market Entry: HS 30

Note: The three figures show the correlation between average (log) price across firms exporting to a destination and destination market size (Panel a), average (log) price and average (log) revenue across destinations of each firm (Panel b), and average (log) price of a firm across destinations and average number of markets a firm enters (Panel c), of firms in sector HS 30 (Pharmaceutical). Market size is proxied by population size and the data is from Penn World Table.

Table 4: Description of HS 2-digit Industries and Number of Observations

HS 2	Obs	HS 2	Obs	HS 2	Obs	HS 2	Obs
2	30,707	24	6,503	51	1,780	73	27,812
3	58,406	30	28,032	52	3,047	74	6,489
4	27,854	32	3,420	54	900	76	3,604
6	2,998	33	58,712	55	1,928	82	31,914
7	53,205	34	30,956	57	29,694	83	6,406
8	53,451	35	3,713	58	500	84	47,596
9	36,534	36	1,750	59	1,035	85	91,988
10	3,848	37	902	61	234,282	87	21,361
11	4,079	38	15,284	62	265,844	88	1,515
15	13,055	39	31,740	63	74,382	89	8,254
16	29,784	40	16,135	64	66,311	90	31,572
17	11,371	42	59,404	65	14,244	91	29,964
18	12,387	43	3,802	66	6,506	92	16,893
19	39,318	44	12,643	67	4,578	93	3,776
20	76,252	46	6,690	68	1,477	94	61,268
21	34,332	48	46,325	69	16,443	95	52,143
22	47,661	49	31,867	70	19,589	96	46,185
23	2,307	50	395	71	22,075	97	11,678

Note: This table summarizes the number of bilateral trade transaction observations within each HS 2 sector. Raw Data source is from CEPII

Table 5: Summary of Importing Countries' Products

Country	Obs	Country	Obs	Country	Obs	Country	Obs	Country	Obs
AFG	902	CCK	86	GUY	935	MAR	1,194	STP	687
ALB	1,063	COL	1,103	HTI	780	MOZ	1,123	SAU	1,152
DZA	1,094	COM	797	HND	966	OMN	1,136	SEN	1,045
ASM	250	COG	1,064	HKG	1,195	NRU	364	SYC	868
AND	1,030	ZAR	998	HUN	1,171	NPL	1,010	SLE	701
AGO	1,127	COK	692	ISL	1,119	NLD	1,201	IND	1,107
ATG	992	CRI	1,108	IDN	1,148	ABW	1,085	SGP	1,184
AZE	1,096	HRV	1,157	IRN	945	NCL	1,094	SVK	1,177
ARG	1,036	CUB	863	IRQ	1,041	VUT	720	VNM	1,145
AUS	1,172	CYP	1,156	IRL	1,182	NZL	1,142	SVN	1,160
AUT	1,186	CZE	1,181	ISR	1,139	NIC	1,015	SOM	611
BHS	1,123	BEN	882	ITA	1,203	NER	821	ZAF	1,164
BHR	1,155	DNK	1,192	CIV	1,093	NGA	1,130	ZWE	1,054
BGD	931	DMA	488	JAM	1,082	NIU	299	ESP	1,209
ARM	1,019	DOM	1,132	JPN	1,214	NFK	289	SUR	958
BRB	1,141	ECU	1,016	KAZ	1,157	NOR	1,171	SWE	1,187
BEL	1,207	SLV	1,062	JOR	1,125	MNP	294	CHE	1,187
BMU	1,104	GNQ	827	KEN	1,085	FSM	596	SYR	823
BTN	246	ETH	1,020	PRK	747	MHL	306	TJK	743
BOL	969	ERI	302	KOR	1,180	PLW	707	THA	1,180
BIH	1,092	EST	1,163	KWT	1,149	PAK	1,014	TGO	896
BRA	1,128	FLK	382	KGZ	983	PAN	1,143	TKL	95
BLZ	897	FJI	1,038	LAO	733	PNG	948	TON	732
IOT	32	FIN	1,171	LBN	1,143	PRY	992	TTO	989
SLB	531	FRA	1,223	LVA	1,164	PER	1,071	ARE	1,187
VGB	630	PYF	1,066	LBR	741	PHL	1,213	TUN	1,076
BRN	1,076	ATF	164	LBY	1,021	PCN	21	TUR	1,143
BGR	1,165	DJI	796	LTU	1,160	POL	1,181	TKM	888
MMR	936	GAB	939	MAC	1,047	PRT	1,192	TCA	519
BDI	698	GEO	1,093	MDG	898	GNB	462	TUV	231
BLR	1,132	GMB	720	MWI	952	TMP	802	UGA	984
KHM	968	PAL	804	MYS	1,184	QAT	1,159	UKR	1,158
CMR	894	DEU	1,208	MDV	1,046	ROM	1,178	EGY	1,112
CAN	1,198	GHA	1,112	MLI	762	RUS	1,187	GBR	1,205
CPV	919	GIB	970	MLT	1,161	RWA	884	TZA	1,035
CYM	751	KIR	549	MRT	843	SHN	354	USA	1,238
CAF	343	GRC	1,184	MUS	1,120	KNA	501	BFA	854
LKA	1,047	GRL	1,000	MEX	1,168	AIA	314	URY	1,065
TCD	589	GRD	538	TWN	1,167	LCA	679	UZB	874
CHL	1,113	GUM	583	MNG	1,007	SPM	538	VEN	1,100
CHN	1,182	GTM	1,103	MDA	1,078	VCT	499	WLF	451
CXR	261	GIN	869	MSR	164	SMR	389	WSM	806
YEM	950	ZMB	1,063						

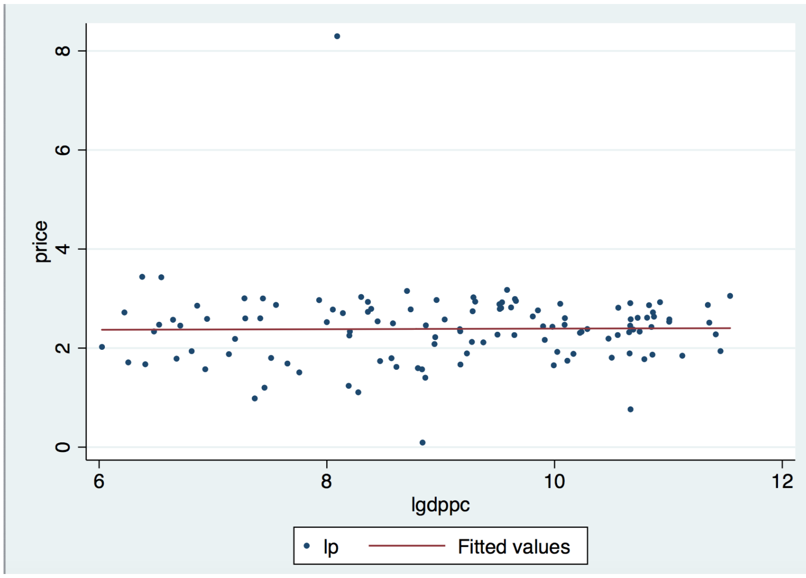
Note: This table summarizes the number of import transaction observations for each country. Raw Data source is from CEPII

Table 6: Summary of Exporting Countries' Products

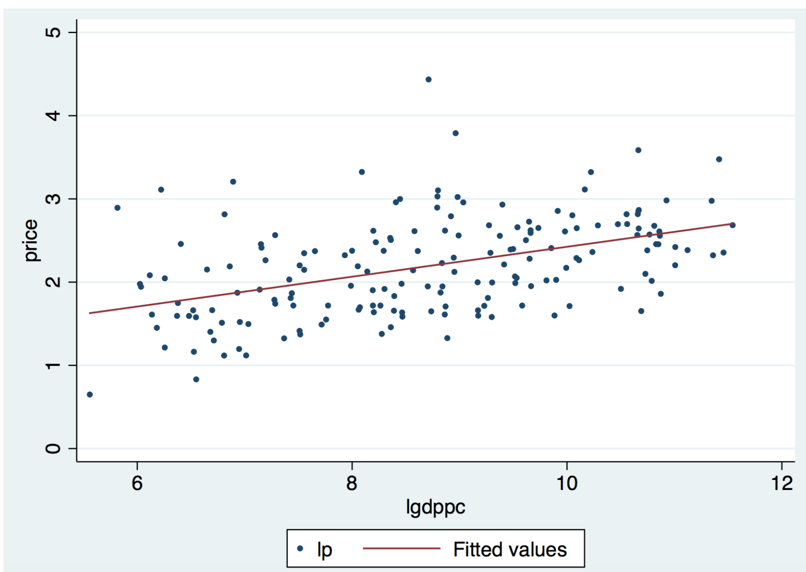
Country	Obs	Country	Obs	Country	Obs	Country	Obs	Country	Obs
AFG	277	CCK	34	GUY	280	MAR	1,024	STP	53
ALB	622	COL	973	HTI	239	MOZ	360	SAU	888
DZA	296	COM	118	HND	635	OMN	706	SEN	588
ASM	128	COG	178	HKG	1,163	NRU	80	SYC	208
AND	387	ZAR	240	HUN	1,124	NPL	571	SLE	241
AGO	158	COK	67	ISL	626	NLD	1,212	IND	1,167
ATG	219	CRI	881	IDN	1,135	ABW	201	SGP	1,180
AZE	414	HRV	1,029	IRN	737	NCL	377	SVK	1,095
ARG	1,027	CUB	186	IRQ	198	VUT	106	VNM	1,105
AUS	1,190	CYP	923	IRL	1,150	NZL	1,145	SVN	1,092
AUT	1,168	CZE	1,173	ISR	1,004	NIC	497	SOM	75
BHS	301	BEN	230	ITA	1,231	NER	242	ZAF	1,186
BHR	839	DNK	1,185	CIV	564	NGA	608	ZWE	466
BGD	755	DMA	152	JAM	537	NIU	25	ESP	1,242
ARM	509	DOM	854	JPN	1,172	NFK	7	SUR	331
BRB	505	ECU	786	KAZ	743	NOR	1,090	SWE	1,167
BEL	1,204	SLV	765	JOR	804	MNP	110	CHE	1,120
BMU	130	GNQ	25	KEN	937	FSM	44	SYR	683
BTN	44	ETH	508	PRK	432	MHL	62	TJK	230
BOL	443	ERI	50	KOR	1,152	PLW	18	THA	1,179
BIH	801	EST	1,095	KWT	814	PAK	1,014	TGO	478
BRA	1,078	FLK	34	KGZ	492	PAN	960	TKL	146
BLZ	241	FJI	804	LAO	317	PNG	148	TON	84
IOT	33	FIN	1,086	LBN	1,002	PRY	417	TTO	507
SLB	47	FRA	1,254	LVA	1,119	PER	968	ARE	1,173
VGB	198	PYF	297	LBR	71	PHL	1,076	TUN	903
BRN	427	ATF	16	LBY	142	PCN	26	TUR	1,152
BGR	1,109	DJI	72	LTU	1,138	POL	1,177	TKM	141
MMR	508	GAB	213	MAC	633	PRT	1,195	TCA	129
BDI	115	GEO	670	MDG	613	GNB	33	TUV	27
BLR	949	GMB	163	MWI	274	TMP	69	UGA	627
KHM	616	PAL	428	MYS	1,156	QAT	484	UKR	998
CMR	421	DEU	1,226	MDV	153	ROM	1,096	EGY	1,015
CAN	1,186	GHA	645	MLI	252	RUS	1,147	GBR	1,218
CPV	141	GIB	85	MLT	660	RWA	303	TZA	640
CYM	76	KIR	34	MRT	167	SHN	40	USA	1,265
CAF	46	GRC	1,153	MUS	801	KNA	46	BFA	306
LKA	971	GRL	95	MEX	1,131	AIA	36	URY	656
TCD	33	GRD	80	TWN	1,106	LCA	88	UZB	371
CHL	1,036	GUM	353	MNG	292	SPM	81	VEN	573
CHN	1,267	GTM	933	MDA	650	VCT	69	WLF	10
CXR	43	GIN	216	MSR	17	SMR	184	WSM	176
YEM	323	ZMB	487						

Note: This table summarizes the number of export transaction observations for each country. Raw Data source is from CEPII

Figure 3: The Correlation between Price and Destination Income



(a) Unit Value and GDP Per Capita: HS 20422



(b) Unit Value and GDP Per Capita: HS 940169

Note: The two figures show the correlation between price and destination GDP per capita for two sectors: (a) HS 20422 (Meat sheep or goats; (b) fresh, chilled or frozen) and HS 940169 (Seats)

Table 7: Summary of Coefficients on Trade Cost Variables

(a) HS 2 - HS 49

HS	Contig	Comlang	Colony	Comcol	Curcol	Smctry	LnDist	RTA	Comcur
2	0.137***	0.050***	0.073***	0.113***	0.057	0.080**	-0.143***	0.121***	0.075***
3	0.065***	0.044***	0.119***	0.115***	0.003	0.009	-0.173***	0.063***	0.008
4	0.125***	0.075***	0.122***	0.127***	0.226***	0.045	-0.173***	0.142***	0.083***
6	0.287***	0.079**	0.223***	-0.038	0.340	-0.145	-0.205***	0.198***	0.002
7	0.068***	0.061***	0.179***	0.124***	0.090	-0.011	-0.207***	0.180***	0.028
8	0.071***	0.071***	0.162***	0.157***	0.008	-0.022	-0.190***	0.121***	-0.006
9	0.091***	0.116***	0.189***	0.055**	0.289*	0.094**	-0.186***	0.114***	0.024
10	0.204***	-0.006	0.111**	0.133***	0.257	0.034	-0.175***	0.187***	0.201***
11	0.202***	0.067*	0.181***	0.304***	0.154	-0.063	-0.217***	0.131***	0.000
15	0.117***	0.093***	0.165***	0.098***	0.083	0.044	-0.207***	0.139***	0.097***
16	0.105***	0.093***	0.185***	0.165***	0.368***	0.027	-0.148***	0.119***	0.009
17	-0.010	0.065***	0.186***	0.142***	0.070	-0.047	-0.247***	0.133***	0.131***
18	0.002	0.076***	0.247***	0.163***	-0.126	-0.015	-0.264***	0.136***	0.049
19	0.027	0.145***	0.176***	0.162***	0.078	0.027	-0.249***	0.109***	-0.016
20	0.056***	0.120***	0.191***	0.194***	-0.044	0.033	-0.181***	0.125***	-0.068***
21	0.019	0.123***	0.164***	0.118***	0.219	0.043	-0.216***	0.118***	-0.009
22	0.077***	0.114***	0.124***	0.228***	0.152*	0.082***	-0.177***	0.160***	-0.067***
23	0.076**	0.100***	0.078**	0.056	0.288	-0.070	-0.206***	0.107***	-0.066**
24	0.001	0.036	0.073**	0.093***	0.039	-0.001	-0.196***	0.190***	0.130***
30	-0.037**	0.160***	0.097***	0.175***	-0.022	-0.007	-0.161***	0.095***	-0.011
32	0.235***	0.058*	0.197***	0.201***	0.269	-0.043	-0.199***	0.056**	-0.014
33	-0.006	0.138***	0.129***	0.139***	0.035	0.027	-0.230***	0.128***	-0.006
34	0.007	0.141***	0.178***	0.119***	0.037	0.052	-0.283***	0.143***	0.050*
35	0.044	0.084***	0.225***	0.274***	0.363**	-0.075	-0.248***	0.112***	0.052
36	0.199***	0.031	-0.040	0.210***	0.235	0.197***	-0.051**	0.085**	0.156**
37	0.051	0.035	0.144**	-0.091	0.513	0.213**	-0.054*	0.195***	0.013
38	0.036	0.054***	0.093***	0.094***	0.317**	-0.019	-0.193***	0.093***	0.061**
39	0.045**	0.136***	0.137***	0.142***	0.119	0.068*	-0.224***	0.131***	-0.036
40	0.085***	0.093***	0.210***	0.067**	0.386**	-0.025	-0.197***	0.048	-0.023
42	0.037	0.095***	0.178***	0.017	0.173	0.065	-0.206***	0.077***	-0.064***
43	0.129***	0.114***	0.099**	0.073	0.671***	-0.159*	-0.161***	-0.004	-0.031
44	0.110***	0.143***	0.216***	0.061	0.315*	-0.002	-0.203***	0.060***	-0.008
46	0.139***	0.136***	0.128***	0.025	0.538**	0.007	-0.230***	0.036	0.072*
48	0.016	0.146***	0.106***	0.175***	-0.029	-0.021	-0.270***	0.131***	-0.014
49	-0.010	0.317***	0.215***	0.151***	0.085	0.071*	-0.247***	0.115***	-0.025

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Note: This table summarizes the estimated coefficients on proxy variables of trade costs, for sectors HS 2 to HS 49. Contig = 1 of the both are contiguous; Comlang =1 if both share the same language; Colony =1 if ever had colonial relation; Comcol =1 if having common colonizer; Curcol =1 if currently in colonial relation; Smctry =1 if were/are the same country; RTA =1 if having regional trade agreement; Comcur =1 if using the same currency. ***, **, * denotes significance at 1%, 5% and 10% respectively.

(b) HS 50 - HS 97

HS	Contig	Comlang	Colony	Comcol	Curcol	Smctry	LnDist	RTA	Comcur
50	0.020	0.120	0.074	-0.026	-0.053	0.188	-0.163***	-0.032	0.171
51	0.134*	0.082	0.128**	0.392**	-0.298	-0.047	-0.155***	0.125***	0.080
52	0.133***	0.001	0.082	-0.048	-0.184	-0.037	-0.214***	0.075**	0.112*
54	0.160**	0.056	0.114	0.188		-0.202	-0.173	-0.052***	-0.007
55	0.132***	0.154***	-0.032	0.026	-0.498*	0.107	-0.181***	0.113**	0.009
57	0.050*	0.097***	0.155***	0.123***	-0.053	-0.061	-0.216***	0.108***	-0.013
58	0.104	0.157	0.164	-0.248	-0.227	0.089	-0.131***	-0.028	-0.002
59	0.059	0.146**	0.050	0.004	-0.622*	-0.017	-0.143***	0.071	0.087
61	0.046**	0.119***	0.144***	0.059***	0.120	0.016	-0.197***	0.098***	-0.003
62	0.043*	0.136***	0.160***	0.041**	0.135	0.010	-0.200***	0.081***	-0.029
63	0.063***	0.135***	0.177***	0.084***	0.056	0.022	-0.219***	0.128***	-0.002
64	0.088***	0.110***	0.150***	0.102***	0.125	-0.014	-0.217***	0.087***	0.022
65	0.077***	0.111***	0.232***	0.110***	0.405**	-0.048	-0.205***	0.096***	0.027
66	0.129***	0.097***	0.185***	0.078	0.451**	0.001	-0.228***	0.109***	0.063*
68	0.132**	0.077	-0.052	-0.100	1.140**	-0.076	-0.178***	0.017	0.129*
69	0.110***	0.122***	0.186***	0.124***	0.531**	-0.006	-0.184***	0.107***	-0.079***
70	0.090***	0.119***	0.110***	0.153***	0.346	-0.049	-0.193***	0.098***	0.012
71	0.011	0.140***	0.242***	0.108***	0.070	0.084	-0.176***	0.109***	0.001
74	0.066**	0.101***	0.208***	0.273***	-0.168	0.047	-0.223***	0.130***	-0.084**
76	0.149***	0.074***	0.232***	0.182***	0.242	-0.016	-0.235***	0.144***	0.047
82	0.051*	0.122***	0.166***	0.060*	0.104	0.034	-0.196***	0.094***	0.011
83	0.139***	0.120***	0.269***	-0.038	0.155	-0.081	-0.187***	0.079***	-0.044
84	0.044**	0.094***	0.111***	0.122***	0.359*	0.055	-0.193***	0.104***	-0.017
85	0.019	0.135***	0.133***	0.135***	0.094	0.013	-0.185***	0.109***	0.016
87	0.161***	0.070***	0.143***	0.159***	0.457***	0.005	-0.142***	0.126***	0.026
88	0.051	0.079*	-0.147***	-0.106	-1.882***	0.124*	-0.046**	0.057	-0.049
89	0.091***	0.025	0.116***	0.203***	-0.330**	0.029	-0.133***	0.067***	-0.052*
90	0.058**	0.065***	0.137***	0.141***	0.223	-0.009	-0.135***	0.075***	-0.044*
91	0.036	0.086***	0.180***	0.177***	0.330***	0.038	-0.170***	0.029	0.089 ***
92	0.089***	0.068***	0.091***	0.206***	0.721***	0.064	-0.137***	0.049**	0.016
93	0.060*	0.099***	0.063*	0.342***	-0.180	0.127*	-0.077***	0.045	0.031
94	0.034	0.167***	0.127***	0.078***	0.139	0.062	-0.231***	0.098***	-0.074***
95	0.074***	0.110***	0.193***	0.059**	0.480***	-0.025	-0.176***	0.065***	-0.013
96	0.064**	0.101***	0.186***	0.092***	0.660***	0.032	-0.206***	0.104***	-0.027
97	0.040	0.110***	0.099***	0.026	0.358**	0.127**	-0.102***	0.056***	-0.102***

Note: This table summarizes the estimated coefficients on proxy variables of trade costs, for sectors HS 50 to HS 97. Contig = 1 of the both are contiguous; Comlang =1 if both share the same language; Colony =1 if ever had colonial relation; Comcol
.5 =1 if having common colonizer; Curcol =1 if currently in colonial relation; Smctry =1 if were/are the same country; RTA =1 if having regional trade agreement; Comcur =1 if using the same currency. ***, **, * denotes significance at 1%, 5% and 10% respectively.

Table 8: Estimated Preference for Quality

HS	Obs	Mean	Std.Dev	Min	Max	HS	Obs	Mean	Std.Dev	Min	Max
2	165	22.246	19.613	0.467	120.217	54	165	11.385	13.524	1.000	89.390
3	165	16.230	12.954	0.642	99.572	55	165	11.407	12.325	1.000	70.688
4	165	21.944	19.275	0.023	95.676	58	165	5.814	7.687	1.000	39.734
6	165	15.513	16.725	1.000	102.454	59	165	13.130	14.915	1.000	87.704
7	165	16.686	13.018	1.000	91.702	61	165	19.649	18.534	1.000	98.075
8	165	19.338	17.456	1.000	93.673	62	165	20.201	19.074	1.000	100.413
9	165	21.288	19.457	1.000	96.457	63	165	21.464	18.519	1.000	90.493
10	165	21.508	20.186	1.000	132.176	64	165	17.749	13.834	1.000	77.016
11	165	20.349	20.691	1.000	148.433	65	165	17.903	15.941	1.000	79.300
15	165	21.821	21.960	1.000	170.171	66	165	19.995	20.808	1.000	136.851
16	165	20.542	18.605	1.000	91.212	67	165	15.871	14.654	1.000	79.738
17	165	21.330	20.083	1.000	120.062	68	165	13.762	13.674	1.000	69.466
18	165	23.452	24.309	1.000	154.248	69	165	19.893	21.115	1.000	174.533
19	165	19.730	17.928	1.000	87.576	70	165	26.733	31.433	1.000	166.876
20	165	13.773	9.373	1.000	42.538	71	165	17.061	16.126	0.876	97.138
21	165	21.046	18.647	1.000	89.231	73	165	20.877	18.926	1.000	115.750
23	165	22.211	39.912	1.000	417.558	74	165	17.933	16.758	1.000	87.612
24	165	19.376	17.441	1.000	93.222	77	165	19.266	16.757	1.000	81.233
30	165	17.782	15.580	1.000	88.500	82	165	21.521	21.301	1.000	153.153
32	165	16.370	15.530	1.000	78.624	85	165	9.549	56.190	0.978	590.516
34	165	15.013	11.013	0.000	54.480	87	165	21.242	19.659	1.000	121.543
35	165	16.151	23.239	1.000	252.413	88	165	8.442	8.623	0.000	47.360
36	165	18.633	21.963	1.000	143.656	89	165	21.767	25.082	1.000	164.926
37	165	7.529	9.940	1.000	73.404	90	165	19.339	17.718	1.000	87.486
38	165	25.404	29.797	1.000	178.241	91	165	19.110	18.261	1.000	98.730
39	165	21.551	19.905	1.000	149.762	92	165	20.431	22.115	1.000	154.758
40	165	19.242	17.163	0.609	79.498	93	165	14.949	13.256	0.000	71.716
42	165	19.754	17.691	1.000	87.856	94	165	20.294	18.134	1.000	87.038
49	165	20.422	18.574	1.000	90.914	95	165	19.526	17.907	1.000	84.246
50	165	4.876	6.636	1.000	38.863	96	165	23.772	26.979	1.000	191.981
51	165	8.913	9.538	0.000	44.815	97	165	18.996	20.996	1.000	174.981
52	165	15.120	15.745	1.000	89.140						

Note: This table summarizes estimated preference for quality ($\kappa_{i,s}$) across all countries i within each sector s.

Table 9: Estimated Marginal Cost of Quality

HS	Obs	Mean	Std.Dev	Min	Max	HS	Obs	Mean	Std.Dev	Min	Max
2	165	5.098	3.600	0.000	18.030	54	165	1.948	1.847	0.000	13.054
3	165	3.650	2.453	0.000	24.217	55	165	1.637	2.557	0.000	31.159
4	165	5.912	6.072	0.000	67.456	58	165	1.385	1.097	0.000	9.063
6	165	3.938	8.218	0.000	102.771	59	165	2.252	2.422	0.000	12.221
7	165	3.871	1.716	0.000	8.806	61	165	2.742	1.486	0.000	10.675
8	165	4.242	2.156	0.000	16.841	62	165	3.051	1.714	0.000	14.742
9	165	4.271	3.949	0.000	47.431	63	165	5.839	3.079	0.000	21.517
10	165	4.413	3.849	0.000	31.479	64	165	4.525	3.065	0.000	30.028
11	165	3.126	3.263	0.000	27.200	65	165	2.413	1.688	0.000	9.500
15	165	3.524	2.351	0.000	13.085	66	165	2.196	2.542	0.000	24.453
16	165	3.553	2.603	0.000	21.460	67	165	1.988	1.576	0.000	10.410
17	165	3.284	2.201	0.000	16.038	68	165	1.816	1.683	0.000	9.698
18	165	3.512	2.380	0.000	12.900	69	165	2.756	1.681	0.000	10.819
19	165	2.469	1.931	0.000	15.552	70	165	3.908	2.803	0.000	14.830
20	165	3.956	1.884	0.000	12.288	71	165	3.625	2.377	0.000	17.847
21	165	4.053	2.107	0.000	17.662	73	165	3.714	2.075	0.000	11.556
23	165	1.843	3.430	0.000	38.749	74	165	2.301	1.510	0.000	7.564
24	165	4.121	2.994	0.000	18.264	77	165	2.951	2.109	0.000	16.693
30	165	3.648	1.906	0.000	9.800	82	165	3.261	1.908	0.000	9.653
32	165	1.966	1.857	0.000	11.108	85	165	5.292	45.482	0.247	585.700
34	165	4.615	2.607	0.000	16.672	87	165	3.965	2.265	0.000	10.860
35	165	3.204	3.066	0.000	21.819	88	165	1.664	1.817	0.000	20.027
36	165	1.765	1.771	0.000	10.764	89	165	3.404	2.598	0.000	18.004
37	165	1.275	0.879	0.000	6.082	90	165	3.089	2.180	0.000	16.907
38	165	3.278	4.996	0.000	52.698	91	165	2.967	2.330	0.000	14.631
39	165	5.994	2.513	0.000	12.972	92	165	2.533	1.790	0.000	10.225
40	165	2.759	2.512	0.000	24.370	93	165	2.431	2.326	0.000	12.901
42	165	3.930	1.835	0.000	13.093	94	165	3.932	1.809	0.000	11.029
49	165	3.972	2.692	0.000	24.601	95	165	3.248	2.012	0.000	20.826
50	165	1.134	0.630	0.000	4.231	96	165	3.588	2.238	0.000	17.202
51	165	2.859	2.968	0.000	18.538	97	165	3.853	1.848	0.000	11.709
52	165	1.764	1.545	0.000	9.746						

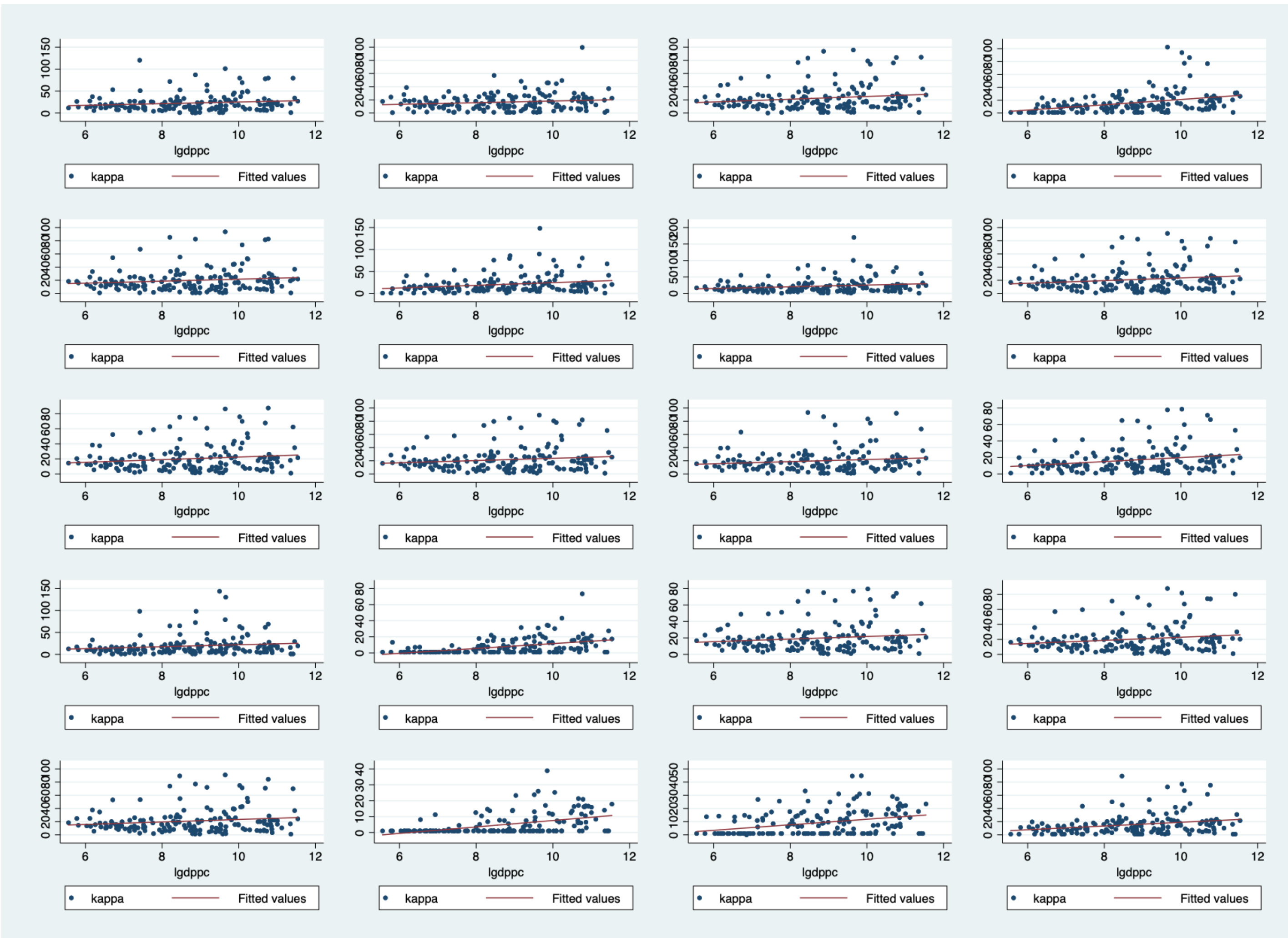
Note: This table summarizes estimated cost for quality ($\mu_{i,s}$) across all countries i within each sector s.

Table 10: Preference for Quality and GDP Per Capita

HS	Coefficients	HS	Coefficients	HS	Coefficients	HS	Coefficients
2	1.879*	23	1.438	54	3.506***	74	2.561***
3	1.238*	24	1.613*	55	2.989***	76	2.044**
4	2.067**	30	0.867	58	2.163***	82	1.692
6	4.128***	32	2.431***	59	3.903***	85	1.231
7	0.062	34	0.040	61	2.009**	87	1.319
8	1.518*	35	-0.207	62	1.960**	88	1.852***
9	0.985	36	2.228*	63	1.314	89	3.152**
10	1.451	37	3.016***	64	0.240	90	2.128**
11	3.033***	38	2.144	65	1.917**	91	2.698***
15	2.623**	39	0.328	66	2.082*	92	2.889**
16	2.029**	40	1.568*	67	1.955**	93	2.025***
17	1.656	42	2.062**	68	2.993***	94	1.649*
18	2.106	49	1.891*	69	2.422**	95	1.800*
19	1.733*	50	2.032***	70	2.857*	96	2.146
20	0.186	51	2.090***	71	2.679***	97	3.422***
21	1.692*	52	2.829***	73	1.580		

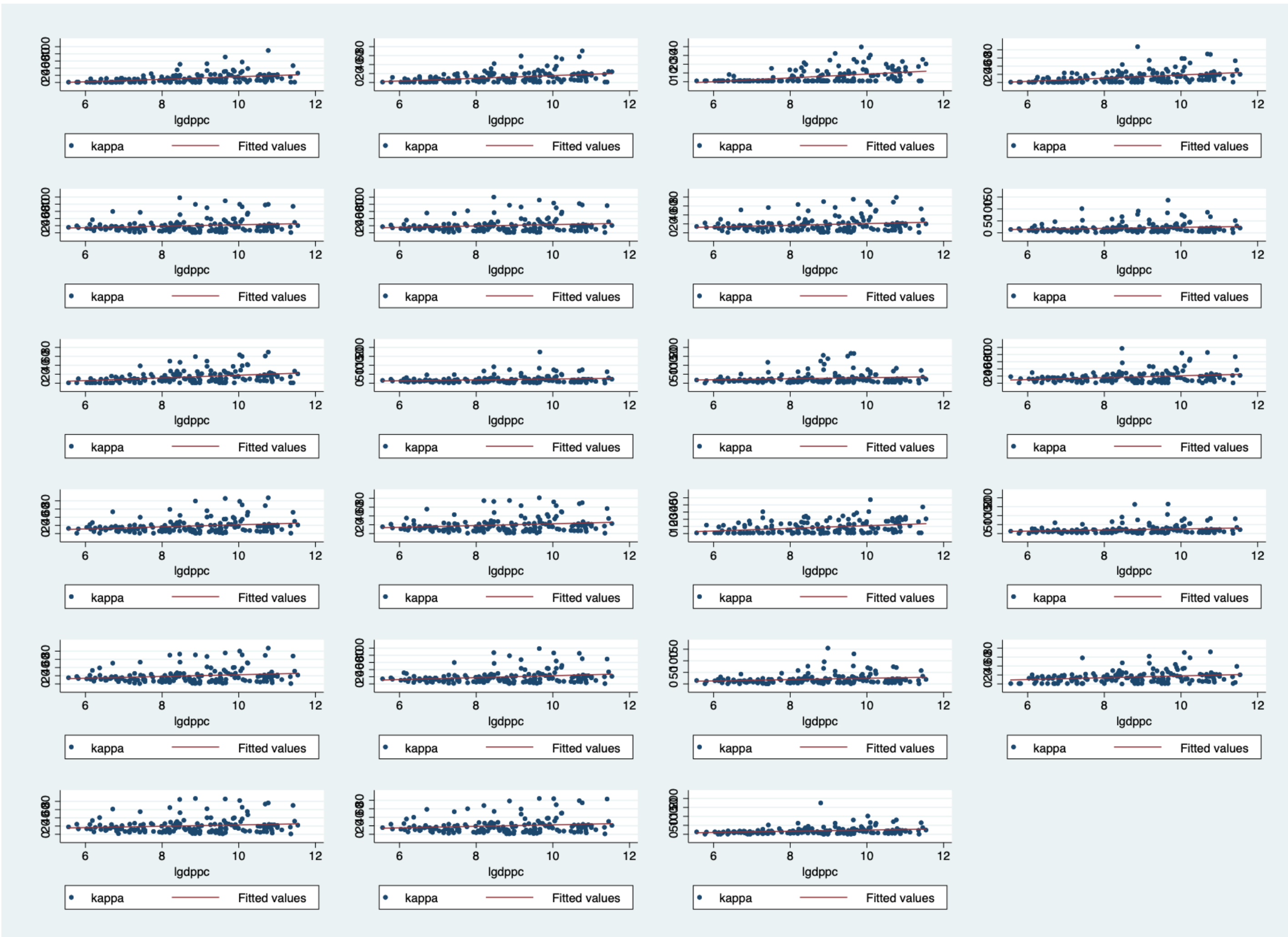
Note: This table the estimated coefficients on (log) GDP per capita with dependent variable being the κ_i for each sector s. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively

Figure 4: Preference for Quality and Income, HS 2 - HS 51



Note: The figures show positive correlations between income and quality preferences for sectors: HS 2, HS 3, HS 4, HS 6, HS 8, HS 11, HS 15, HS 16, HS 19, HS 21, HS 24, HS 32, HS 36, HS 37, HS 40, HS 42, HS 49, HS 50, HS 51

Figure 4: Preference for Quality and Income, HS 52 - HS 97



Note: The figures show positive correlations between income and quality preferences for sectors: HS 54, HS 55, HS 58, HS 59, HS 61, HS 62, HS 65, HS 66, HS 68, HS 69, HS 70, HS 71, HS 74, HS 76, HS 87, HS 88, HS 89, HS 90, HS 91, HS 92, HS 93, HS 94, HS 96

Table 11: Cost of Quality and GDP Per Capita

HS	Coefficients	HS	Coefficients	HS	Coefficients	HS	Coefficients
2	0.494***	23	0.264	54	0.395***	74	0.246***
3	0.219*	24	0.210	55	0.278**	77	0.115
4	0.521	30	-0.028	58	0.186***	82	0.209**
6	0.338	32	0.169*	59	0.715***	85	1.208
7	0.044	34	0.151	61	-0.205***	87	-0.247**
8	-0.146	35	0.404***	62	-0.076	88	0.425***
9	-0.055	36	-0.076	63	0.279*	89	0.166
10	0.192	37	0.163***	64	-0.199	90	0.060
11	0.337*	38	-0.184	65	-0.063	91	-0.139
15	0.312**	39	0.453***	66	0.157	92	0.120
16	0.185	40	0.187	67	0.070	93	0.584***
17	0.053	42	0.121	68	0.427***	94	0.046
18	0.328***	49	0.147	69	-0.150	95	0.077
19	-0.176*	50	0.053	70	0.156	96	0.208*
20	0.110	51	0.767***	71	-0.105	97	-0.128
21	-0.113	52	0.191**	73	0.155		

Note: This table the estimated coefficients on (log) GDP per capita with dependent variable being the μ_i for each sector s. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively

Table 12: Summary of Exogenous Competitiveness

(a) HS 2 - HS 51

HS	Obs	Mean	Std.Dev	Min	Max
2	150	24.900	30.751	10.451	308.543
3	138	1.609	4.517	0.674	49.741
4	148	0.577	1.377	0.221	16.706
6	129	5.67E+03	5.83E+03	1.55E+03	3.96E+04
7	155	1.989	1.036	1.290	8.073
8	148	136.358	64.449	71.293	398.349
9	150	0.529	0.369	0.336	3.782
10	152	1.442	1.383	0.395	4.362
11	157	0.197	0.057	0.121	0.581
15	154	0.824	0.822	0.251	3.487
16	151	0.685	0.463	0.367	3.840
17	156	0.361	0.272	0.197	2.481
18	158	0.050	0.021	0.028	0.117
19	163	0.060	0.025	0.037	0.226
20	142	0.429	0.242	0.297	2.184
21	155	0.057	0.034	0.038	0.337
23	160	0.011	0.002	0.007	0.023
24	147	0.004	0.001	0.002	0.008
30	158	0.325	0.625	0.168	7.216
32	159	9.104	2.486	7.390	33.174
34	145	6251.746	3636.260	4089.427	40193.020
35	152	0.060	0.024	0.029	0.183
36	153	436.416	30.690	404.460	637.010
37	143	3.28E+07	2.19E+06	3.10E+07	4.92E+07
38	159	0.060	0.063	0.029	0.437
39	147	0.015	0.061	0.004	0.662
40	158	0.361	0.475	0.161	5.763
42	158	12.000	64.131	4.345	792.150
49	164	0.117	0.159	0.048	0.682
50	107	4.01E+12	7.98E+11	3.32E+12	1.13E+13
51	95	0.442	0.305	0.151	1.777

Note: This table summarizes the estimated exogenous competitiveness from quality model for industries from HS 2 to HS 51

(b) HS 52 - HS 96

HS	Obs	Mean	Std.Dev	Min	Max
52	154	0.354	0.245	0.229	3.183
54	122	9051.833	1944.386	7409.059	27034.280
55	149	0.474	0.070	0.361	0.904
58	149	1.407	0.154	1.155	2.506
59	116	0.781	0.261	0.345	1.080
61	156	3.372	1.820	2.151	19.650
62	155	1.013	0.408	0.679	3.317
63	157	1.537	1.890	0.846	21.568
64	148	0.550	0.372	0.323	2.306
65	153	4.423	5.596	2.232	38.725
66	157	80.861	25.629	50.781	334.302
67	148	6.701	9.744	2.679	75.814
68	143	10.399	3.691	6.252	41.790
69	161	107.424	1266.542	5.332	16078.190
70	158	11.084	10.113	4.999	117.903
71	146	1.06E+05	3.95E+05	2.86E+03	1.85E+06
73	159	0.384	0.244	0.240	2.430
74	154	59.894	20.527	43.466	234.731
76	158	0.077	0.029	0.042	0.223
82	159	24.072	15.373	14.861	171.604
85	162	5242.618	2099.089	4312.667	27509.740
87	158	2.802	0.958	2.006	6.494
88	133	524.241	19.825	501.511	644.742
89	150	14.529	10.022	7.053	87.736
90	161	3.463	25.910	0.802	329.955
91	159	9.40E+04	2.33E+04	7.56E+04	2.71E+05
92	150	5.985	2.880	3.919	21.810
93	135	2769.903	6592.229	1639.503	78574.520
94	164	0.218	0.081	0.153	0.619
95	154	3.116	3.515	1.331	37.424
96	157	0.197	0.083	0.127	0.558

Note: Note: This table summarizes the estimated exogenous competitiveness from quality model for industries HS 52 to HS 96

Table 13: Summary of Cutoffs — Quality Model

HS	Obs	Mean	Std.Dev	Min	Max	HS	Obs	Mean	Std.Dev	Min	Max
2	150	3.193	2.258	-3.773	8.843						
3	138	1.097	2.869	-10.654	7.451	52	154	0.527	2.504	-6.717	10.367
4	148	1.008	1.617	-7.744	4.466	54	104	2.720	2.819	-4.052	17.634
6	128	7.627	2.840	-1.662	14.552	55	148	0.321	3.007	-7.431	7.327
7	154	2.160	2.769	-8.700	10.649	58	144	-4.662	3.801	-12.224	14.796
8	147	3.079	2.453	-9.172	13.662	59	116	1.582	1.895	-6.410	4.840
9	150	1.271	1.890	-6.190	4.611	61	154	0.670	3.494	-7.308	9.192
10	152	0.793	2.024	-5.359	5.373	62	155	-0.568	3.570	-8.134	7.563
11	157	0.293	2.377	-11.553	12.827	63	157	1.753	3.012	-8.383	10.598
15	154	1.069	1.622	-6.561	4.172	64	148	0.235	3.075	-7.296	7.520
16	151	0.788	1.743	-6.752	4.771	65	153	1.883	2.421	-3.978	9.374
17	156	1.478	1.650	-5.644	5.916	66	157	1.921	2.542	-3.859	14.613
18	158	0.264	1.434	-3.614	5.453	67	141	0.923	3.630	-9.452	7.234
19	163	-0.456	1.475	-5.850	6.520	68	141	3.829	2.277	-5.093	7.577
20	142	-0.012	2.088	-13.366	11.607	69	161	2.516	2.881	-5.794	13.437
21	155	-0.772	1.703	-7.983	10.165	70	158	2.477	2.091	-3.990	7.993
23	160	-2.093	1.907	-7.440	2.399	71	122	6.911	3.253	-0.570	15.437
24	146	-5.573	3.395	-19.292	3.481	73	159	1.360	1.467	-3.445	4.580
30	156	-0.648	2.535	-6.231	9.380	74	153	0.526	2.202	-5.759	18.850
32	158	-0.210	2.195	-7.951	12.375	76	158	0.590	1.368	-4.148	5.923
34	138	0.856	2.276	-6.754	17.849	82	159	2.959	2.190	-2.797	8.213
35	152	-0.364	2.131	-12.268	5.465	87	156	1.713	2.887	-7.842	13.780
36	141	2.766	3.501	-4.758	14.432	88	123	0.098	3.029	-6.952	15.822
37	84	7.881	2.917	1.732	25.094	89	149	2.490	2.154	-4.532	8.526
38	159	-0.886	1.577	-4.756	6.580	90	156	0.835	1.440	-2.976	4.344
39	147	-1.963	2.057	-9.644	3.091	91	98	5.958	3.803	-2.000	25.677
40	158	0.287	1.675	-5.473	9.903	92	146	1.197	3.382	-7.977	8.698
42	154	0.914	2.770	-8.523	8.218	93	105	6.577	2.748	-3.537	18.500
49	163	0.449	1.914	-4.101	9.980	94	164	0.662	2.157	-10.345	8.008
50	106	22.518	3.090	15.606	38.232	95	153	0.347	2.618	-7.854	11.375
51	94	0.590	3.265	-14.942	5.291	96	157	-0.042	2.060	-5.586	4.974

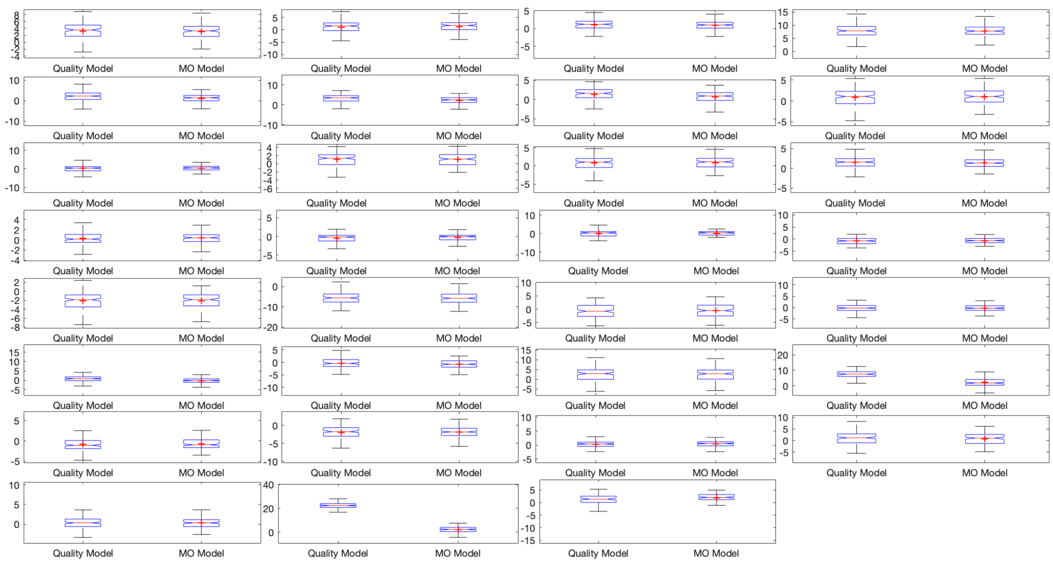
Note: This table summarizes the estimated exogenous competitiveness c_M^i across countries within each sector s from quality model

Table 14: Summary of Cutoffs —Melitz and Ottaviano Model

HS	Obs	Mean	Std.Dev	Min	Max	HS	Obs	Mean	Std.Dev	Min	Max
2	150	3.011	2.214	-3.992	8.409						
3	138	1.249	2.645	-8.513	6.687	52	154	0.495	2.501	-6.882	7.866
4	148	0.868	1.228	-2.975	4.239	54	104	1.041	2.077	-4.777	5.708
6	128	7.710	2.764	-0.780	15.091	55	148	0.065	2.562	-6.670	4.982
7	154	1.216	1.979	-4.815	7.150	58	144	1.049	2.572	-5.458	13.692
8	147	2.261	2.126	-2.952	12.880	59	116	1.700	1.351	-2.378	4.444
9	150	0.654	1.684	-4.379	3.718	61	154	0.792	3.299	-6.633	10.001
10	152	0.997	1.848	-5.317	5.391	62	155	-0.611	3.498	-8.208	8.613
11	157	0.436	1.352	-4.034	3.497	63	157	1.879	2.569	-4.476	7.188
15	154	1.047	1.439	-2.104	4.277	64	148	0.124	2.744	-6.358	8.317
16	151	0.849	1.620	-6.824	4.562	65	153	2.020	2.333	-3.684	9.270
17	156	1.341	1.236	-2.432	5.477	66	157	1.943	2.580	-4.759	14.359
18	158	0.404	1.234	-2.701	4.046	67	141	1.217	3.488	-6.993	7.586
19	163	-0.273	1.013	-2.728	2.819	68	141	3.971	1.908	-1.216	7.532
20	142	0.173	1.198	-2.071	2.534	69	161	2.326	2.653	-5.742	8.726
21	155	-0.625	1.104	-2.981	1.894	70	158	2.570	2.003	-3.190	8.366
23	160	-2.125	1.851	-7.661	1.200	71	122	6.987	3.883	-5.886	15.516
24	146	-5.581	3.025	-15.509	2.437	73	159	1.500	1.253	-2.480	4.756
30	156	-0.443	2.427	-5.975	4.664	74	153	0.488	1.452	-4.534	6.413
32	158	-0.225	1.452	-4.578	3.050	76	158	0.557	1.131	-4.030	4.030
34	138	-0.095	1.354	-5.192	3.013	82	159	1.858	2.116	-3.206	5.999
35	152	-0.751	1.718	-6.521	2.556	87	156	1.902	2.518	-5.229	7.500
36	141	2.621	3.361	-7.049	10.561	88	123	-0.144	1.899	-5.253	5.816
37	84	2.459	2.584	-4.488	7.855	89	149	2.773	2.055	-2.797	10.367
38	159	-0.736	1.397	-3.502	6.090	90	156	0.969	1.361	-2.965	4.320
39	147	-1.879	1.561	-7.064	3.002	91	98	6.833	3.035	2.149	21.273
40	158	0.401	1.295	-5.337	5.052	92	146	1.443	3.264	-6.880	8.791
42	154	0.815	2.659	-7.365	9.969	93	105	7.317	2.357	-2.368	17.926
49	163	0.303	1.433	-3.599	5.719	94	164	1.006	1.677	-4.750	5.649
50	106	1.955	2.781	-6.967	7.527	95	153	0.268	2.484	-7.657	5.498
51	94	1.768	2.238	-5.315	7.984	96	157	0.107	2.070	-4.670	5.063

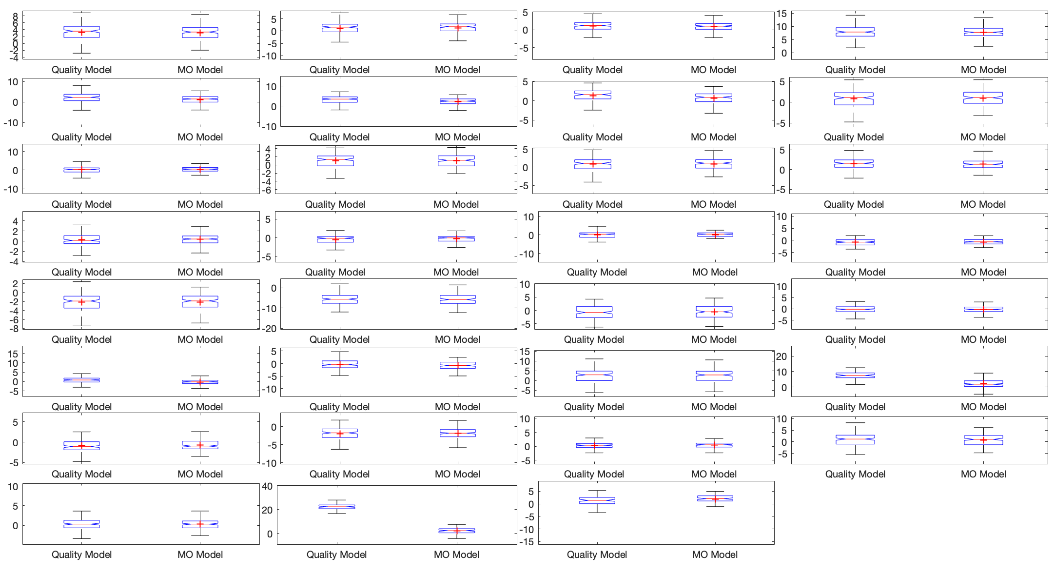
Note: This table summarizes the estimated exogenous competitiveness c_M^i across countries within each sector s from Melitz and Ottaviano (2008) model

Figure 5: Distribution of Cutoffs, HS 2 - HS 51



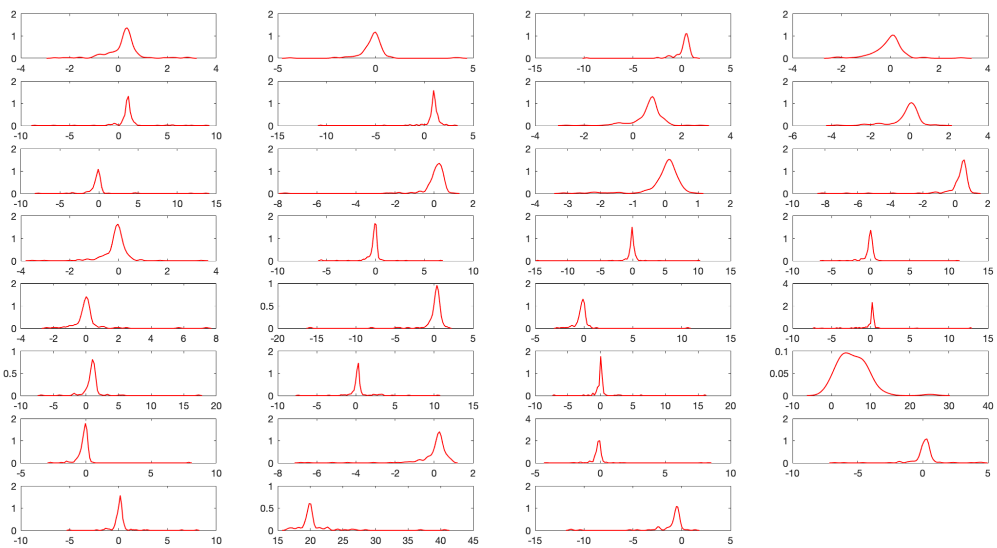
Note: The figures show differences in distribution of cutoffs between the model in this paper (right) and Melitz and Ottaviano (left): HS 2, HS 3, HS 4, HS 6, HS 7, HS 8, HS 9, HS 10, HS 11, HS 15, HS 16, HS 17, HS 18, HS 19, HS 20, HS 21, HS 23, HS 24, HS 30, HS 32, HS 34, HS 35, HS 36, HS 37, HS 38, HS 39, HS 40, HS 42, HS 49, HS 50, HS 51

Figure 5: Distribution of Cutoffs, HS 52 - HS 97



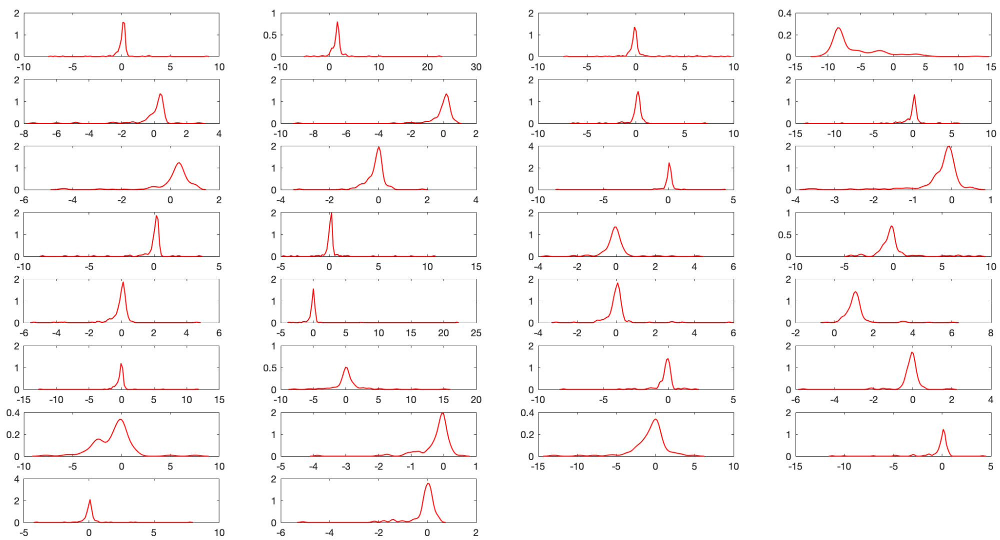
Note: The figures show differences in distribution of cutoffs between the model in this paper (right) and Melitz and Ottaviano (left): HS 52, HS 54, HS 55, HS 58, HS 59, HS 61, HS 62, HS 63, HS 64, HS 65, HS 66, HS 67, HS 68, HS 69, HS 70, HS 71, HS 73, HS 74, HS 76, HS 82, HS 87, HS 88, HS 89, HS 90, HS 91, HS 92, HS 93, HS 94, HS 95, HS 96

Figure 6: Distribution of of Differences Cutoffs, HS 2 - HS 51



Note: The figures show distribution of differences in cutoffs predicted by model in this paper and Melitz and Ottaviano for sectors: HS 2, HS 3, HS 4, HS 6, HS 7, HS 8, HS 9, HS 10, HS 11, HS 15, HS 16, HS 17, HS 18, HS 19, HS 20, HS 21, HS 23, HS 24, HS 30, HS 32, HS 34, HS 35, HS 36, HS 37, HS 38, HS 39, HS 40, HS 42, HS 49, HS 50, HS 51

Figure 6: Distribution of Differences in Cutoffs, HS 52 - HS 97



Note: The figures show distribution of differences in cutoffs predicted by model in this paper and Melitz and Ottaviano for sectors: HS 52, HS 54, HS 55, HS 58, HS 59, HS 61, HS 62, HS 63, HS 64, HS 65, HS 66, HS 67, HS 68, HS 69, HS 70, HS 71, HS 73, HS 74, HS 76, HS 81, HS 86, HS 87, HS 88, HS 89, HS 90, HS 91, HS 92, HS 93, HS 94, HS 95

Table 15: International Trade Cost Increase

HS	Mean	Std.Dev	Min	Max	HS	Mean	Std.Dev	Min	Max
2	2.801	2.284	-0.003	9.085					
3	1.983	3.815	-0.327	30.816	52	1.935	1.768	-0.085	6.716
4	0.944	1.178	-0.302	4.733	54	13.115	6.858	0.000	39.165
6	3.914	4.133	-0.038	24.256	55	1.217	1.876	-0.353	15.144
7	1.248	1.236	-0.383	3.983	58	5.617	3.677	-0.053	15.358
8	3.591	3.468	-0.348	15.524	59	0.752	1.322	-0.602	8.314
9	1.411	1.341	-0.200	7.070	61	3.032	4.738	-0.220	18.739
10	3.196	3.037	-0.001	24.547	62	2.988	6.235	-0.179	45.542
11	0.731	0.837	-0.244	5.103	63	1.520	2.268	-0.452	12.386
15	1.002	1.428	-0.433	8.380	64	1.173	2.023	-0.294	9.771
16	1.277	1.521	-0.255	6.770	65	1.856	1.703	-0.095	10.980
17	1.973	1.369	0.212	6.722	66	3.150	2.721	-0.032	14.317
18	1.362	1.105	-0.296	5.531	67	3.587	5.030	-0.466	23.328
19	0.986	1.816	-0.398	12.198	68	0.839	1.219	-0.439	6.521
20	1.298	1.960	-0.505	13.862	69	2.108	2.579	-0.254	13.567
21	0.583	1.015	-0.247	8.883	70	2.675	2.609	-0.302	12.418
23	0.900	1.212	-0.261	5.901	71	5.430	3.946	0.033	15.622
24	2.055	2.091	-0.006	14.665	73	2.160	1.785	-0.249	7.655
30	2.829	2.432	-0.263	12.214	74	3.756	3.876	-0.023	22.587
32	4.943	4.259	-0.022	30.004	76	0.148	0.388	-0.505	1.933
34	28.687	13.970	-0.074	71.330	82	2.988	3.571	-0.027	17.884
35	0.276	0.407	-0.184	2.016	87	1.815	1.789	-0.712	7.665
36	12.454	9.820	0.216	45.854	88	8.191	4.952	-0.054	22.213
37	14.389	5.979	-0.053	36.342	89	1.434	1.475	-0.113	8.867
38	0.662	0.893	-0.174	3.920	90	3.195	2.180	0.030	10.248
39	0.596	0.981	-0.526	4.460	91	8.818	6.094	-0.065	24.584
40	1.112	1.552	-0.368	8.873	92	2.605	3.745	-0.320	22.862
42	8.844	6.304	0.023	28.939	93	3.810	2.954	-0.278	10.813
49	0.311	0.429	-0.114	3.005	94	1.109	2.610	-0.709	17.924
50	7.222	5.252	-0.017	23.817	95	3.633	3.020	0.040	16.968
51	1.071	2.407	-0.309	16.746	96	1.074	1.305	-0.088	5.768

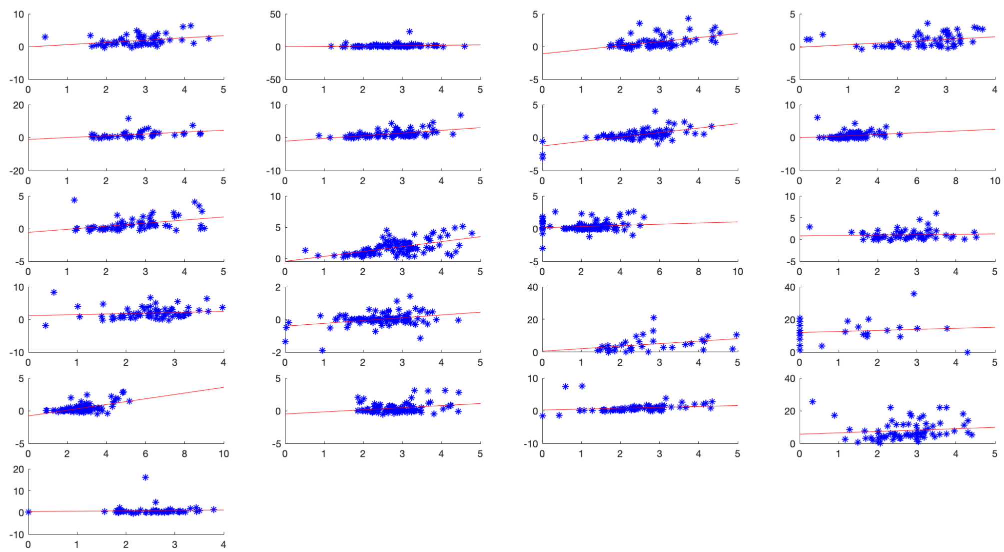
Note: This table summarizes the effects on cutoffs (endogenous competitiveness) of a 5% increase in international trade costs under quality model

Table 16: International Trade Cost Increase–MO

HS	Mean	Std. Dev.	Min	Max	HS	Mean	Std. Dev.	Min	Max
2	1.047	1.272	-0.293	7.608					
3	0.586	1.051	-0.158	7.937	52	0.607	0.931	-0.010	6.390
4	0.446	0.787	-0.661	5.415	54	0.646	1.266	-0.399	9.755
6	2.593	3.507	-0.452	27.547	55	0.597	1.095	-0.370	7.856
7	0.663	1.209	-0.107	11.402	58	1.168	1.486	-0.130	7.156
8	1.616	1.636	-0.137	8.661	59	0.543	0.847	-0.399	4.301
9	0.389	0.565	-0.138	2.651	61	1.189	1.491	-0.031	7.398
10	0.497	0.697	-0.526	5.233	62	1.363	1.891	-0.061	10.884
11	0.381	0.725	-0.150	7.001	63	0.633	0.750	-0.508	3.724
15	0.449	0.662	-0.034	4.073	64	0.695	0.876	-0.075	4.262
16	0.659	1.185	-0.463	8.025	65	0.791	2.017	-0.125	22.371
17	0.364	0.561	-0.010	3.607	66	2.033	2.519	-0.131	19.504
18	0.232	0.320	-0.009	1.939	67	4.231	4.888	-0.462	19.710
19	0.327	0.420	-0.010	2.236	68	0.727	1.212	-0.159	8.095
20	0.407	0.533	-0.361	2.586	69	1.127	1.502	-0.173	8.505
21	0.412	0.670	-0.013	4.640	70	0.518	0.886	-0.394	5.239
23	0.481	0.764	-0.012	4.653	71	3.212	4.667	-0.223	24.524
24	0.923	1.302	-0.292	10.050	73	0.457	0.665	-0.036	4.666
30	0.731	0.952	-0.179	4.721	74	0.336	0.673	-0.031	4.304
32	0.400	0.613	-0.253	3.211	76	0.240	0.422	-0.104	3.735
34	0.419	0.636	-0.006	3.691	82	0.858	1.104	-0.362	5.341
35	0.525	0.824	-0.009	5.677	87	0.766	1.347	-0.749	6.729
36	7.257	6.698	0.096	36.632	88	1.041	1.260	-0.185	8.286
37	2.159	1.844	-0.065	8.031	89	4.455	3.799	-0.039	17.700
38	0.330	0.518	-0.084	3.462	90	0.339	0.426	-0.378	2.027
39	0.284	0.562	-0.013	4.220	91	9.938	5.588	-0.051	36.798
40	0.401	0.740	-0.023	5.858	92	2.672	4.312	-0.399	24.148
42	0.952	1.652	-0.084	13.658	93	8.151	4.063	1.295	18.768
49	0.300	0.418	-0.217	2.798	94	0.488	0.711	-0.368	5.283
50	0.792	1.732	-0.020	13.111	95	0.649	0.984	-0.273	6.777
51	0.840	1.897	-0.131	12.506	96	0.644	0.762	-0.107	3.713

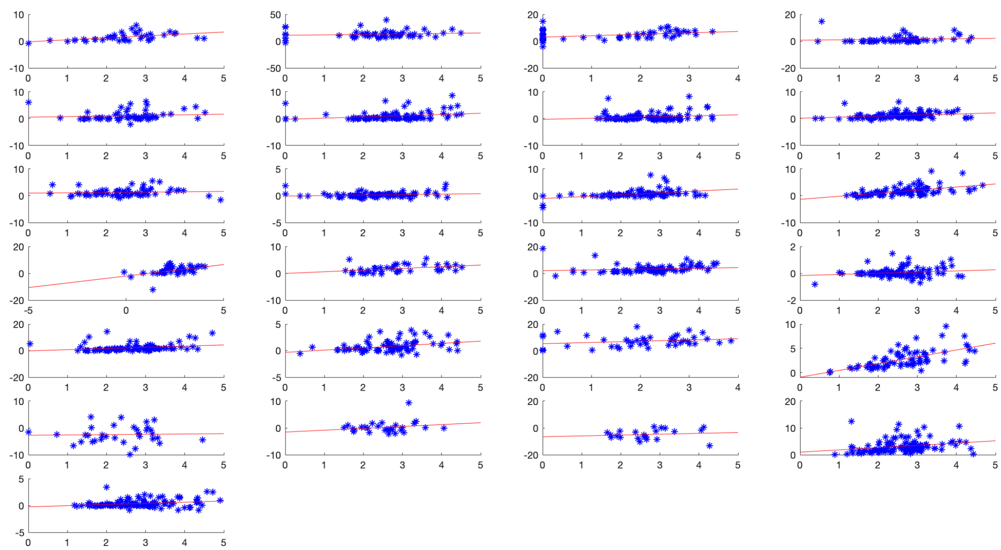
Note: This table summarizes the effects on cutoffs (endogenous competitiveness) of a 5% increase in international trade costs under Melitz and Ottaviano (2008) model

Figure 7: Change in Cutoffs and Quality Preferences, HS 2 - HS 51



Note: The figures show positive correlations between quality preferences and difference in loss from trade barrier between the model in this paper and Melitz and Ottaviano for sectors: HS 2, HS 3, HS 4, HS 7, HS 8, HS 9, HS 11, HS 15, HS 16, HS 17, HS 23, HS 24, HS 30, HS 35, HS 36, HS 37, HS 38, HS 39, HS 40, HS 42, HS 51

Figure 7: Change in Cutoffs and Quality Preferences, HS 52 - HS 97



Note: The figures show positive correlations between quality preferences and difference in loss from trade barrier between the model in this paper and Melitz and Ottaviano: HS 52, HS 54, HS 58, HS 61, HS 62, HS 63, HS 64, HS 65, HS 66, HS 68, HS 69, HS 70, HS 71, HS 73, HS 74, HS 76, HS 82, HS 87, HS 88, HS 90, HS 91, HS 92, HS 93, HS 95, HS 96

Table 17: Summary of Cutoff Changes

(a) Summary of Cutoff Changes

Country	Δ	Country	Δ	Country	Δ	Country	Δ
ABW	0	DMA	0	BOL	-92.825249	GTM	-142.23793
AFG	0	DNK	-114.35749	BRA	-88.041534	GUM	0
AGO	-5.9250102	DOM	-290.53134	BRB	0	GUY	0
AIA	0	DZA	-211.93385	BRN	-105.61481	HKG	0
ALB	0	ECU	-150.62788	BTN	-30.520798	HND	-71.087296
AND	0	EGY	-139.12598	CAF	-6.0313959	HRV	-35.601143
ARE	110.83006	ERI	0	CAN	-134.60129	HTI	10.083085
ARG	-172.65367	ESP	-3.0844131	CCK	0	HUN	-71.353348
ARM	-83.855202	EST	-137.4808	CHE	-221.01123	IDN	-61.682568
ASM	0	ETH	-14.915351	CHL	148.51651	IND	-79.18856
ATF	0	FIN	-139.43924	CHN	-18.930056	IOT	0
ATG	0	FJI	-1.2493064	CIV	-566.53101	IRL	-159.63408
AUS	-85.625969	FLK	0	CMR	20.903	IRN	125.87421
AUT	-35.475746	FRA	-48.415028	COG	9.3548021	IRQ	-94.298141
AZE	-88.898872	FSM	0	COK	0	ISL	-217.56667
BDI	197.47388	GAB	-317.1246	COL	-32.865913	ISR	-117.73706
BEL	4.9142151	GBR	-89.882896	COM	0	ITA	-4.3799672
BEN	340.07468	GEO	-77.644836	CPV	0	JAM	-181.83876
BFA	-499.91898	GHA	313.25208	CRI	-150.97874	JOR	-117.16895
BGD	-52.478401	GIB	0	CUB	0	JPN	-34.355942
BGR	-193.67613	GIN	-221.29001	CXR	0	KAZ	-3.359056
BHR	0	GMB	-127.25304	CYM	0	KEN	114.01509
BHS	-313.15955	GNB	425.91129	CYP	-286.89645	KGZ	-32.405098
BIH	-70.668152	GNQ	164.41464	CZE	-132.38187	KHM	-155.89485
BLR	9.4817276	GRC	-42.363346	DEU	-97.001007	KIR	0
BLZ	-127.64666	GRD	0	DJI	-76.750755	KNA	0
BMU	0	GRL	0				

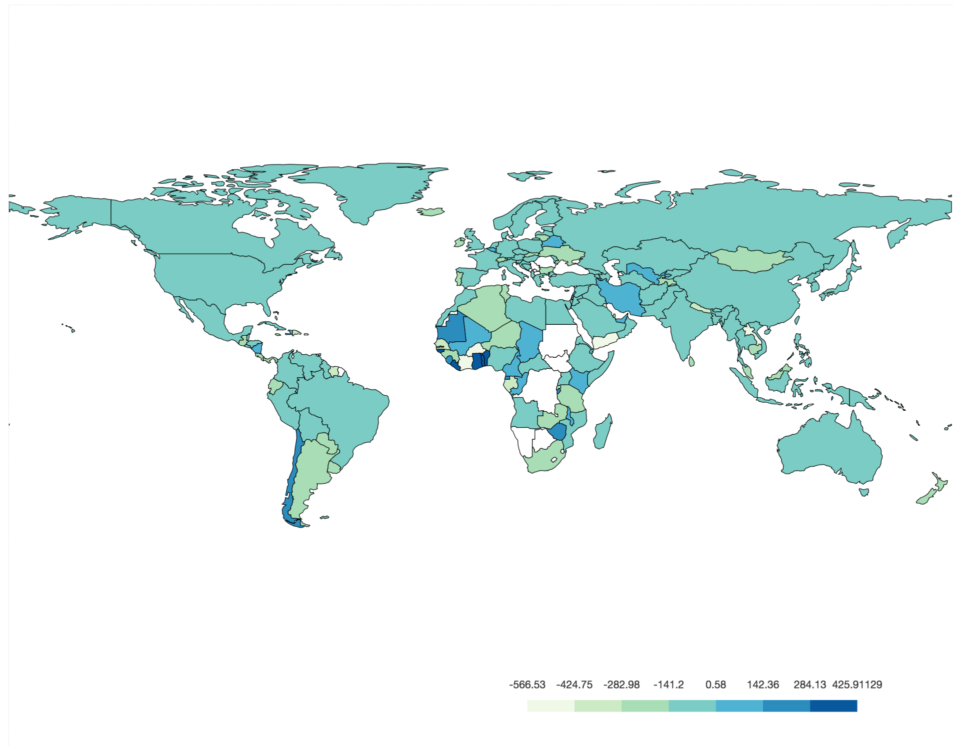
Note: This table summarizes the changes in endogenous cutoffs following an increase in preference for quality

(b) Summary of Cutoff Changes (continue)

Country	Δ	Country	Δ	Country	Δ	Country	Δ
KOR	-35.787136	QAT	-219.32658	MYS	-158.87752	TKM	-52.555267
KWT	-460.9559	ROM	0	NCL	0	TMP	0
LAO	-436.81769	RUS	-98.661285	NER	-230.2971	TON	0
LBN	20.976509	RWA	-396.1434	NFK	0	TTO	-104.69793
LBR	292.86221	SAU	-45.471489	NGA	-42.240189	TUN	-165.00168
LBY	0	SEN	-349.76016	NIC	74.577103	TUR	-73.441292
LCA	0	SGP	0	NIU	0	TUV	0
LKA	-184.27283	SHN	0	NLD	-138.3261	TWN	-55.560108
LTU	-159.97792	SLB	0	NOR	-83.566177	TZA	-234.38101
LVA	-20.440449	SLE	194.28214	NPL	-314.22827	UGA	-58.329792
MAC	0	SLV	-65.059845	NRU	0	UKR	-150.4944
MAR	-100.28398	SMR	0	NZL	-180.14423	URY	-185.035
MDA	-37.104824	SOM	0	OMN	-0.6131459	USA	-83.864113
MDG	-21.992657	SPM	0	PAK	-30.568909	UZB	110.60154
MDV	0	STP	0	PAL	0	VCT	0
MEX	-26.129211	SUR	-325.828	PAN	-197.16428	VEN	-17.546169
MHL	0	SVK	-167.24568	PCN	0	VGB	0
MLI	7.2255492	SVN	-107.09841	PER	-114.9763	VNM	-68.709572
MLT	0	SWE	-112.68818	PHL	-77.56852	VUT	0
MMR	-69.190582	SYC	0	PLW	0	WLF	0
MNG	-217.73524	SYR	-77.680817	PNG	0	WSM	0
MNP	0	TCA	0	POL	-64.078629	YEM	-515.06506
MOZ	-138.54242	TCD	105.06513	PRK	0	ZAF	-143.84947
MRT	179.3062	TGO	301.63589	PRT	-181.69063	ZAR	0
MSR	0	THA	-39.003437	PRY	-254.91846	ZMB	-184.53088
MUS	0	TJK	-232.86932	PYF	0	ZWE	150.78076
MWI	37.507915	TKL	0				

Note: This table summarizes the changes in endogenous cutoffs following an increase in preference for quality

Figure 8: Changes in Cutoffs Across Countries



The figure illustrates the distribution of rise/fall in endogenous competitiveness across countries

Table 18: Gains from Preference Shock and Country Characteristics

Dependent Variable:	Changes in Cost Cutoff		
	(1)	(2)	(3)
(log) Population	-6.188**	-8.510***	-8.929***
	(3.139)	(2.044)	(3.299)
Initial Preference		-0.795	-0.634
		(0.606)	(0.700)
(log) GDP per capita			-13.617
			(9.317)
Number of Observations	168	168	160

Notes: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Robust standard errors are in parentheses. The dependent variable in specifications (1)-(3) is the level of aggregate cutoff change at the country-level. Country-level control variables are the initial preferences for quality and (log) GDP per capita.