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The Effects of Product Quality on Net Trade

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Abstract: We determine the effects of product quality on the value of net trade for developed and developing countries. By incorporating the intensity of consumers' preferences for quality, we can identify different quality impacts on net trade as product quality may affect prices and preferences. Using manufacturing data and a direct measure of quality, we estimate the quality effects for developed and developing countries. We conclude that product quality is positively related to net trade, and developed countries enjoy a higher quality effect. We find the quality effects may differ due to GDP per capita and the number of product varieties.

KEYWORDS: Developed and developing countries, Net trade, Product quality
JEL Classification: F14

1. Introduction

Net trade, the difference between the monetary value of exports and imports of output in an economy, plays an important role in the economic growth of a nation. Countries generally try to create trade policies that encourage a trade surplus. A surplus often allows countries to hire more workers, reduces unemployment and generates more income for residents. This often translates into a higher standard of living (Amadeo 2013). Additionally, currency stabilization may be aided by a trade surplus.

Developed countries have larger values of net trade than developing countries. The average value of net trade for all goods in developed countries was $85.4 billion in 2010, which was more than 80 times the value in developing countries.[1] For the 42 highest value exporting countries in manufacturing in 2010 (25 developed countries and 17 developing countries), the average value of net trade for developed countries was $26 billion, and $19.7 billion for developing countries.

The difference in the value of net trade between country types may be related to the quality of products produced. Numerous studies have consistently found that developed countries produce higher quality products than developing countries. Hallak and Schott (2011) and Feenstra and Romalis (2012) quantify the quality of output for a wide range of countries and conclude that the product quality produced in developed countries is higher. Schott (2004) and Grossman and Helpman (1991) find that increases in product quality takes place most often in developed countries with larger endowments of physical and human capital.

The objective of this paper is to quantify the impact of the quality of products produced in a country on its value of net trade. We also aim to analyze how product quality affects developed and developing countries' net trade differently and identify possible reasons for different quality effects. We develop a model which captures the demand-side relationship between net trade and product quality motivated by the theoretical model in Hallak and Schott (2011). Using manufacturing industry data for bilateral trade among the 42 top exporting countries from 1989 to 2010, we estimate the effects of product quality on the value of net trade and compare the quality effects for the two types of countries. To explain the differentiation in the quality effects on the value of net trade, we consider how GDP per capita and the average number of varieties within a sector affect the intensity of preferences on quality

[1] The value of net trade for all goods is calculated based on the data of GDP and Final Consumption Expenditure from World Bank's World Development Indicators (WDI) database.

We define quality as any tangible (e.g., durability) or intangible (e.g., product image due to advertising) attribute (other than price and preference for variety) that increases all consumers' valuation of the good (Hallak and Schott 2011). We find that product quality has a positive impact on the value of net trade for developed and developing countries, and developed countries have a higher quality effect than developing countries. The different levels of GDP per capita and the number of product varieties within a sector of developed and developing countries may explain why the demand-driven quality effects differ. GDP per capita has a positive impact on the quality effect for developed countries, and product variety within a sector negatively affects the quality effect for developed and developing countries.

Previous studies show a significant relationship between product quality and trade characteristics. Linder (1961) notes the role of quality as a determinant of the direction of trade and argues that the consistency of production and consumption pattern leads countries with similar income per capita to trade with one another more. Flam and Helpman (1987) use a North-South trade model to show that the production of northern low-quality industrial products is shifted to the South. Crozet, Head, and Mayer (2011) estimate the effect of quality differences on heterogeneous export firms and conclude that quality monotonically increases firm-level prices, the probability of market entry, and export values. However, we are not aware of any work addressing the relationship between product quality and net trade.

Other literature investigates the different roles of product quality in trade between developed and developing countries. Hallak (2006) constructs export price indices to find rich countries import relatively more from countries that produce higher quality goods. Edwards and Lawrence (2010) show that unit values of standardized (low-tech) manufactured products exported by developed and developing countries are somewhat similar, however the medium- and high-tech manufactured exports differ greatly. To consider how various trade or investment policies are likely to impact the value of net trade for countries, we must understand how product quality affects net trade for different country types.

The quality effect on net trade plays an important role in trade performance. The use of technical regulations and standards in international trade has increased as tariff and quota barriers have declined (Maskus, Otsuki, and Wilson 2001). Product quality standards are widely perceived to be important for success in exporting (Wilson and Otsuki 2004). However, these types of quality standards present a greater challenge for developing countries. Essaji (2008) finds that technical regulations substantially impinge on poor countries' exports. In part, the 2008 Doha development round stalled over non-tariff barriers between developed and developing countries. Our results related to the different quality effects on net trade for different country types and ways to increase the quality effect shed some light on how to improve quality standards, which could help address this stalemate.

To accurately capture the effect of product quality on net trade, a direct measure of quality is important. Using observed export prices (unit values), or export price indices as a proxy for quality is often unsatisfactory as these measures may systematically vary for numerous reasons including consumer preferences or manufacturing costs. Khandelwal (2010) estimates the quality of countries' exports to the United States using information of prices and market shares, and finds that products with large variation in prices could nonetheless possess little differences in quality.

We include a direct measure of product quality developed by Hallak and Schott (2011). Using the data of trade balances, they quantify the manufacturing quality for top exporters from 1989 to 2003. They find that the value of net trade is positively correlated with product quality and negatively correlated with export price.[2] However, the magnitudes of the effects of product quality and export price are constrained to be equal in their model.

We build on this previous work by the incorporating the intensity of consumer preferences on quality. This allows us to capture how consumers prefer the quality of products in a sector. We assume that this intensity varies across sectors but is constant across countries for a specific sector. Including the intensity of preferences for quality yields a more general theoretical model and permits the impacts of quality and price on net trade to vary. The impact of product quality on net trade is the product of the export price effect and the intensity of preferences for quality. Intuitively, product quality affects net trade by influencing the export price and the demand for quality. Holding the price effect on net trade constant, a larger intensity of consumer preferences for quality indicates a higher impact of quality on net trade.

We hypothesize that there are two factors influencing the quality effect through the intensity of preferences for quality; GDP per capita and product variety within a sector. Hallak (2006) finds that income per capita positively affects the intensity of preferences for quality. We use GDP per capita to capture the different quality effects caused by different country types. Additionally, differing levels of product variety

[2] Export price in the paper generally indicates aggregate export price to sector level.

within a sector in developed and developing countries may explain why the intensities of preferences on quality differ. Developed countries often produce more varieties than developing countries (e.g., Schott 2004, Hummels and Klenow 2005). The effect of variety on the intensity of preferences on quality is ambiguous. Some researchers assert that brands which offer increased variety are perceived as having higher quality (e.g., Kassarjian 1978, Berger, Draganska, and Simonson 2007). Others have raised doubts about the wisdom of offering too many options as it may generate decision uncertainty and purchase deferral (e.g., Dhar 1996, 1997, Iyengar and Lepper 2000, Schwartz 2004). We include the average number of varieties within a sector to examine the impacts of the intensity of preferences on quality.

The remainder of this paper is organized as follows. In Section 2, we present the theoretical framework to demonstrate the relationship between the value of net trade and product quality and the factors which could explain the differing quality effects. Section 3 contains a discussion of the estimation of the effects of product quality on the value of net trade and the empirical strategy to examine explanations for different quality effects. We provide a data description in Section 4 and results in Section 5. Conclusions are given in Section 6.

2. Theoretical Framework

The value of net trade for each sector in each country is generated by solving a representative consumer's problem with a utility function that incorporates consumer preferences towards variety and quality for a product, as in Hallak and Schott (2011). We assume a Cobb-Douglas utility function, *U*. The utility from a sector, u_s, takes a constant elasticity of substitution form,

$$(1) \quad U = \prod_{s=1}^{S} u_s^{b_s}, \quad u_s = \sum_{k=1}^{K} \sum_{z=1}^{Z_s} \left\{ \left[\xi_z (\lambda_s^k)^{m_s} x_z^k \right]^{\frac{\sigma_s - 1}{\sigma_s}} n_z^k \right\}^{\frac{\sigma_s}{\sigma_s - 1}}, \quad \sigma_s > 1.$$

Sectors are indexed by s , and the parameter b_s is the total expenditure share of a sector.[3] Countries are indexed by k , and products in a sector are indexed by *z*. Here, ξ_z represents the intensity of consumer preferences for varieties of a product and λ_s^k denotes quality. It is assumed that ξ_z varies across products but is constant across different countries, and λ_s^k varies across countries and sectors but is constant for different products in a sector. We define m_s as the intensity of consumer preferences for product quality in sector s , x_z^k is the quantity per variety, σ_s is the elasticity of substitution, and n_z^k is the number of varieties within a product.

Our model differs from previous work by incorporating the intensity of consumer preferences on quality, m_s, which captures consumers' preferences for the quality of the products in a sector. It varies across sectors but is constant across countries for a specific sector. For example, m_s may be larger for food than clothing if consumers care more about the quality of food than clothing. Including the intensity of preferences for quality allows us to distinctly identify the effects of product quality and export price on the value of net trade.

Given the export price of product, p_z^k , and total expenditure in sector s , the representative consumer chooses the product quantity per variety x_z^k that maximizes utility from each sector given a budget constraint. Using the first order conditions of quantities per variety, we show that quantity per variety depends on the term $\dfrac{p_z^k}{\xi_z(\lambda_s^k)^{m_s}}$, which can be interpreted as quality-adjusted price. After calculating country k 's value of export and import flows in sector s , we demonstrate that a country's normalized net trade in sector s is a function of its product quality and aggregate export price,

(2) $\tilde{T}_{st}^k = \Upsilon'_{st} + \rho_s \ln \lambda_{st}^{ko} + \gamma_s \ln P_{st}^{ko} + \iota_{st}^k$,

[3] The share is denoted as $b_s = E_s^k / E^k$, $E^k = GDP^k - T^k$, $E_s^k = GDP_s^k - T_s^k$, where E^k is country k 's total expenditure, E_s^k is country k 's expenditure on sector s , T^k is country k 's value of total net trade, and T_s^k is country k 's value of net trade in sector s .

where $\tilde{T}^k_{st}$ is the normalized value of net trade.[4] Here, Υ'_{st} is a constant term, λ^{ko}_{st} is country k's product quality relative to the numeraire country ($\lambda^{ko}_{st} = \lambda^k_{st} / \lambda^o_{st}$), and P^{ko}_{st} is country k's aggregate export price relative to the numeraire country ($P^{ko}_{st} = P^k_{st} / P^o_{st}$). The coefficients ρ_s and γ_s represent the effects of quality and aggregate export price on the value of net trade within a sector, respectively. We define ι^k_{st} as the error term which captures estimation error of product quality and aggregate export price and the idiosyncratic component of the covariance (μ^k_{st}).

To investigate the different quality effects on net trade for developed and developing countries, we derive a demand-side relationship between the quality effect from Equation (2) and income per capita and the average number of varieties within a sector. The quality effect, ρ_s, is a function of the effect of aggregate export price on net trade from Equation (2), γ_s, and the intensity of preferences for quality, m_s,

(3) $\rho_s = -\gamma_s m_s$.

Intuitively, product quality affects net trade by influencing price and consumers' preferences towards quality. A larger intensity of consumer preferences for quality results in a higher impact of quality on net trade while holding the price effect on net trade constant.

Based on previous literature, we postulate a relationship between the intensity of preferences for quality and GDP per capita and average number of varieties within a sector,

(4) $m_s = \omega_{0s} + \omega_{1s} \ln y^{ko}_t + \omega_{2s} \ln \bar{n}^{ko}_{st}$,

where y^{ko}_t is country k's GDP per capita relative to the numeraire country in year t ($y^{ko}_t = y^k_t / y^o_t$), $\bar{n}^{ko}_{st}$ is country k's average number of varieties in a sector relative to the numeraire country ($\bar{n}^{ko}_{st} = \bar{n}^k_{st} / \bar{n}^o_{st}$), ω_{0s} is a constant, ω_{1s} and ω_{2s} are the marginal effects of GDP per capita and average number of varieties.

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[4] The normalized value of net trade has the expression as $\tilde{T}^k_{st} = \frac{T^k_{st} - b_s T^k_t}{E^k_t} - b_s t^k_{st}$, where $T^k_{st} = Exports^k_{st} - Imports^k_{st}$, $T^k_t = Exports^k_t - Imports^k_t$, $E^k_t = GDP^k_t - T^k_t$, and τ^k_{st} is the summary measure of trade barriers. The derivation is given in the Appendix.

We include GDP in Equation (4) as Hallak (2006) shows that GDP per capita positively affects the intensity of preferences for quality. His findings suggest that consumers have stronger preferences for the quality produced by developed countries. Consumers may detect real quality differences or may just rely on perception. Erickson, Johansson, and Chao (1984) find that country-of-origin knowledge affects beliefs formation through inferences made by consumers. Underwriters Laboratories (UL), a global safety and science company, released its annual study of 2012, which shows that consumers from across the globe rate the quality of sourced materials from developed countries as superior to those from developing countries. Howard (1989) and Han (1989) conclude that consumers' attitudes in relation to the quality of an automobile manufactured in a specific country produced a "halo effect" for all products originating from that country. They show that country image may serve as a halo from which consumers infer a brand's product attributes when consumers are not familiar with a country's products. Developed countries may have the "halo effect" since they produce higher quality manufacturing goods than developing countries.

We find a positive correlation between the intensity of preferences on quality and the average number of varieties based on the assumption that the number of varieties negatively relates to quality-adjusted price as suggested by Romalis (2004) and Bernard, Redding, and Schott (2007).[5] The positive correlation could exist if more product variety signals higher quality.

We substitute Equation (4) into Equation (3), to obtain the relationship between quality effect and GDP per capita and average number of varieties within a sector,

$$\rho_s = \upsilon_s + \theta_s \ln y_t^{ko} + \varsigma_s \ln \overline{n}_{st}^{ko} + \delta_{st}^{ko}, \tag{5}$$

where θ_s and ς_s are corresponding slopes with the forms $\theta_s = -\gamma_s \omega_{1s}$ and $\varsigma_s = -\gamma_s \omega_{2s}$, υ_s is a constant and δ_{st}^{ko} is the error term which captures the random error. We assume the error term is not correlated with the independent variables.

3. Estimation Strategy

[5] It is Assumption 3 in the Appendix: $\ln \overline{n}_{st}^{ko} - \ln y_t^{ko} = -\eta(\ln P_{st}^{ko} - m_s \ln \lambda_{st}^{ko})$. Here, the term $\ln P_{st}^{ko} - m_s \ln \lambda_{st}^{ko}$ is the quality-adjusted price.

We may face endogeneity issues when examining the effect of quality on the value of net trade. First, the aggregate export price may be correlated with the estimation error of quality since shocks to quality may be associated with changes in the export price. Second, we may observe a reverse causality between net trade and export price as the information of quantity demanded is contained in the value of net trade. We test for endogeneity using the Hausman test. We reject the null hypothesis that there is no identification problem at the one percent significance level using the data of developed countries, but we fail to reject the null hypothesis for developing countries.

To address this endogeneity issue, we use the real exchange rate as an instrumental variable for aggregate export price. The exchange rate is correlated to aggregate export price, since it is mostly determined by macroeconomic conditions which would affect export prices in the international competitiveness. Additionally, all the export prices have been transformed into U.S. dollars using the exchange rate. We assume that the exchange rate is uncorrelated with the error term. We estimate Equation (2) with ordinary least squares (OLS) and two-stage least-squares (2SLS) methods using developed and developing countries data separately. The OLS estimates are provided to show how the results differ when we do not control for endogeneity.

We directly investigate whether the effects of quality on net trade are statistically different between developed and developing countries by incorporating a country type indicator variable to Equation (2),

$$(6) \quad \tilde{T}_{st}^{k} = \Upsilon'_{st} + \rho_s \ln \lambda_{st}^{ko} + \gamma_s \ln P_{st}^{ko} + \beta_s d \ln \lambda_{st}^{ko} + \iota_{st}^{k} .$$

Here β_s is the parameter for estimation and d is a variable that equals one if it is a developed country and zero otherwise. We estimate Equation (6) using the real exchange rate as an instrumental variable for aggregate export price, and we combine the data of developed and developing countries in the sample.

We use the relationship specified in Equation (5) to explain quality effect differences by country type. Although we use the direct quality measure in the previous estimation, we cannot estimate Equation (5) directly due to a considerable lack of data measuring the quality effect.[6] Instead we estimate the coefficients θ_s and ς_s using OLS and 2SLS for developed and developing countries separately after

[6] By estimating Equation (2), we only could obtain one data point of quality effect for each type of country.

substituting the demand-driven quality effect given in Equation (5) into Equation (2),

$$\tilde{T}^{k}_{st} = (\Upsilon'_{st} + \upsilon_s \ln \lambda^{ko}_{st}) + \theta_s (\ln y^{ko}_{t} \ln \lambda^{ko}_{st}) + \varsigma_s (\ln \bar{n}^{ko}_{st} \ln \lambda^{ko}_{st}) + \gamma_s \ln P^{ko}_{st} + (\iota^{k}_{st} + \delta^{ko}_{st} \ln \lambda^{ko}_{st}).$$

Again, we reject the null hypothesis that there is no identification issue at the five percent significance level for developed countries but fail to reject the null hypothesis for developing countries.

4. Data

We use manufacturing industry data for bilateral trade among 42 top exporting countries from 1989 to 2010, including 25 developed countries and 17 developing countries.[7] We focus on countries' exports to a single "common importer" and the United States is treated as the numeriare country. The sector is defined as overall manufacturing, which contains four 1-digit SITC industries.[8] The data on net trade by sector is more available and reliable, and using sector data could reduce the bias of estimated quality due to the use of imported intermediate inputs outside of the sector.

The trade data comes from the United Nations Commodity Trade Statistics Database (COMTRADE), which records manufacturing import and export flows. Countries' values of net trade are found by subtracting each country's imports from exports. Total expenditure, E^k, is computed by subtracting total net trade from GDP. The data of total net trade, GDP and GDP per capita are drawn from the World Bank's World Development Indicators (WDI) database. We use the average share of manufacturing in total expenditure calculated by Hallak and Schott (2011).

We generate the product quality variable based on Hallak and Schott's quality equation. They specify a linear path for the evolution of product quality,

(7) $\ln \lambda^{ko}_{st} = \alpha^{ko}_{os} + \alpha^{ko}_{1s} t + \varepsilon^{ko}_{st}$,

[7] The 25 developed countries are: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Hong Kong, Hungary, Ireland, Israel, Italy, Japan, Korea, Netherlands, New Zealand, Norway, Portugal, Singapore, Spain, Sweden, Switzerland, and United Kingdom. The 17 developing countries are: Argentina, Brazil, Chile, China, Colombia, India, Indonesia, Malaysia, Mexico, Morocco, Pakistan, Philippines, Poland, Romania, South Africa, Thailand, and Turkey.

[8] We focus on manufacturing products which belong to SITC industries 5 through 8; they are Chemicals, Manufactured Material, Machinery, and Miscellaneous Manufactures, respectively. Following standard practice, we exclude SITC 68, nonferrous metals, from manufacturing.

where α_{os}^{ko} is a country fixed effect and α_{1s}^{ko} is the slope of the time trend. We use their estimates of α_{os}^{ko} and α_{1s}^{ko} to solve for the product quality variable in the sector for each country in each year.

We use the Hallak and Schott (2011) approach to estimate the aggregate export price and trade barriers. They show that the aggregate export price is bounded by the Paasche and Laspeyres indexes: $\ln H_s^{kk'} \leq \ln P_s^{kk'} \leq \ln L_s^{kk'}$. The aggregate export prices are estimated by maximizing the joint likelihood function $\ln L = \sum_k \sum_{k'>k} \left\{ \ln\left[1-\Phi\left(\frac{\ln H_s^{kk'} - \ln P_s^{kk'}}{\psi_s}\right)\right] + \ln \Phi\left(\frac{\ln L_s^{kk'} - \ln P_s^{kk'}}{\psi_s}\right) \right\}$, where Φ is the cumulative normal and ψ_s is the standard deviation of the error which is distributed normally with mean zero. Aggregate export price is estimated with export price for each product, which corresponds to 10-digit U.S. Harmonized System (HS) categories. Information on U.S. imports from 1989 to 2006 comes from Feenstra et al. (2002). We update that dataset to 2010 using data from U.S. imports statistics published by the U.S. Census Bureau. Both of the datasets record the customs-insurance-freight (c.i.f.) values, free-on-board (f.o.b.) values, and quantity of U.S. imports. The unit value or "price" of export product from country k, p_z^k, is computed by dividing f.o.b. value, v_z^k, by import quantity, q_z^k, $p_z^k = v_z^k / q_z^k$.

The transportation barriers are calculated by summing the transportation costs and tariffs, where the basic transportation cost is defined as $a_{zt}^k = (cif_{zt}^k - fob_{zt}^k) / fob_{zt}^k$, which is the ratio of difference between c.i.f. and f.o.b. values and f.o.b. value. After estimating c_{st} and e_{st} using the equation that $\ln a_{zt}^{ko} = c_{st} \ln D^{ko} + e_{st} X^{ko} + \varepsilon_{zt}^{ko}$, $a_{st}^{kk'}$ could be obtained by computing $\exp(\hat{c}_{st} \ln D^{kk'} + \hat{e}_{st} X^{kk'})$, where $\ln D^{ko}$ represents the great circle distance in kilometers between the capitals of country k and the U.S. and X^{ko} is a series of dummy variables representing whether country k shares a common language or border with the United States or was ever a colony of the United States. Adding countries' most favored nation tariff rates and preferential tariff rates, we get the final bilateral trade costs $\tau_s^{kk'}$. Given that $\tau_s^k = \ln\left[\sum_{k'} \left(\frac{\tau_s^{kk'}}{G_s^{k'}}\right)^{1-\sigma_s} E^{k'}\right]$ and $(G_s^{k'})^{1-\sigma_s} = \sum_{k''} \sum_z n_z^{k''} (\tilde{p}_z^{k''} \tau_s^{k''k'})^{1-\sigma_s}$ as seen in the Appendix, we need to compute the term $\sum_z n_z^{k''} (\tilde{p}_z^{k''})^{1-\sigma_s}$ to get the total trade barriers τ_s^k . The term is approximated by the share of country k'' in total exports of all countries of that sector. Transportation costs are estimated by using U.S. import data and tariff information is derived from the Trade Analysis and Information System (TRAINS) Database.

We use the number of varieties in a sector rather than within a product considering the data availability and notational compactness. Since the data of variety is not directly available, we calculate it based on the relationship that $\ln \overline{n}_{st}^{ko} = \ln GDP_t^{ko} - \eta_s (\ln P_{st}^{ko} - m_s \ln \lambda_{st}^{ko})$.[9] We use the real exchange rates historical data from 1989 to 2010 provided by the Economic Research Service in the U.S. Department of Agriculture.

Table 1 provides descriptive information for normalized net trade, product quality, estimated aggregate export price, GDP per capita, and average number of varieties in the sector for developed and developing countries. The average values of all variables are higher for developed countries than developing countries. On average, we may find a positive correlation between normalized net trade and product quality. The minimum values of normalized net trade and average varieties for developed countries are less than those of developing countries; while the maximum normalized value of net trade of developed countries is more than 17 times the value of developing countries. The standard deviations tell us that the data of normalized value of net trade have the smallest variation and average numbers of varieties data have the largest variation for both developed and developing countries. The statistics of quality and price are very close for both developed and developing countries.

5. Results

Estimates of the effects of quality on the value of net trade in Equation (2) using separate developed and developing countries samples are reported in Table 2. Based on the 2SLS results, we find that the coefficients on product quality for developed and developing countries are positive and significantly

[9] The parameter η_s is computed based on this equation $\gamma_s = b_s(1 - \sigma_s - \eta_s)$ which is shown in Appendix. Given that $\gamma_s = -0.154$, $m_s = 1.114$, which are estimated by using all the countries in the sample in Equation (2) , $\sigma_s > 1$, and $\eta_s \geq 0$, η_s is in the range from 0 to 0.72. We choose the value that $\eta_s = 0.5$ in the estimation, since the value near zero may results in serious multicollinearity problem.

different from zero at the one percent level. Developed countries have a coefficient on quality an order of magnitude higher than developing countries. The coefficient on aggregate export price of developed countries is negative and significant, at the five percent level. In contrast, the coefficient on aggregate export price for developing countries is positive but insignificant.

With OLS there is a large decrease in the coefficient on quality produced by developed countries, although the significance level is almost unchanged. The coefficient on price using 2SLS is about 6 times as large as the value using OLS for developed countries. OLS generates a slightly higher estimated coefficient on quality than 2SLS, and the coefficient on price using OLS is positive and significant for developing countries. The 2SLS amplifies both impacts of quality and price on net trade since it controls for the endogeneity problem for developed countries.

We see that product quality has a positive impact on the value of net trade for developed and developing countries. Controlling for export price, the growth of product quality would result in an increase in the value of net trade. Developed countries have a higher quality effect on net trade, which indicates that developed countries have a much larger increase in the value of net trade given the same improvement of product quality compared with developing countries. Increasing price has two contradictory impacts on the value of net trade. A decline in the quantity demanded would lead to less net trade due to the rise in price. However, the increasing price itself might make the value of net trade larger. The negative impact of price dominates for developed countries, while the positive impact dominates for developing countries. These results suggest the price elasticity of demand for developed countries goods is elastic, while it is inelastic for developing countries. It might be the case that the prices of developing countries are too low to generate a large impact on demand.

The results comparing the quality effects between developed and developing countries from Equation (6) are given in Table 3. The coefficient on the country type variable is positive and differs significantly from zero at the one percent level. The coefficient on price is negative and significant and the 2SLS estimate is almost twice as large as the estimate using OLS. Consistent with the results of Table 2, developed countries have a higher quality effect on net trade than developing countries. Thus, the value of net trade would increase more for developed countries for the same level of increase in product quality. In general, the negative impact of price on the value of net trade is dominant, which indicates that an increase in price reduces net trade.

Table 4 summarizes the results of estimating the factors that might explain the different product quality effects on net trade for developed and developing countries given in Equation (5). The estimate of the coefficient of GDP per capita has the expected sign and is statistically significant for developed countries, but is not significant for developing countries. The coefficients on average number of varieties are negative and significant for both developed and developing countries. The marginal effect of variety on the quality effect is relatively higher for developed countries. The impact of variety on the quality effect, ς_s, is a negative product of the price effect, γ_s, and the variety effect on the intensity of preferences for quality, ω_{2s}, i.e. $\varsigma_s = -\gamma_s \omega_{2s}$. The price effect is negative for developed countries and positive for developing countries. Thus, the average number of varieties negatively affects the intensity of preferences on quality for developed countries but positively affects this intensity for developing countries. Using the average values of GDP per capita and variety and the corresponding coefficients estimates for developed and developing countries, we obtain similar quality effects shown in Table 2.

Consumers appear to prefer the product quality produced by developed countries. A higher GDP per capita contributes to a larger quality effect and the quality effect would increase further as GDP per capita rises for developed countries. Developed countries with higher GDP per capita may exhibit the “halo effect”, which could explain why consumers may prefer their product quality.

The negative relationship between product variety within a sector and the quality effect indicates that net trade would increase less given the same increase of quality when variety increases. One possible explanation for variety’s negative effect on the intensity of preferences towards quality for developed countries might be the fact that too many varieties are offered, which reduces the number of products purchased. Previous literature (Dhar 1996, 1997, Iyengar and Lepper 2000, Schwartz 2004) has suggested that too many options may result in confused or overwhelmed consumers who purchase less. For developing countries, a larger number of varieties may be treated as a sign of higher quality and variety might be a complement to the relatively lower product quality. Thus, variety has a positive impact on the intensity of preferences for quality.

We provide three sensitivity analyses to verify the results are robust to changes of countries in the sample, functional form, and measure of quality. First, similar estimates are obtained after selectively removing each country from the estimation, which implies that results are not overly dependent on any particular country.

Second, we check the validity of the functional form of Equation (2) by incorporating three terms: the square of quality and export price, and the product of quality and export price. The 2SLS results are shown in Table 5. The coefficients for the square of quality and the product of quality and export price are insignificant for developed and developing countries, while the coefficient for the square of export price is significant. The coefficients of quality and export price are consistent with the results in Table 2, although the difference of quality effects between developed and developing countries decreases. The goodness of fit measures using different functional forms is very similar.

Third, we replicate the estimation of Equation (6) using a different measure of quality in Feenstra and Romalis (2012). They let firms chose price and quality simultaneously and estimate quality in an extended monopolistic competition framework. We use three years of quality estimated by them considering the availability of data. Table 6 reports the comparison of the results using different quality measures.[10] Consistent with the result of quality effects comparison displayed in Table 3, we find that developed counties have a larger quality effect on net trade using either quality estimate, while the difference of quality effect is smaller using Feenstra and Romalis's quality measure. The insignificance of the estimated coefficients may be due to the small sample size using the quality estimated by Feenstra and Romalis (2012).

6. Summary and Conclusions

This paper estimates the effect of product quality on the value of net trade and compares the quality effects between developed and developing countries. We also explain why the quality effects differ by country type. We propose a new theoretical model by incorporating the intensity of consumer preferences on quality to the standard model, which allows us to identify the different magnitudes of effects of quality and

[10] The data of quality estimates estimated by Feestra and Romalis in 1987, 1997 and 2007 are publicly available; we use the quality estimates data in 1987 as an approximate quality in 1989. 24 developed and 15 developing countries are same sample points. No quality estimates for Greece, Morocco, and Pakistan in Feestra and Romalis (2012). The real exchange rate data are used for corresponding years.

export price on net trade. Additionally, rather than using a proxy variable for product quality, we use a direct measure of quality to estimate the quality effect.

Using trade and quality data for 42 top manufacturing exporters from 1989 to 2010, we find that product quality has a positive impact on the value of net trade for developed and developing countries, and developed countries have a higher quality effect than developing countries. Export price has two contradictory impacts on the value of net trade. For developed countries, increasing export price will result in decreasing value of net trade, but export price has an opposite influence on the value of net trade for developing countries. In order to increase the value of net trade, developed countries could lower the export price and increase the product quality, whereas developing countries may moderately increase the export price while improving product quality.

The different levels of GDP per capita and product variety of developed and developing countries could explain why the quality effects differ. GDP per capita has a positive impact on the quality effect for developed countries, and variety negatively affects the quality effect for developed and developing countries. The marginal effect of variety for developed countries is higher. Consumers prefer the quality produced by developed countries. The average number of varieties negatively affects intensity of preferences for quality for developed countries but positively affects this intensity for developing countries. Faced with increasing export quality standards, developed and developing countries could reduce the number of varieties appropriately to enhance the quality effect on net trade. Developing countries could also seek the means to increase consumers' preferences for their products.

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References

Amadeo, K. "About Balance of Trade," About US Economy, URL: http://useconomy.about.com/od/tradepolicy/g/Balance-of-Trade.htm, Data accessed: 9 April, 2013.

Berger, J., Michaela D., and Itamar S., "The Influence of Product Variety on Brand Perception and Choice," Marketing Science 26 (2007), 460-472.

Bernard, Andrew B., Stephen Redding, and Peter K. Schott, "Heterogeneous Firms and Comparative Advantage," Review of Economic Studies 74 (2007), 31-66.

Crozet, M., Head, K. and Mayer, T., "Quality Sorting and Trade: Firm-level Evidence for French Wine," CEPR Discussion Paper 7295 (2011).

Dhar, R., "The Effect of Decision Strategy on the Decision to Defer Choice," Journal of Behavioral Decision Making 9 (1996), 265-281.

Dhar, R., "Consumer Preference for a No-choice Option," Journal of Consumer Research 24 (1997), 215-231.

Edwards, L., and Lawrence, Robert Z., "Do Developed and Developing Countries Compete Head to Head in High-tech," NBER Working Paper 16105 (2010).

Erickson, G. M., J. K. Johansson, and P. Chao, "Image Variables in Multi-Attribute Product Evaluations: Country-of-Origin Effects," Journal of Consumer Research 11 (1984):694-699.

Essaji, A., "Technical Regulations and Specialization in International Trade," Journal of International Economics 76 (2008), 166-176.

Feenstra, R., Romalis, J., and Schott, P., "U.S. Imports, Exports, and Tariff Data," NBER Working Paper 9387 (2002).

Feenstra, R., and Romalis, J., "International Prices and Endogenous Quality," NBER Working Paper 18314 (2012).

Flam, H., and E. Helpman, "Vertical Product Differentiation and North-South Trade," American Economic Review 77:5 (1987), 810-822.

Grossman, G., and E., Helpman, "Quality Ladders in the Theory of Growth," Review of Economic Studies 58 (1991), 43-61.

Hallak, J., "Product Quality and the Direction of Trade," Journal of International Economics 68:1 (2006), 238-265.

Hallak, J., and Schott, P., "Estimating Cross-Country Differences in Product Quality," Quarterly Journal of Economics 126:1 (2011), 417-474.

Han, C. M., "Country Image: Halo or Summary Construct?" Journal of Marketing Research 26 (1989), 222-229.

Howard, D. G., "Understanding How American Consumers Formulate Their Attitudes about Foreign Products," Journal of International Consumer Marketing 2 (1989), 7-24.

Hummels, D., and Klenow, P., "The Variety and Quality of a Nation's Exports," American Economic Review 95 (2005), 704-723.

Iyengar, S. S., and M. R. Lepper., "When Choice is Demotivating: Can One Desire Too Much of a Good Thing?" Journal of Personality and Sociology Psychology 79 (2000), 995-1006.

Kassarjian, H., "Presidential Address 1977: Anthropomorphism and Parsimony," Advances in Consumer Research: Association for Consumer Research 5 (1978), xii-xiv.

Khandelwal, A., "The Long and Short (of) Quality Ladders," Review of Economic Studies 77 (2010), 1450-1476.

Linder, S., "An Essay on Trade and Transformation", Almqvist &Wiksell, Stockholm (1961).

Maskus, K. E., T. Otsuki, and J. S. Wilson, "An Empirical Framework for Analyzing Technical Regulations and Trade," In Maskus, K.E. and Wilson, J.S. (Eds.) Quantifying Trade Effect of Technical Barriers: Can It Be Done? University of Michigan Press, Ann Arbor, MI (2001).

Romalis, John, "Factor Proportions and the Structure of Commodity Trade," American Economic Review 94 (2004), 67-97.

Schott, P., "Across-Product versus Within-Product Specialization in International Trade," Quarterly Journal of Economics 119:2 (2004), 647-678.

Schwartz, B., "The Paradox of Choice: Why More is Less," Harper Collins, New York (2004).

Underwriters Laboratories, a study named "The Product Mindset" (2012).

Wilson, J. S. and T., Otsuki, "Standards and Technical Regulations and Firms in Developing Countries: New Evidence from a World Bank Technical Barriers to Trade Survey," Preliminary Draft (2004).

Table 1: Descriptive Statistics for Developed and Developing Countries

Variable	Sample	Mean	Min	Max	Standard deviation
Normalized value of net trade[11]	Developed	0.004	-0.203	2.873	0.078
	Developing	-0.020	-0.186	0.161	0.058
Product quality	Developed	1.284	0.451	16.478	0.503
	Developing	0.694	0.398	3.432	0.283
Export price	Developed	1.297	0.472	16.167	0.417
	Developing	0.682	0.278	2.067	0.310
GDP per capita	Developed	2.547	0.456	7.352	0.461
	Developing	0.253	0.044	1.073	0.851
Average variety	Developed	0.037	0.001	0.773	1.208
	Developing	0.019	0.003	0.583	1.047

Note: all the values are the ratios relative to the U.S.

[11] The values of net trade are normalized using the expression $\tilde{T}_{st}^{k} = \frac{T_{st}^{k} - b_s T_t^k}{E_t^k} - b_s \tau_{st}^{k}$.

Table 2: Regression Results for the Effect of Product Quality

and Export Price on Net Trade

	OLS		2SLS	
	Developed Countries	**Developing Countries**	**Developed Countries**	**Developing Countries**
ln(Product quality)	0.147***	0.079***	0.277***	0.075***
	(0.006)	(0.009)	(0.064)	(0.009)
ln(Export price)	-0.056***	0.081***	-0.342**	0.025
	(0.008)	(0.008)	(0.140)	(0.059)
Constant	-0.018***	-0.022***	0.024	0.017
	(0.003)	(0.005)	(0.316)	(0.023)
Observations	550	374	550	374
R-squared	0.67	0.33	0.64	0.30

Note: robust standard errors with significance levels: ***0.01; **0.05; *0.10.

Table 3: Results of Quality Effect Comparison between

Developed and Developing Countries

	OLS	**2SLS**
Country type*ln(Product quality)	0.074***	0.064***
	(0.009)	(0.013)
ln(Product quality)	0.077	0.064
	(0.008)	(0.019)
ln(Export price)	-0.065***	-0.128***
	(0.005)	(0.021)
Constant	-0.017	-0.015
	(0.002)	(0.003)
Observations	924	924
R-squared	0.59	0.48

Note: robust standard errors with significance levels: ***0.01; **0.05; *0.10.

Table 4: Results of Factors that Affect the Quality Effect on Net Trade

	OLS		2SLS	
	Developed Countries	**Developing Countries**	**Developed Countries**	**Developing Countries**
ln(GDP per capita)	0.018*	-0.008	0.080***	0.024
	(0.009)	(0.006)	(0.025)	(0.093)
ln(Average variety)	-0.033***	-0.017***	-0.062**	-0.027
	(0.003)	(0.003)	(0.021)	(0.030)
Observations	550	374	550	374
R-squared	0.63	0.38	0.62	0.38

Note: robust standard errors with significance levels: ***0.01; **0.05; *0.10.

Table 5: 2SLS Results for the Effect of Product Quality and Export Price on Net Trade Incorporating the Square of Quality and Price and the Product of Quality and Price

	Developed Countries	**Developing Countries**
ln(Product quality)	0.203***	0.137**
	(0.011)	(0.058)
ln(Export price)	-0.191***	0.074
	(0.022)	(0.099)
[ln(Product quality)]^2	-0.018	-0.008
	(0.012)	(0.028)
[ln(Export price)]^2	0.076***	0.109***
	(0.011)	(0.019)
[ln(Product quality)] * [ln(Export price)]	-0.004	0.139
	(0.022)	(0.148)
Constant	-0.009***	0.016***
	(0.003)	(0.028)
Observations	550	374
R-squared	0.60	0.33

Note: robust standard errors with significance levels: ***0.01; **0.05; *0.10.

Table 6: Quality Effect Contrast between Developed and Developing Countries

Using Quality Measures from HS and FR

	OLS using HS	**OLS using FR**	**2SLS using HS**	**2SLS using FR**
Country type*ln(Product quality)	0.074***	0.006	0.064***	0.034
	(0.009)	(0.081)	(0.013)	(0.107)
ln(Product quality)	0.077	0.056	0.064	-0.024
	(0.008)	(0.073)	(0.019)	(0.193)
ln(Export price)	-0.065***	-0.007	-0.128***	0.029
	(0.005)	(0.028)	(0.021)	(0.080)
Constant	-0.017	0.001	-0.015	-0.010
	(0.002)	(0.010)	(0.003)	(0.025)
Observations	924	117	924	117
R-squared	0.59	0.34	0.48	0.32

Notes: Product quality estimated by HS (Hallak and Schott 2011). Product quality estimated by FR (Feenstra and Romalis 2012). Robust standard errors with significance levels: ***0.01; **0.05; *0.10.

Appendix: Derivation of the Relationship between Net trade and Product Quality and Export Price

Consider the representative consumer's problem,

$$\max_{x_z^k} u_s = \sum_{k=1}^{K}\sum_{z=1}^{Z_s}\left\{\left[\xi_z(\lambda_s^k)^{m_s} x_z^k\right]^{\frac{\sigma_s-1}{\sigma_s}} n_z^k\right\}^{\frac{\sigma_s}{\sigma_s-1}}$$

$$s.t. \sum_{k=1}^{K}\sum_{z=1}^{Z_s} p_z^k \tau_s^{kk'} x_z^k n_z^k \le b_s E^k \quad \forall k, \forall s,$$

where $\tau_s^{kk'}$ is the iceberg trade costs from country k to country k'.

Differentiating u_s with respect to x_z^k yields the optimality condition (for an interior solution):

$$(u_s)^{\frac{1}{\sigma_s-1}}\left[\xi_z(\lambda_s^k)^{m_s}\right]^{\frac{\sigma_s-1}{\sigma_s}}(x_z^k)^{-\frac{1}{\sigma_s}} = \lambda p_z^k \tau_s^{kk'},$$

where λ is Lagrange Multiplier. Similar FOC holds for another product z'. Taking the ratio of FOCs and rearranging, we can have the following equation,

$$\frac{x_z^k}{x_{z'}^k} = \left(\frac{p_z^k \tau_s^{kk'}}{p_{z'}^k \tau_s^{kk'}}\right)^{-\sigma_s}\left[\frac{\xi_z(\lambda_s^k)^{m_s}}{\xi_{z'}(\lambda_s^k)^{m_s}}\right]^{\sigma_s-1}.$$

Multiplying both sides by $p_z^k \tau_s^{kk'}$ for arbitrary other good z and summing over all other goods, we can solve the quantity $x_{z'}^k$ as

$$x_{z'}^k = \left(\sum_k\sum_z p_z^k \tau_s^{kk'} x_z^k\right)\frac{\left(p_{z'}^k \tau_s^{kk'}\right)^{-\sigma_s}}{\left[\xi_{z'}(\lambda_s^k)^{m_s}\right]^{1-\sigma_s}\sum_k\sum_z\left[\frac{p_z^k \tau_s^{kk'}}{\xi_z(\lambda_s^k)^{m_s}}\right]^{\sigma_s-1}}.$$

Multiplying both sides by $p_{z'}^k \tau_s^{kk'} n_{z'}^k$, we can find that the left hand side is the country k's expenditure on good z' denoted as $Expenditure_{z'}^k$. Then multiplying n_z^k for both sides, the equation above turns into

$$Expenditure_{z'}^k \cdot n_z^k = n_{z'}^k\left(\sum_k\sum_z p_z^k \tau_s^{kk'} x_z^k n_z^k\right)\left[\frac{p_{z'}^k \tau_s^{kk'}}{\xi_{z'}(\lambda_s^k)^{m_s}}\right]^{1-\sigma_s}\sum_k\sum_z\left[\frac{p_z^k \tau_s^{kk'}}{\xi_z(\lambda_s^k)^{m_s}}\right]^{\sigma_s-1}.$$

Substituting the budget constraint into the right hand side, we can rewrite this equation as

$$Expenditure_{z'}^{k} \cdot n_{z}^{k} = n_{z'}^{k} b_s E^k \left[\frac{p_{z'}^{k} \tau_s^{kk'}}{\xi_{z'} (\lambda_s^k)^{m_s}} \right]^{1-\sigma_s} \sum_{k} \sum_{z} \left[\frac{p_{z}^{k} \tau_s^{kk'}}{\xi_{z} (\lambda_s^k)^{m_s}} \right]^{\sigma_s - 1} .$$

Using the definition of $\tilde{p}_z^k = \dfrac{p_z^k}{\xi_z (\lambda_s^k)^{m_s}}$, the above expression could be written for a general good z as

$$Expenditure_{z}^{k} = \frac{n_z^k (\tilde{p}_z^k \tau_s^{kk'})^{1-\sigma_s}}{\sum_{k''} \sum_{z} n_z^{k''} (\tilde{p}_z^{k''} \tau_s^{k''k'})^{1-\sigma_s}} b_s E^k .$$

Summing all the goods in sector s and all the expenditure for countries $k \neq k'$, we can obtain the value of exports in sector s for country k,

$$Exports_s^k = \sum_{k' \neq k} \left[\sum_{z} \frac{n_z^k (\tilde{p}_z^k \tau_s^{kk'})^{1-\sigma_s}}{(G_s^{k'})^{1-\sigma_s}} \right] b_s E^{k'}$$

where $(G_s^{k'})^{1-\sigma_s} = \sum_{k''} \sum_{z} n_z^{k''} (\tilde{p}_z^{k''} \tau_s^{k''k'})^{1-\sigma_s}$.

According to the expression of exports value, the term $\sum_{z} \dfrac{n_z^k (\tilde{p}_z^k \tau_s^{kk'})^{1-\sigma_s}}{(G_s^{k'})^{1-\sigma_s}}$ can be treated as the share of country k 's expenditure on sector s in country k'. So country k 's imports value is the difference between the total expenditure on sector s and the expenditure on sector s in country k,

$$\operatorname{Im} ports_s^k = \left[1 - \sum_{z} \frac{n_z^k (\tilde{p}_z^k)^{1-\sigma_s}}{(G_s^k)^{1-\sigma_s}} \right] b_s E^k .$$

The value of net trade is generated by subtracting imports from exports,

$$T_s^k = Exports_s^k - \operatorname{Im} ports_s^k = \sum_{k' \neq k} \left[\sum_{z} \frac{n_z^k (\tilde{p}_z^k \tau_s^{kk'})^{1-\sigma_s}}{(G_s^{k'})^{1-\sigma_s}} \right] b_s E^{k'} - \left[1 - \sum_{z} \frac{n_z^k (\tilde{p}_z^k)^{1-\sigma_s}}{(G_s^k)^{1-\sigma_s}} \right] b_s E^k .$$

Normalizing the value of net trade by $b_s E^k$ and rearranging, we can rewrite the expression as

$$\text{(3)} \quad \frac{T_s^k}{b_s E^k} = \sum_{z} \frac{n_z^k}{E^k} (\tilde{p}_z^k)^{1-\sigma_s} \exp\left(\tau_s^k\right) - 1$$

where $\tau_s^k = \ln \left[\sum_{k'} \left(\dfrac{\tau_s^{kk'}}{G_s^{k'}} \right)^{1-\sigma_s} E^{k'} \right]$.

In the following derivation, we need to use some definitions and assumptions in Hallak and Schott (2011).

Definition 1 $\tilde{P}_s^k \equiv \left[\sum_z \overline{n}_z (\tilde{p}_z^k)^{1-\sigma_s}\right]^{\frac{1}{1-\sigma_s}}$ where $\overline{n}_z = \frac{1}{K}\sum_k \frac{n_z^k}{\frac{1}{Z_s}\sum_z n_z^k}$

Definition 2 $\tilde{P}_s^{kk'} = \tilde{P}_s^k / \tilde{P}_s^{k'}$

Definition 3 $P_s^k \equiv \left[\sum_z \overline{n}_z \, \xi_z^{\sigma_s - 1} (p_z^k)^{1-\sigma_s}\right]^{\frac{1}{1-\sigma_s}}$

Assumption 1 $n_z^k = \overline{n}_s^k \left(\overline{n}_z + \tilde{n}_z^k\right)$ [12]

Assumption 2 $\sum_z \tilde{n}_{\mathbf{z}}^k \left(\frac{\tilde{p}_z^k}{\tilde{P}_s^k}\right)^{1-\sigma_s} = Z_s \operatorname{cov}_s\left(\tilde{n}_{\mathbf{z}}^k, \left(\frac{\tilde{p}_z^k}{\tilde{P}_s^k}\right)^{1-\sigma_s}\right) = Z_s(\varphi_s + \mu_s^k)$

Assumption 3 $\frac{\overline{n}_s^k}{Y^k} = \left(\tilde{P}_s^k\right)^{-\eta_s}$ where $\eta_s \geq 0$

Using Assumption 1, the right hand side of Equation (3) can be rewritten as $\frac{\overline{n}_s^k}{E^k}\left(\tilde{P}_s^k\right)^{1-\sigma_s} \exp\left(\tau_s^k\right)\left[\sum_z \overline{n}_z \left(\frac{\tilde{p}_z^k}{\tilde{P}_s^k}\right)^{1-\sigma_s} + \sum_z \tilde{n}_{\mathbf{z}}^k \left(\frac{\tilde{p}_z^k}{\tilde{P}_s^k}\right)^{1-\sigma_s}\right] - 1$.

Based on Definition 1 and Assumption 2, the above expression turns into $\frac{\overline{n}_s^k}{Y^k}\frac{Y^k}{E^k}\left(\tilde{P}_s^k\right)^{1-\sigma_s} \exp\left(\tau_s^k\right)\left[1 + Z_s(\varphi_s + \mu_s^k)\right] - 1$.

Using Assumption 3 and the fact that $\frac{Y^k}{E^k} = 1 + \frac{T^k}{E^k}$, Equation (3) could be rewritten as

(4) $$1 + \frac{T_s^k}{b_s E^k} = \left(\tilde{P}_s^k\right)^{1-\sigma_s - \eta_s}\left(1 + \frac{T^k}{E^k}\right)\exp\left(\tau_s^k\right)\left[1 + Z_s(\varphi_s + \mu_s^k)\right].$$

[12] $\sum_z \tilde{n}_z^k = 0$ and $\overline{n}_s^k = \frac{1}{Z_s}\sum_z n_z^k$.

Taking natural logarithms on both sides and using $\ln(1+x) \approx x$, we can express Equation as

(5) $$\frac{T_s^k - b_s T^k}{E^k} = \Upsilon_s + \gamma_s \ln \tilde{P}_s^k + b_s \tau_s^k + \iota_s^k$$

where $\Upsilon_s = b_s Z_s \varphi_s$, $\gamma_s = b_s(1-\sigma_s - \eta_s)$ and $\iota_s^k = b_s Z_s \mu_s^k$.

Using Definition 1, 2 and 3 as well as the facts that $\tilde{p}_z^k = \dfrac{p_z^k}{\xi_z (\lambda_s^k)^{m_s}}$, $P_s^{ko} = P_s^k / P_s^o$ and $\lambda_{st}^{ko} = \lambda_{st}^k / \lambda_{st}^o$,

we can show that $\ln \tilde{P}_s^{kk'} = \ln \tilde{P}_s^k - \ln \tilde{P}_s^{k'}$ and $P_s^{kk'} = \left(\lambda_s^{kk'}\right)^{m_s} \tilde{P}_s^{kk'}$.

Substituting the expressions above into Equation (5) and adding time t to the equation, we can get the relationship between the value of net trade and quality and price using the numeraire country as the baseline,

$$\tilde{T}_{st}^k = \Upsilon'_{st} + \rho_s \ln \lambda_{st}^{ko} + \gamma_s \ln P_{st}^{ko} + \iota_{st}^k$$

where $\tilde{T}_{st}^k = \dfrac{T_{st}^k - b_s T_t^k}{E_t^k} - b_s \tau_{st}^k$, $\Upsilon'_{st} = \Upsilon_{st} + \gamma_s \ln \tilde{P}_{st}^o$ and $\rho_s = -\gamma_s m_s$.