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The Effect of Product Quality on Net Trade in the Manufacturing Sector: Contrasts between Developed and Developing Countries

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Abstract

This paper determines and compares the effects of product quality on the value of net trade in the manufacturing sector of developed and developing countries. By incorporating the intensity of consumers' preferences for quality, we identify quality impacts on net trade. We estimate the quality effects for 25 developed countries and 17 developing countries from 1989 to 2010. We conclude that product quality is positively related to net trade, and developed countries experience a higher quality effect. The variation of GDP per capita and average number of product varieties in the manufacturing sector could explain the different quality effects across country types.

JEL Classification: F14

Keywords: developed and developing countries, manufacturing, net trade, product quality

1. Introduction

Manufacturing has emerged as an important sector of trade for almost all countries. Most developed countries have experienced increases in manufacturing exports as a share of GDP during the past 30 years. For the OECD countries overall, the manufacturing export share of GDP rose at an annual

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rate of 1.4% between 1970 and 1998 (Bergoeing, Kehoe, Strauss-Kahn, & Yi, 2004). For the 42 top exporting countries in the manufacturing sector in terms of dollars, manufacturing accounts for more than 65% of merchandise exports in developing countries (Hanson & Robertson, 2008). The average value of net trade for developed countries was $26 billion and $19.7 billion for developing countries in 2010.

The quality of manufacturing products exported often differs by country. Hallak and Schott (2011) and Feenstra and Romalis (2012) quantify the quality of manufacturing products from a wide range of countries and conclude that developed countries produce higher quality products on average. Schott (2004) and Grossman and Helpman (1991) find that product quality increases most often in developed countries with a comparative advantage in endowment of physical and human capital.

Previous studies show a significant relationship between product quality and trade. 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 more with one another. 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.

Additionally, the roles of product quality in trade may differ 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 of developed and developing countries differ greatly. However, none of these studies focus on the effects of product quality on net trade or compare quality effects between developed and developing countries.

The objective of this paper is to quantify the impact of the quality of manufacturing products produced in a country on its value of net trade allowing for the intensities of consumers' preferences for quality to vary across sectors and countries. We also aim to analyze how product quality affects developed and developing countries' net trade differently and identify possible reasons for the differences.

We develop a model which captures the relationship between net trade and the quality of manufacturing products. 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 manufacturing good (Hallak & Schott, 2011). We incorporate the intensity of consumers' preferences for quality in the theoretical model of Hallak and Schott (2011).[1] This intensity measure captures how much quality matters to consumers for the goods within a sector produced in a country, which may vary across sectors and countries. Including the intensity of preferences for quality makes the theoretical model more general and permits the impacts of quality and price on net trade to vary. Also, it allows us to distinguish the different quality effects among countries.

We find that 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 for the manufacturing goods. The different levels of GDP per capita and numbers of product varieties within the manufacturing sector of developed and developing countries may explain why the quality effects differ. GDP per capita has a positive impact on the quality effect for developed countries,

[1] We assume consumers in the world market are price-takers and concentrate on the demand side in trade activity. This is a common practice in the literature, such as Hallak and Schott (2011) and Hallak (2006).

and variety within the manufacturing sector negatively affects the quality effect for developed and developing countries.

2. Method

To determine the value of net trade for each sector in each country we solve a representative consumer's problem with a utility function that incorporates consumer preferences towards quality and variety for a product, as in Hallak and Schott (2011). The consumer chooses the quantity to maximize the total utility U, represented by a Cobb-Douglas function. The utility from a sector takes a constant elasticity of substitution form,

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

Sectors are indexed by s, and the parameter b_s is the share of a sector in total expenditure.[2] We index countries by k, and products in a sector by z. Here, ξ_z represents the intensity of consumer preferences for varieties within a product and λ_s^k denotes quality. We assume that ξ_z varies by products but remains constant across countries, and λ_s^k varies across countries and sectors but is constant for different products in a sector. We define m_s^k 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. This two-tier utility function represents the consumer's preference for the quantity, quality, and variety of a product in all sectors of all countries. We use u_s to denote the preference for the product in a sector from all countries, and aggregate the utilities of all sectors to obtain total utility.

Our model builds on Hallak and Schott (2011) by incorporating the intensity of consumer preferences on quality. We include m_s^k which captures how much consumers care about the quality of the products in a sector from a country. It varies across sectors and countries. For example, m_s^k may be larger for food than clothing if consumers care more about the quality of food than they care about quality for clothing. The intensity of quality may be higher for goods produced in developed countries if consumers value the quality of products from developed countries more. Including the intensity of preferences for quality allows us to identify the effects of product quality and export price on the value of net trade and distinguish the different quality effects among countries.[3]

Given the export price of each product from each country, p_z^k, and the 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 the utility

[2] 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.

[3] The derivation of the relationship between net trade and product quality is shown in the Appendix.

maximization problem in Equation (1), we show that quantity per variety depends on the term $\frac{p_z^k}{\xi_z(\lambda_s^k)^{m_s^k}}$, which could be interpreted as quality-adjusted price, and country k 's expenditure on each product. 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,

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

where $\tilde{T}_{st}^k$ is the normalized value of net trade.[4] Here, Υ'_{st} is a constant term, λ_{st}^{ko} is country k 's product quality relative to the numeraire country ($\lambda_{st}^{ko} = \lambda_{st}^k / \lambda_{st}^o$), and P_{st}^{ko} is country k 's aggregate export price relative to the numeraire country ($P_{st}^{ko} = P_{st}^k / P_{st}^o$). The coefficients ρ_s^k and γ_s represent the effects of quality and aggregate export price on the value of net trade, respectively. We define ι_{st}^k as the error term which captures estimation errors of product quality and aggregate export price and the idiosyncratic component of the covariance (μ_{st}^k).

The quality effect, ρ_s^k, 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^k based on the derivation,

$$\rho_s^k = -\gamma_s m_s^k. \quad (3)$$

Intuitively, product quality affects net trade by influencing price and consumers' preferences towards quality. A higher 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.

In order to investigate what drives different quality effects on net trade for different countries as measured by ρ_s^k in Equation (2), we postulate a relationship between the intensity of preferences for quality and GDP per capita and average number of varieties within a sector,

$$m_s^k = \omega_{0s}^k + \omega_{1s} \ln y_t^{ko} + \omega_{2s} \ln \overline{n}_{st}^{ko}, \quad (4)$$

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

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 affects belief formation through inferences made by consumers. Underwriters Laboratories

[4] The normalized value of net trade has the expression as $\tilde{T}_{st}^k = \frac{T_{st}^k - b_s T_t^k}{E_t^k} - b_s \tau_{st}^k$, where $T_{st}^k = Exports_{st}^k - Imports_{st}^k$, $T_t^k = Exports_t^k - Imports_t^k$, $E_t^k = GDP_t^k - T_t^k$, and τ_{st}^k is the summary measure of trade barriers.

[UL] (2012), 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 (1990) 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 often produce higher quality manufacturing goods than developing countries.

The intensity of preferences on quality positively correlates with the average number of varieties based on the assumption that number of varieties negatively relates to quality-adjusted price (Romalis, 2004; Bernard, Redding, & Schott, 2007).[5] A positive correlation might occur if a larger number of varieties signal higher quality.

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

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

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^k is a constant and δ_{st}^{ko} is the error term which captures random error.

The coefficients θ_s and ς_s for developed and developing countries are identified separately in Equation (6) after substituting the quality effect given in Equation (5) into Equation (2),

$$\tilde{T}_{st}^k = (\Upsilon'_{st} + \upsilon_s \ln \lambda_{st}^{ko}) + \theta_s (\ln y_t^{ko} \ln \lambda_{st}^{ko}) + \varsigma_s (\ln \overline{n}_{st}^{ko} \ln \lambda_{st}^{ko}) + \gamma_s \ln P_{st}^{ko} + (\iota_{st}^k + \delta_{st}^{ko} \ln \lambda_{st}^{ko}), \quad (6)$$

where $\Upsilon'_{st} + \upsilon_s \ln \lambda_{st}^{ko}$ is the intercept and $\iota_{st}^k + \delta_{st}^{ko} \ln \lambda_{st}^{ko}$ represents the random error term.

We use manufacturing industry data for bilateral trade among 42 exporting countries from 1989 to 2010. Among all the exporters, we include 25 developed countries and 17 developing countries.[6] 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.[7] 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

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

[6] 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.

[7] We include 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.

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).

In order to accurately capture the effect of quality on net trade, a direct measure of quality for manufacturing goods is important. Using observed export prices (unit values) is unsatisfactory as they may systematically vary for numerous reasons including consumer preferences or manufacturing costs. Khandelwal (2010) finds that products with large variation in prices could nonetheless possess little differences in quality.

We use the direct measure of manufacturing product quality developed by Hallak and Schott (2011). We generate the product quality variable based on a linear path for the evolution of product quality,

$$\ln \lambda_{st}^{ko} = \alpha_{os}^{ko} + \alpha_{1s}^{ko} t + \varepsilon_{st}^{ko}, \tag{7}$$

and solve the country fixed effect, α_{os}^{ko} and the slope of the time trend, α_{1s}^{ko} in a consumer's problem given global market. We use the 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.[8]

We use the approach for estimation of the aggregate export price and trade barriers in Hallak and Schott (2011). They show that the aggregate export price is bounded by the Paasche and Laspeyres indexes: $\ln H_s^{kk'} \le \ln P_s^{kk'} \le \ln L_s^{kk'}$, and using U.S. imports data, $\ln P_s^{ko}$ for each year 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, Romalis, and Schott (2002). We extend that 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 equals the ratio of the difference between c.i.f. and f.o.b. values and f.o.b. value. After estimating c_{st} and e_{st} using the relationship that $\ln a_{zt}^{ko} = c_{st} \ln D^{ko} + e_{st} X^{ko} + \varepsilon_{zt}^{ko}$, we can obtain $a_{st}^{kk'}$ by computing $\exp(\hat{c}_{st} \ln D^{kk'} + \hat{e}_{st} X^{kk'})$. Here, $\ln D^{ko}$ 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 (MFN) tariff rates and preferential (PRF)

[8] Hallak and Schott (2011) estimate the country fixed effect and the slope of the time trend using the relationship between net trade and product quality. We use this quantified quality directly by assuming quality is a fixed characteristic of each country with a fixed time trend.

tariff rates, we obtain the final bilateral trade costs represented by $\tau_s^{kk'}$. Considering that $\tau_s^k = \ln\left[\sum_{k'}\left(\frac{\tau_s^{kk'}}{G_s^{k'}}\right)^{1-\sigma_s} E^{k'}\right]$ and $(G_s^{k'})^{1-\sigma_s} = \sum_{k''}\sum_z n_z^{k''}(\tilde{p}_z^{k''}\tau_s^{k''k'})^{1-\sigma_s}$ from the Appendix, we need to compute the term $\sum_z n_z^{k''}(\tilde{p}_z^{k''})^{1-\sigma_s}$ to determine 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 $\ln \overline{n}_{st}^{ko} = \ln GDP_t^{ko} - \eta_s(\ln P_{st}^{ko} - m_s^k \ln \lambda_{st}^{ko})$.[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.

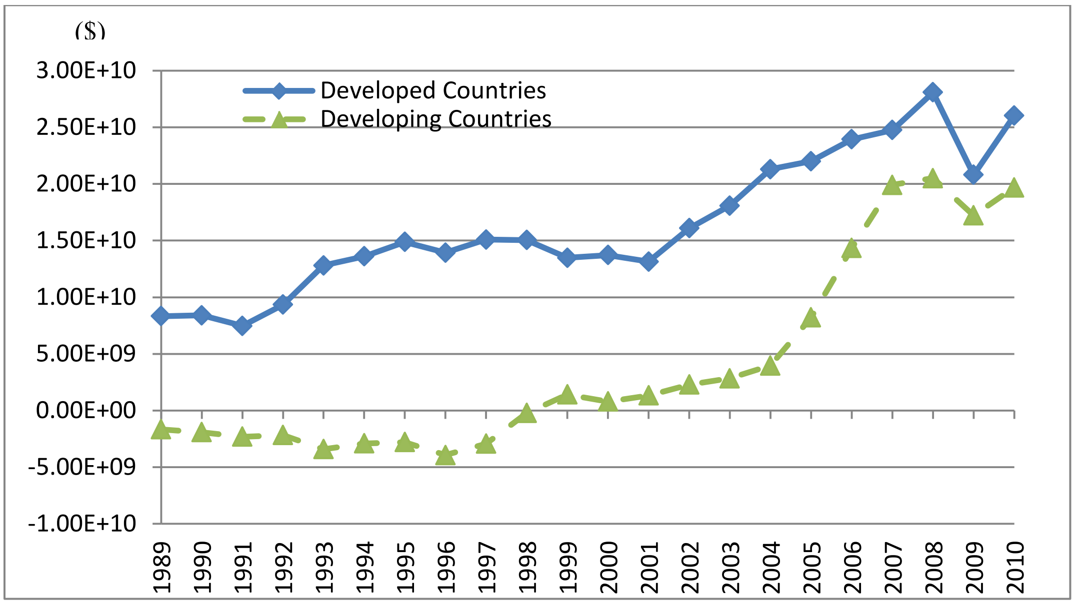

Figure 1. Average manufacturing net trade for developed and developing countries, 1989-2010

Figure 1 shows the increasing trends of average value of manufacturing net trade for these 42 developed and developing countries, and how countries are closing the value gap. 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 manufacturing sector for developed and developing countries. The average values of all variables are higher for developed countries than developing countries. If we treat the average values of developed and developing countries as two

[9] The parameter η_s is computed based on this equation $\gamma_s = b_s(1-\sigma_s-\eta_s)$ which is shown in the Appendix. Given that $\gamma_s = -0.154$, $m_s^k = 1.114$, 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 a serious multicollinearity problem.

data points, we 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 means of quality and price are very similar for both developed and developing countries.

Table 1. Descriptive statistics for developed and developing countries

Variable	Country Type	Mean	Min	Max	Standard Deviation
Normalized value of net trade[10]	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.

3. Results

The effect of quality on the value of net trade, ρ_s^k in Equation (2) is of particular interest. However, endogeneity issues may exist. First, the aggregate export price may correlate 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 value of net trade contains the quantity demanded. We test for endogeneity using the Hausman test, reject the null hypothesis of no identification problem at the one percent significance level using the data of developed countries. However, 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 with aggregate export price, since macroeconomic conditions determine it. 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 error term.[11]

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

[11] Hallak and Schott (2011) use the exchange rate as the instrument variable for endogenous export price. We test the relevance of this instrument variable, and the F-statistic is greater than 10, which indicates that the exchange rate represents a strong instrument.

Table 2 contains estimates of the effects of quality on the value of net trade in Equation (2) using separate developed and developing countries samples. Based on the 2SLS results, we find positive coefficients on product quality for developed and developing countries significantly different from zero at the one percent level. Developed countries have a coefficient on quality with an order of magnitude higher than developing countries. The coefficient on the 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 and insignificant.

Table 2. The effect of product quality and export price on net trade

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

Notes: Robust standard errors with significance levels: ***0.01; **0.05; *0.10. Standard errors are shown in parentheses.

The OLS estimates result in a coefficient on quality produced by developed countries much larger than the 2SLS results, 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 in the manufacturing sector. 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 increase 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. Therefore, we observe an elastic price elasticity of demand for developed countries, while it is inelastic for developing countries. It might be the case that the prices of developing countries products are too low to generate a large impact on demand with a small price change.

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

$$\tilde{T}_{st}^{k} = \Upsilon'_{st} + \rho_s^k \ln \lambda_{st}^{ko} + \gamma_s \ln P_{st}^{ko} + \beta_s^k d \ln \lambda_{st}^{ko} + \iota_{st}^k, \tag{8}$$

where β_s^k is the parameter for estimation and d is a dummy variable that equals one for a developed country and zero otherwise. We estimate Equation (8) using the real exchange rate as an instrumental variable for aggregate export price.

We report the results comparing the quality effects between developed and developing countries from Equation (8) 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. The 2SLS estimate is almost as twice 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 in the manufacturing sector. 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 3. Comparing the quality effect between developed and developing countries

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

Notes: Robust standard errors with significance levels: ***0.01; **0.05; *0.10. Standard errors are shown in parentheses.

Table 4 summarizes the results of estimating the factors that explain the different product quality effects on net trade for developed and developing countries in the manufacturing sector given in Equation (6). The estimate of the coefficient of GDP per capita has the expected sign and is statistically significant for developed countries but not for developing countries. The coefficients on the 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 quality effects similar to those shown in Table 2.

Table 4. Factors that impact the quality effect on net trade

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

Notes: Robust standard errors with significance levels: ***0.01; **0.05; *0.10. Standard errors are shown in parentheses.

Consumers prefer the manufacturing 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 have greater confidence in their product quality.

The negative relationship between product variety within the manufacturing sector and the quality effect indicates that net trade would increase less given the same increase of quality when variety increases. Variety's negative effect on the intensity of preferences towards quality for developed countries might occur if offering too many varieties overwhelms consumers and reduces purchasing. Previous literature (Dhar, 1996, 1997; Iyengar & Lepper, 2000; Schwartz, 2004) has raised doubts about the wisdom of offering consumers many options to choose from as consumers may become indecisive and make no purchase. For developing countries, a larger number of varieties may signal higher quality and variety might act as a complement to the relatively lower product quality. Thus, variety may have a positive impact on the intensity of preferences for quality.

We provide three sensitivity analyses to verify the robustness of these results to changes of countries in the sample, functional form, and measure of quality. First, we obtain similar estimates after selectively removing each country from the estimation. This implies that no single country significantly impacts the results.

Second, we check the validity of the functional form of Equation (2) by incorporating three different terms: the squares of quality and export price, and the interaction of quality and export price. Table 5 contains the 2SLS results. 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 does not differ much.

Table 5. 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

Notes: Robust standard errors with significance levels: ***0.01; **0.05; *0.10. Standard errors are shown in parentheses.

Table 6. Quality effect comparisons between countries using quality measures from HS and FR

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

Notes: This paper use the product quality estimated by HS (Hallak & Schott, 2011). We use the quality estimated by FR (Feenstra & Romalis, 2012) as a robustness check. Robust standard errors with significance levels: ***0.01; **0.05; *0.10. Standard errors are shown in parentheses.

Third, we replicate the estimation of Equation (8) using a different measure of manufacturing good quality in Feenstra and Romalis (2012). They let firms choose price and quality simultaneously and estimate quality in an extended monopolistic competition framework. We use three years of their quality estimates. Table 6 reports the comparison of the results using the different quality measures. [12] 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 occur because of the small sample size available using the quality estimated by Feenstra and Romalis (2012).

4. Discussion

We estimate the effect of product quality on the value of net trade and compare the quality effects between developed and developing countries in the manufacturing sector. We 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 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 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/or 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' confidence in their products.

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Appendix

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

Consider the representative consumer's problem,

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

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

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):

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

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

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

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

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

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 becomes

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

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

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

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

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

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,

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

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

According to the expression of exports value, the term $\sum_z \frac{n_z^k\left(\tilde{p}_z^k \tau_s^{kk'}\right)^{1-\sigma_s}}{\left(G_s^{k'}\right)^{1-\sigma_s}}$ 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,

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

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

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

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

$$\frac{T_s^k}{b_s E^k} = \sum_z \frac{n_z^k}{E^k}\left(\tilde{p}_z^k\right)^{1-\sigma_s} \exp\left(\tau_s^k\right) - 1 \tag{A1}$$

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

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

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

Assumption 1 $n_z^k = \overline{n}_s^k \left(\overline{n}_z + \tilde{n}_z^k \right)$ [13]

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

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 (A1) can be rewritten as $\frac{\overline{n}_s^k}{E^k} \left(\tilde{P}_s^k \right)^{1-\sigma_s} \exp\left(\tau_s^k \right) \left[\sum_z \overline{n}_z \left(\frac{\tilde{p}_z^k}{\tilde{P}_s^k} \right)^{1-\sigma_s} + \sum_z \tilde{n}_z^k \left(\frac{\tilde{p}_z^k}{\tilde{P}_s^k} \right)^{1-\sigma_s} \right] - 1$.

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

Using Assumption 3 and the fact that $\frac{Y^k}{E^k} = 1 + \frac{T^k}{E^k}$, Equation (A1) could be rewritten as

$$1 + \frac{T_s^k}{b_s E^k} = \left(\tilde{P}_s^k \right)^{1-\sigma_s-\eta_s} \left(1 + \frac{T^k}{E^k} \right) \exp\left(\tau_s^k \right) \left[1 + Z_s \left(\varphi_s + \mu_s^k \right) \right]. \tag{A2}$$

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

$$\frac{T_s^k - b_s T^k}{E^k} = \Upsilon_s + \gamma_s \ln \tilde{P}_s^k + b_s \tau_s^k + \iota_s^k \tag{A3}$$

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

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

Using Definition 1, 2 and 3 as well as the facts that $\tilde{p}_z^k = \dfrac{p_z^k}{\xi_z \left(\lambda_s^k\right)^{m_s^k}}$, $P_s^{ko} = P_s^k / P_s^o$ and $\lambda_{st}^{ko} = \lambda_{st}^k / \lambda_{st}^o$, we can show that $\ln \tilde{P}_s^{ko} = \ln \tilde{P}_s^k - \ln \tilde{P}_s^o$ and $\ln \tilde{P}_s^{ko} = \ln P_s^{ko} - \ln\left(\left(\lambda_s^{ko}\right)^{m_s^k} \left(\lambda_s^o\right)^{m_s^k - m_s^o} \right)$. Since what we need is the relative quality to the numeraire country, we normalize λ_s^o to one.

Substituting the expressions above into Equation (A3) and adding time t to the equation, we get the relationship between the value of net trade and quality and price using the numeraire country as the baseline,

$$\tilde{T}_{st}^k = \Upsilon'_{st} + \rho_s^k \ln \lambda_{st}^{ko} + \gamma_s \ln P_{st}^{ko} + \iota_{st}^k \tag{A4}$$

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 $\rho_s^k = -\gamma_s m_s^k$.